EXPLORING APPROACHES TO RESEARCH IN THE ANIMAL SCIENCES IN VIETNAM

A workshop held in the city of Hue, Vietnam
31 July–3 August, 1995

Editor: **W.J. Pryor**

Workshop Steering Committee:

Mr John Perkins, (Convener), Australia
Ms Tran Thi Dan, Ho-Chi-Minh City, Vietnam
Dr Nguyen Kim Duong, Hue, Vietnam
Professor Luu Trong Hieu, Ho-Chi-Minh City, Vietnam
Dr Le Viet Ly, Hanoi, Vietnam
Mr Le Duc Ngoan, Hue, Vietnam
Professor Bill Pryor, ACIAR, Australia
Ms Kim Taylor, ACIAR, Australia

The Australian Centre for International Agricultural Research (ACIAR) was established in June 1982 by an Act of the Australian Parliament. Its mandate is to help identify agricultural problems in developing countries and to commission collaborative research between Australian and developing country researchers in fields where Australia has special research competence.

Where trade names are used this constitutes neither endorsement of, nor discrimination against, any product by the Centre.

ACIAR PROCEEDINGS

This series of publications includes the full proceedings of research workshops or symposia organised or supported by ACIAR. Numbers in this series are distributed internationally to selected individuals and scientific institutions.

Pryor, W.J. ed., 1996. Exploring Approaches to Research in the Animal Sciences in Vietnam: A workshop held in the city of Hue, Vietnam, 31 July–3 August, 1995. ACIAR Proceedings No. 68, 216 p.

ISBN 1 86320 173 4

Typesetting and layout by Scribbly Gum Publications Pty Ltd, Canberra

Printed by: Pirie Printers Pty Ltd, Canberra

Contents

Editor's Foreword 6

Foreword 7

Map showing Agroecological Zones of Vietnam 8

Workshop Conclusions 9

Background **13**

A review of animal science research in Vietnam 15
Le Viet Ly

Animal husbandry advances which contributed to major livestock development in Vietnam 21
Tran The Thong

Approaches to Research **25**

A scoring system for assessing research priorities 26
N.J. Sturgess

A glass of milk and an egg a day...for every child in Vietnam 30
J.A. Gartner

Farming systems research: a brief review and example 36
R.J. Petheram

Overviews of the Major Farm Animal Species in Vietnam **45**

Some results of study of beef and dairy cattle in Vietnam 46
Nguyen Van Thuong

Development of poultry production in Vietnam 50
Duong Thanh Liem

Research work on pig production in the Mekong Delta 52
Tran The Thong, Le Thanh Hai and Vo Ai Quac

Animal health improvement: a high priority for livestock development 57
Nguyen Tien Dzung

Research and development of the goat in Vietnam 60
Dinh Van Binh, Nguyen Quang Suc and Le Viet Ly

Short Papers—Species and Disciplines **63**

Improved tropical dairy production 64
G..I. Alexander and M..J. Tierney

Dairy cattle production on small farms in Cu Chi District, HCMC 68
Huynh Ngoc Dien

Dairy cattle production in southern Vietnam 69
Le Viet Anh

Achievable production targets for intensive pig production 71
P.E. Hughes

Factors effecting farrowing rate and birth litter size in piggeries in southern Vietnam and Queensland 76
T.T. Dan and P.M. Summers

Local feed resources in smallholder pig development in central Vietnam 82
Le Duc Ngoan, Nguyen Kim Duaong, Nguyen Thi Loc and Du Thanh Hang

Improvement of productivity and meat quality of pigs in the Red River Delta region by crossbreeding 86
Nguyen Thien, Phung Thi Van, Pham Nhat Le, Pham Huu Doanh, Nguyen Nghi, Nguyen Khanh Quac and Vo Trong Hot

Management and productivity of cattle and buffalo: a case study from Phuoc Thanh Village, Saigon River Delta 90
Le Dang Danh, Chau Chau Hoang, Nguyen Kim Cuong, Pham Trong Nghia, Tran Van Chinh Nguyen Van Phat and John Perkins

Cattle production in central Vietnam 94
Nguyen Kim Duong, Nguyen Xuan Ba and Hoang Manh Quan

Adequacy of pig diets in the Red River Delta 97
Vu Duy Giang and Nguyen Trong Tien

Proportion of ingredients and nutrient levels in the rations of dairy cows in the Red River Delta 98
Vu Duy Giang and Nguyen Trong Tien

Research on the nutrition of large ruminants in Indonesia: a case study 103
E. Teleni

Control of fasciolosis in cattle and buffalo 104
Bruce Copeman

Studies on buffaloes in the Mekong Delta of Vietnam 105
N. V. Thu, N.T.K. Dong, T.R. Preston and R.A. Pearson

Livestock viruses and germplasm transfer 110
G.I. Alexander and T.D. St George

Family of Tabanidae in North Vietnam 113
Phan Dich Lan

The result of multiple ovulation/embryo transfer (MOET) in cattle 114
Hoang Kim Giao, Nguyen Duc Thac, Nguyen Thanh Duong, Do Kim Tuyen, Luu Cong Khanh, Nguyen Van Ly and Nguyen Thi Thoa

Applications of molecular genetic technologies in livestock improvement 115
D.J.S. Hetzel and S.S. Moore

Determining the estimated breeding value (EBV) in pig herds in Vietnam 120
Nguyen Van Thien, Tran The Thong, Nguyen Thien, Dinh Hong Luan, Le Thanh Hai, Dang Vu Binh, Nguyen Que Coi, Tran Kim Anh, Vo Hong Hanh, Vo Van Su, Ta Bich Duyen and Nguyen Minh Tam

Pig breeding in central Vietnam and its improvement 123
Hoang Nghia Duyet and Nguyen Kim Duong

Design of structured livestock breeding programs 127
Scott Newman and Gerard Davis

Production and poultry health—a case study, China 1983–1995 132
Trevor J. Bagust

Breeds and feed components in the cost structure of meat-line and egg-line chickens 137
Lo A. Cau

Economic efficiency of duck raising in the Mekong River Delta 138
Nguyen The Bin

Studies on performance of CV Super-M duck breed in the southern provinces of Vietnam 142
Duong Xuan Tuyen and Nguyen Cong Quoc

Growth and Meat Performance of CV Super-M ducks under two management systems in the Red River Delta 146
Luong Tat Nho, Hoang Van Tieu, Dang Thi Dung, Le Xuan Tho, Doan Van Xuan and Nguyen Duc Trong

By-products from food industries: processing and utilisation for animal feed in Vietnam 149
Le Van Lien, Nguyen Thien and Le Viet Ly

Aflatoxin in animal feeds and its influence on poultry production in Vietnam 153
Duong Thanh Liem and Le Anh Phung

Short Papers -Systems, Economics and Management **157**

Action and consequence: sensible economics for rational researchers 159
John Perkins

Buffalo Rearing in a northern mountainous village, Vietnam 163
Mai Van Sanh, Nguyen Duc Thac, Dao Lan Nhi and R.J. Petheram

Farming systems of Thai My village, Saigon River Delta with special emphasis on the role of cattle and buffalo 167
Chau Chau Hoang and John Perkins

Development of dairying in Ho-Chi-Minh City—economic aspects in production and consumption 172
Nguyen The Bin and Luong Van Tac

Helping to improve pig production in Vietnam 176
D.N. Singh, C.P. McPhee and J.S. Kopinski

Effects of transport and stunning on the quality of pork 182
Nguyen Ngoc Tuan, Dang Quan Dien and Luu Trong Hieu

Social features and the development of swine production in Vietnam 186
Le Thanh Hai

Customers for animal science research in Vietnam: what do they need? 190
Chris Landon-Lane, Nguyen Ngoc Kinh, Nguyen Dinh Hung and Buy Khanh Ban

Livestock development in relation to the territorial structure of the South-eastern Zone 195
Tong Quang Minh

Cattle production and research in the central region of Vietnam 200
Vu Van Noi and Le Viet Ly

Development of farming systems on high land based on livestock raising combined credit programs 203
Duong Duy Dong and Luu Trong Hieu

A profile of a cattle rearing domain in the Red River Delta 207
Vu Chi Cuong, Le Viet Ly, Vu Van Noi and R.J. Petheram

Research priorities for improving animal production in the Mekong Delta of Vietnam 213
Chau Ba Loc, Vo Van Son and Truong Chi Son

Editor's Foreword

The preparation of these Proceedings has been a process involving some special problems and all authors are thanked for their cooperation. Seventy-five per cent of the papers were contributed by Vietnamese scientists in the English language, a tongue which for many is most difficult and often a third or fourth language. The task of rendering the submitted contributions into conventional English, ensuring that precise meaning was maintained, may have resulted in some loss of nuances of language. I would like to thank the Vietnamese contributors in particular for their ready cooperation since the workshop as we together endeavoured to obtain their desired meaning in English in their papers. Where this may not have been totally achieved, readers are cordially invited to communicate directly with the authors at the addresses included in the publication.

In this major re-drafting process, assistance was provided by colleagues in three specialist areas. I wish to extend thanks and acknowledge expertise provided by the following:

Dr Paul Ferrar, ACIAR, Canberra, (Entomology);
Professor Ross Humphreys, Brisbane (Agronomy); and
Mrs Ann Pryor, (English as a Second Language).

W.J. Pryor
Editor

Foreword

Vietnam has experienced enormous changes since 1990. The policy of doi moi (or liberalisation) brought a relaxation in many policies, including a shift towards a market-based economy and the injection of international funds through loans, grants and direct investment. The country has sprung to the forefront as Asia's most rapidly-growing economy.

Change and growth are most visible in the cities but the sense of urgency and excitement has permeated through to the rural areas and those institutes involved in agricultural research, education and communication.

Scientific research centres became isolated during the 1980s. Funding was minimal and professional contacts—largely restricted to the former USSR and Eastern bloc countries—had withered. The new inflow of ideas, possibilities and funding brought very positive responses from researchers throughout Vietnam. Everyone is keen to participate but the question remains one of choice, 'What types of research in the agricultural sector of Vietnam will provide the greatest benefits to all participants?'

A similar question confronted ACIAR, which had inaugurated some collaborative research programs in the country. One such project (Management of Village Cattle and Buffalo) included a proposal for a small workshop to review the final stages and make recommendations for the direction of future research. Dr Denis Hoffmann (Manager, ACIAR Animal Sciences Program 2) suggested that the proposal be expanded to cover all the major animal species and related disciplines. This workshop is the result.

It proved an extremely popular forum. Original plans were based on an estimate of 30–40 participants. In the event, more than 65 delegates registered from Vietnam and 20 from Australia. More than 50 papers and presentations were given, plus eighteen hours of discussion in both large and specialist groups.

Professor Vo Hung (Rector, Hue Agricultural University) welcomed delegates to the opening session. His presentation was echoed with contributions from Professor Bill Pryor (ACIAR), Professor Nguyen Ngoc Kinh, (Director, Department of Science and Technology, Ministry of Agriculture and Food Industries) and Dr Luu Trong Hieu, (Director of International Programs, University of Agriculture and Forestry, HCMC). Professor Boris Schedvin (Deputy Vice-Chancellor —Academic, University of Melbourne) led the closing ceremony, with Dr Le Viet Ly, Ms Tran Thi Dan, Dr Peter Young and John Perkins. Limits on space preclude reproduction of these speeches but all are thanked for their thoughtful comments.

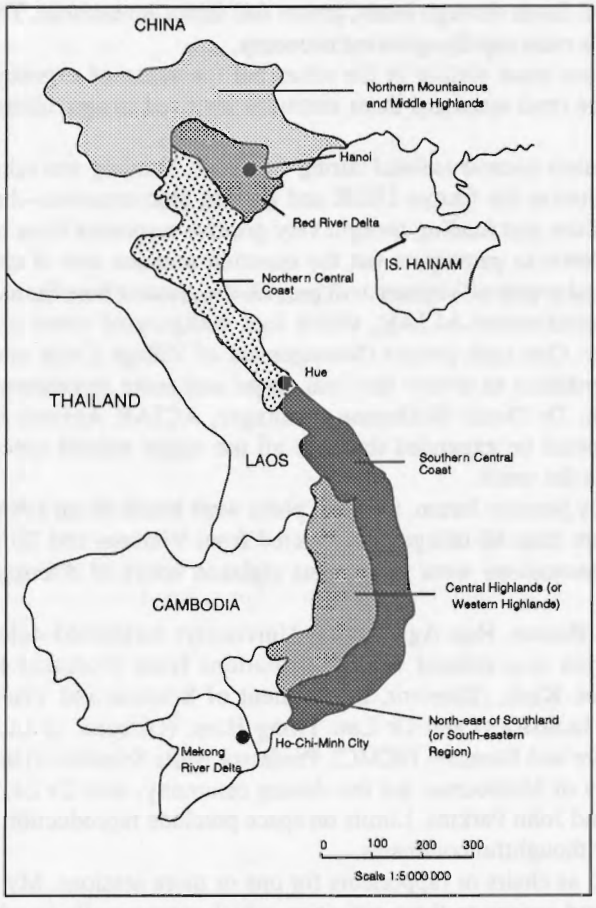
Many delegates acted as chairs or rapporteurs for one or more sessions. My thanks go to all those who contributed time and energy to these activities, which were usually in addition to presenting a paper and contributing to the discussions. The Workshop Steering Committee deserves particular mention. It first met in May 1995 and had delivered a large international meeting by the end of July—congratulations to all those who worked so hard and to such good effect:

Many other people contributed throughout. Special mention must be made of the great logistical support received from staff of the Hue Agricultural University including transport arrangements, secretarial assistance and an audio-visual crew. Mrs Ann Pryor typed and assisted the Editor in the preparation of the pre-conference publication, 'Program and Abstracts'; the Editor deserves further mention for his great efforts in editing the final publication, these Proceedings.

Finally, grateful thanks are due to ACIAR for its generous sponsorship of the Workshop. It was a pleasure to welcome the thoughtful participation of Dr Peter Young, Acting Coordinator, Animal Sciences Program 2, and acknowledge the consistent strong backing received from Dr Denis Hoffmann.

John Perkins
Convener,
Workshop Steering Committee

Map showing the seven* agro-ecological zones of Vietnam.



* Some authorities have described eight such zones where the Midland and Mountainous region of this map has been divided.

Common Abbreviations used in this Proceedings

HCMC	Ho-Chi-Minh City
VND	Vietnamese Dong, (1 Australian Dollar = 8000 VND)

Workshop Conclusions

Recommendations: Research Areas of Greatest Impact

To identify preferred research areas in the animal sciences and enable such recommendations to be made, three general aims were kept in mind throughout the planning of this workshop. They were to:

- provide an opportunity for policy-makers, researchers and administrators to discuss and debate future approaches and directions for research in the animal sciences in Vietnam;
- develop a set of major goals for animal science research—with an attendant rationale for the choices—that spans the next ten years; and
- provide guidance to the major national and international participants in animal science research working in Vietnam.

Two important points must be made. First, it is acknowledged that the **ranking** of priorities for research in the animal sciences belongs with the Government of the Socialist Republic of Vietnam and its agencies. No attempt has been made to provide any such ranking, rather a formal framework for assessing priorities was suggested. Secondly, putting nearly one hundred researchers, educators and senior administrators in close proximity for four days produces an exponential growth of opinions, ideas and directions. Any final distillation of recommendations must inevitably be partial and incomplete. No final consensus was reached but the points below represent important and recurrent themes.

Guiding Principles

- A general statement for directing research strategies was formulated by delegates from Vietnam and accepted by most participants:

  > *'Research should concentrate on goals which improve the well-being of farming families in Vietnam and the development of sustainable systems.'*

- Strategies should be directed towards the development of **applied rather than basic research.** Needs are immediate: the costs of developing infrastructure to support basic research are enormous, given the current resource base; and a large and appropriate inventory of technologies and techniques already exists for testing within Vietnam's physical, social and economic environments.
- **Intensification will be an increasingly common characteristic** of all farming systems within Vietnam, including the animal production components. This will have significant implications for research, particularly health, nutrition and management.
- Institutes should consider offering **a greater number of small specific research projects for possible funding** under collaborative bilateral or multilateral arrangements. This will give funding agencies greater scope and flexibility to use their limited resources, particularly when many research projects are of value only to particular regions, disciplines or species.

Evaluation of Research Priorities

- An important paper from Neil Sturgess, supplemented with a seminar, outlined the benefits of **adopting a formal methodology for assessing priorities and evaluating proposals to conduct research**. The value of such a methodology was highlighted by the problems faced at the end of the workshop, when delegates met considerable difficulty agreeing to a set of research preferences for the animal sciences.

Systems and Management

Farming Systems

- There is relatively little published information on most aspects of animal production at the village level. An expansion in the **description and analysis of current farming systems within Vietnam** would increase understanding for all researchers and improve the possibility of making sensible recommendations.
- Similarly, **increased use of on-farm testing and experimentation** will provide vital information on the adaptation of technologies and practices under Vietnamese conditions.

Economics and Management

- A number of studies indicated that the economics of an enterprise were of more immediate interest and concern to farmers than the technology or productivity. **Proper evaluation of profitability** is essential if change is to be considered.
- Current formal credit policies tend to favour short-term projects, that is, less than two years' duration. This effectively discriminates against investment in animals by smallholders and particularly into ruminant-centred enterprises. It is suggested that farm animals are largely supported through systems of informal credit in village societies, about which little is known **Research into formal and informal credit systems and loan policies** would help determine the background economic costs of animal management.
- Many delegates commented on the lack of familiarity—among researchers and administrators—with the theories underpinning neo-classical market economics. As these are widely-accepted and practised by farmers and others there is an urgent need for **training in market economics** and the **production of an economics and farm management text** appropriate to Vietnam.

Disciplines

Nutrition

- **Practical feed formulation using local resources** was a strong recommendation for all species. Pigs and poultry are already catered for, to some extent, through least-cost feed programs but there is an excellent opportunity to develop software for **a computerised set of recommendations on rations for ruminants** as a regional application throughout Vietnam, Laos and Cambodia.
- Research should continue on the **nutrient composition of current feeds and ingredients** but, as much of these data already exist for similar physical and farm environments, greater attention should be given to the use of these data rather than continued accumulation.
- There has been a substantial increase in the production of manufactured feed. There is concern about the presence and dangers of **toxins in manufactured feeds** at the ingredient, production and storage levels.

Health

- There is a dearth of **basic epidemiological data for domestic farm animals** in Vietnam. Simple, rapid, cross-sectional field studies should be mounted to provide better guidance for future research in veterinary and health sciences.
- Concern was expressed about possible **human/animal health interactions** in more intensive production systems.
- Again, intensification/disease interactions will require the **development of appropriate vaccines and associated control programs.**
- Training and infrastructure required for the **development of a national diagnostic veterinary laboratory system.**

Genetics and Breeding

- More than one-quarter of the papers examined some aspect of genetics and breeding. Cross-breeding studies were particularly popular but it is suggested that, for large ruminants, much of this work has reached a cul-de-sac as recommendations made cannot be sustained by small-holder farmers rearing only 3-4 animals. There was a perception that researchers in Vietnam need the support and training to facilitate important conceptual shifts in approach. **Advanced training in molecular genetics** and the **introduction of gene-mapping techniques** might be appropriate directions, although expensive equipment would be needed to support such work.

Species

Pigs

- Pigs are an extremely important component of most village systems in Vietnam. Challenges to current husbandry practices are inevitable, particularly with the introduction of intensive large piggeries. **All aspects of management should be considered as candidates for research**—nutrition, breeding and health—but **separate programs should be developed for village-level and industrial systems.**
- **Practical diet formulation utilising local resources.**
- Continue **breeding trials to determine the most appropriate cross-breeds for village-level producers.**
- New regulations will soon require that pigs are penned within all Vietnamese farms, regardless of location and herd size. **Penning and disease relationships in village piggeries** deserve study as part of the broader issue of intensification.

Beef Cattle

- Work on better use of feed resources is a priority, particularly **practical recommendations on feed formulation.**
- **Improved management of health, with particular reference to parasites.**
- Mention was made of the potential for exports within Southeast Asia. This would require careful selection of animals, plus attention to management of nutrition and health to achieve the **meat characteristics** preferred in different markets.

Poultry

- **Ducks within integrated farming systems** (rice/pigs/fish/ducks).
- Management of **mid-size breeder/broiler chicken flocks** for smallholder farmers (both research and the development of appropriate training programs).
- Management of **industrial-level chicken production**—disease; nutrition; economics.

Dairy Cattle

- As elsewhere, Holstein-Friesian (or H-F cross) bull calves are usually slaughtered within one week of birth. Research could estimate the profitability of rearing bull calves under existing constraints of labour and feed resources.
- Most dairy producers were said to be concerned about the **economics of dairy production**, that is, milk price; loans; cooperatives, rather than technical questions.
- **General nutrition and health within intensive non-grazing smallholder dairy systems,** especially feed resources and utilisation.

Buffalo

- The role of buffalo in providing draught power for land tillage was mentioned on a number of occasions. There is a suggestion that this role and the place of buffalo may be threatened in some areas by **the increased mechanisation of land preparation and cartage.**
- Reproduction, particularly **better information on purported low fertility rates** in some herds, despite adequate access to mature males.
- **Nutrition**: again, practical feed formulation.

Products and Processes

Food safety

- **Slaughter facilities and hygiene in local abattoirs** were mentioned on a number of occasions. It was agreed that there is scope for research on policy grounds as Vietnam currently has large numbers of 'illegal' abattoirs that, nevertheless, slaughter the majority of animals. Hygiene will become of increasing importance should Vietnam try to enter the **export markets for meats and related products.**
- **Channels of information**—markets and extension.

Preparation and presentation of scientific papers

- It was noted that a very large percentage of papers submitted for this workshop were deficient in the manner of their scientific presentation. A common fault was an absence of description of the methodology: another scientist would not be able to repeat the work. The handling of references revealed a widespread and serious misunderstanding of their use in publications and the manner of their recording. An absence of statistical information was also common. This indicated great scope for **providing training in basic scientific method and its reporting in the literature, particularly for experimental studies**. This would overcome the deficiencies noted.

John Perkins
Workshop Convener

Background

A Review of Animal Science Research in Vietnam

Le Viet Ly*

Abstract

Livestock forms 25% of the agricultural output value in Vietnam, and is almost entirely in the hands of small farmers, much as part of a system integrated with crops and fish. Animal and poultry breeds are described and their productive characteristics discussed. There is a shortage of areas of natural pasture and overgrazing has led to serious soil erosion. Efforts to introduce cultivated grasses are described and some progress reported.

The importance of agricultural by-products in feeding animals is stressed and although nutritional quality of many such by-products is low, a huge quantity is available and its potential in aiding ruminant development is high. The use of feed-processing mills is much below their capacity. Veterinary services are still lacking and recently the government introduced 'The Veterinary Code'.

National research projects for the 1991–95 period are summarised whilst the orientation of research work in animal production from 1995–2000 is recorded. This research will include: production marketing links; systems development; crossbreeding in pigs and cattle; improved feeding systems for intensive poultry production; further importation of good strains of chicken and ducks for both meat and egg purposes; improved dietary composition and efficiency of feed conversion; and prevention and control of animal diseases.

VIETNAM is a tropical country with a monsoonal climate. The total area of the country is 332 000 km^2 and it is densely populated by 73 million inhabitants. The arable area is small, about 7 million ha. Agriculture is based mainly on rice production, supported by other crops such as maize, potato, sweet potato, cassava, groundnut, soybean, sugarcane, fruit trees and other perennial commercial trees such as coffee, rubber, tea and coconut.

Livestock production forms 25% of the agricultural output value. In this sector, production is almost entirely in the hands of smallholders. Livestock enterprises themselves are very small and deal mainly with pigs, cattle, chickens and ducks.

With the use of special intensive farming systems, Vietnam has overcome a long historical period of grain deficit. By 1989, just a few years after the institution of economic reforms in 1986, the country was able to produce enough rice, not only for self-sufficiency but also for annual export to international markets, of about 1.5–2 million t. However, because of high population pressure (only 0.1 ha arable land per capita) serious consideration is being given to the development of sustainable agriculture.

It is clear that sustainable development of Vietnamese agriculture is an urgent problem, because it affects not only the life of millions of citizens but also the environmental conservation of the country. Traditional farming is based on an integrated system of rice, root crops, fruit trees, vegetables, and livestock and poultry (especially duck cum fish in the case of smallholders). Our integrated system known as VAC links the garden (crops) the pond (fish) and the shed (animal). It also means that to maximise benefits, efforts have to be made to combine crops, fish and animal production. This integration will bring more income for rural smallholders. There is much to learn from, as well as to contribute to this system.

Vietnamese agriculture has been divided into seven agroecological zones according to ecological and economic conditions. They are:

1. Northern Mountainous and Middle Highlands.
2. Red River Delta.
3. North Central Coast
4. South Central Coast.
5. Central Highland.
6. North East of Southland.
7. Mekong River Delta.

* National Institute of Animal Husbandry, Thuy Phuong, Thu Liem, Hanoi, Vietnam.

Nationally a variety of crops are cultivated in intensive farming systems, in which:

- 4.260 million ha are in rice cultivation;
- 1.280 million ha are for subsidiary crops and short term industrial crops;
- 0.860 ha are for perennial industrial crops;
- 0.173 ha are water surface areas for fish raising; and
- 0.332 ha are pasture.

The development of animal production in the country has been promoted during recent years. The populations of livestock and poultry are shown in Table 1.

It can be seen from the table how diverse are the objectives of our animal production. There are different components of the livestock herd in each economic zone. For example, in the Northern Mountainous and Middle Highland regions the buffalo herd is densest, while in central Vietnam cattle are most numerous, containing 47% of the total national herd. The population of chickens is distributed over the whole country while ducks are concentrated mainly in the Mekong Delta where 57.7% of the total duck flock is situated. Table 2 shows the disposition of livestock and poultry in the various zones.

Table 1. Livestock and poultry population in Vietnam 1992–1993 (head).

	1992	1993
Pig	12 140 000	14 800 000
Cattle	3 151 000	3 330 000
Buffalo	2 885 000	2 960 000
Goat	312 297	353 000
Sheep	3000	3000
Deer (Sika deer)	12 000	12 000
Chicken	97 500 000	10 239 000
Duck	27 000 000	31 000 000

(1993 census).

Table 2. Livestock and poultry distribution in different ecological economic zones (%).

Ecological economic zones	Pigs	Cattle	Buffalo	Ducks
Northern Mountainous and Midland	24.3	15.4	42.8	10.6
Red River Delta	22.7	8.0	12.3	6.1
Northern Central Coast	17.1	19.8	19.7	7.6
Southern Central Coast	11.4	27.8	5.2	9.9
Central Highland	4.6	11.2	2.0	0.8
North East of Southland	4.5	7.2	5.0	6.2
Mekong River Delta	5.0	9.8	11.9	57.6

Animal and Poultry Breeds in Vietnam

Pig breeds

There are several local pig breeds such as I, Mong Cai and Muong Khuong in northern Vietnam; Co, Meo and Moi in central Vietnam; and Thuoc Nhieu and Ba Xuyen in southern Vietnam. The local pig breeds adapt well to the local climate and to poor feeding but their productivity is low, with a high proportion of fat, low lean meat and high feed conversion rates.

Some exotic breeds, mainly Yorkshire and Landrace, are being reared in Vietnam. Duroc and Hampshire breeds are also present in modest numbers. Exotic pig breeds are being raised around Ho-Chi-Minh City, Hanoi, Bien Hoa, Dong Nai and Can Tho. Crossbreds between local sows and exotic boars are distributed widely through the whole country. Commercial crossbred pigs number 60% of the total national fattening pig population.

Cattle breeds

The local cattle breed, Vietnamese Yellow, is of small size, with a body weight of 160–180 kg/head at maturity. Exotic cattle breeds in Vietnam are Red Sindhi, Sahiwal and Brahman. Their number, only in the hundreds, is still small and they are distributed mainly in breeding centres such as Ba Vi and Duc My. The main task of these centres is to provide breeding males for crossing to improve the body weight of the cattle herd.

Five years ago a thousand doses of frozen cattle semen, including Charolais, Santa Gertrudis, Simmental, Limousin, Hereford, Red Brahman, Droughtmaster and Belmont Red were imported. Holstein Friesian semen has also been imported for crossing to create crossbreds for dairy purposes.

Dairy cattle have been raised in two sub-temperate regions namely Moc Chau and the Lam Dong plateau. These include 3000 head of Holstein Friesian cows whose milk yield of 2500–2800 kg/lactation decreased gradually after importation. Dairy crossbred cattle extend through a large area of the two deltas surrounding Ho-Chi-Minh City and Hanoi and produce 1800–2200 kg of milk/lactation.

Buffalo breeds

Almost all buffalo are of the swamp type, except 200 Murrah buffalo remaining from importation from

India. Buffalo are now mainly used for draught power. In the past, buffalo meat was second to beef in importance, but its role has increased because now about 50% of the meat sold on the market purporting to be beef is actually buffalo meat.

Chicken strains

Local chicken breeds comprise more than 95% of the total chicken population of Vietnam. The Ri breed is the most popular but some other well-known breeds such as Ho chicken and Dong Cao chicken are now being reared. These local chickens are used in a scavenging feeding role. Besides the local chickens, commercial chickens such as Hybro, Plymouth (as broiler) and Leghorn Goldline (as layers) are imported and some other dual-purpose breeds such as Ross and Moravia have been imported in recent years.

Duck strains

Local ducks used for egg laying are the Co strain which yield 180–200 eggs per year. The Bau strain which are a meat type have a liveweight of approximately 1.5–2.0 kg at maturity. The main imported duck strains are Cherry Valley and Pekin. In recent years the Cherry Valley Super Meat (CV Super M) and Khaki Campbell (egg type) have also been imported.

Goat breeds

The local brown and black goat breed known as the Co goat is a meat type which is widely distributed. A popular dual-purpose breed is the Bach Thao which yields 140–150 kg milk/lactation. The big advantage of this breed is its high reproduction rate. Two thirds of births are twins.

Deer breeds

The Sika deer is frequently found on small farms with a total population of 12 000 head. The main product is velvet, not meat. The Sambar deer is now raised in some mountainous areas in small herds.

Pig production has been considered as top priority for the following reasons:

- 70% of meat domestic consumption has come from pork.
- Two thirds of the manure required for intensive farming has come from pig dung. Whilst Vietnam is still deficient in chemical fertilizers the role of pig dung continues to be most important.

Cattle and buffalo production have occupied the second place followed by poultry. It should be emphasised that in the area of duck production Vietnam has the biggest duck flock of neighbouring countries in Southeast Asia.

Feed Resources

There is a shortage of water for plant production especially in the dry season. In some areas of the Central Coast of Southland drought can be serious.

In recent years, there has been a dramatic achievement in the area of food production, 24.5 million t of food being produced annually, which greatly decreased the pressing feed deficit. The annual production of rice bran extracted from paddy rice processing has reached more than 1.0 million t. Production of protein feed sources amounts to 10 000–15 000 t of fish meal, 10 000–20 000 t of soya bean and 20 000–25 000 t of various types of oil cake such as groundnut, soya bean and coconut.

Natural Pasture

Although it is reported that 1.0 million ha of so-called natural pasture exist, the fact is however, that Vietnam has very few large areas of natural pasture. With the increase of human population and the establishment of new economic zones, natural pasture has been cut into small areas and is mixed in with crops and building construction. The mountainous and hilly regions which are too steep either cannot be grazed or the soil is too poor and dry and the area considered as bare 'hills'.

Pasture management is neglected and overgrazing has created serious damage resulting in soil erosion. Grasses in the natural pasture are of poor nutritive value. Regrowth of these grasses is not strong enough to dominate the wild weeds. One big danger for natural pasture is the prevalence of *Eupatorium odoratum*. This grass cannot be eaten by buffalo and cattle because of its strong smell.

Improvement of natural pasture is expensive and has low efficiency because of lack of water and fertilizer. Burning pasture is not accepted as a productive measure as it can encourage wild grasses to grow more quickly than useful grasses and dominate them.

Cultivated Grasses

Grass cultivation has been studied and developed over many years in research institutions and on state farms. Many varieties of grass have been studied and screened, and some of them developed in large areas. The three varieties of grass that have been cultivated most are elephant grass (*Pennisetum purpureum*) Guinea grass (*Panicum maximum*) and pangola grass (*Digitaria decumbens*). These grasses are highly productive with elephant grass yielding 200 t/ha/year equivalent to 22 t dry matter (DM). *Panicum maximum*, which has high drought tolerance, can yield 100 t/ha/year (19 t of DM), its productivity

depending on the amount of fertilizer applied. These two grasses are preferred by farmers. They can be grown in the garden but obtain higher yield under better management.

Para grass (*Brachiaria mutica*) will survive very well in lowland areas along flooded river banks in central Vietnam. This grass also grows well in other areas in the North with productivity of about 80 t/ha.

Leguminous fodder is rarely found in animal rations. The two varieties that can be developed are *Leucaena leucocephala* and *Stylosanthes* sp. In acid soils with a pH > 5, *Leucaena leucocephala* cv Cunningham can give 40–50 t/ha with crude protein of 25%. *Stylosanthes guyanensis* cv Cook (Cook stylo) is also a promising legume with a yield of about 40 t/ha.

Agricultural By-products

Normally, Vietnam produces two, and in some places, three rice crops per year. In the north where the water supply is plentiful, there are two rice crops and one winter cash crop grown each year. Cash crops such as maize, soya bean, potatoes and other vegetables are grown during the cold season and harvested within three months. In some southern provinces, because of high temperatures and ample radiation throughout the year, rice can be grown and harvested three times per year. From these crops, rich sources of agricultural by-products can be derived and these can be important components in the diet of ruminants, especially in the dry season.

Rice straw occupies a very important place in ruminant feeding. In Vietnam there are about 20 million t of rice straw produced each year. This quantity is used as ruminant feed, also as fuel and litter and a part of it is burned in the field immediately after harvesting. Even when only 30% of it is used as animal feed this totals 6 million t of rice straw (18 million MJ), a huge amount. Rice straw is normally piled up and then stored over a lengthy period. Buffalo and cattle are fed rice straw at night or in cold, rainy weather when grazing is not possible. The treatment of rice straw such as with urea is not widely practised at present.

Rice bran is also an important feed source. It is used mostly for feeding of pigs and dairy cows and only used as a supplement for buffalo and cattle when heavy work is being undertaken.

Maize stem is also available in large amounts after harvesting but is rarely used as animal feed and generally only for fuel.

Sweet potato vines are also plentiful but used mostly for pig feeding rather than for buffalo and cattle.

Peanut and soya bean stems are likewise available in large quantities but, because their harvesting time is so short and storage difficult, very little can be used as animal feed and most is used as green manure.

Another commercial crop is sugarcane which is also important for its by-products. Molasses is a high energy feed source especially for beef cattle and buffalo. Sugarcane is harvested in the dry season and sugarcane tops, or bagasse, are important forage crop by-products for ruminants in areas having long dry periods. Sugarcane production in Vietnam appears to be developing quickly and its by-products will become more important in ruminant feeding in the coming years.

Although the nutritional quality of agricultural by-products is low, their huge quantity constitutes a very important potential for ruminant development in Vietnam.

There are about 40 feed processing mills in the country with the capacity to produce annually 600 000 t of compound feed. However, the annual quantity of compounded feed production is only 100 000 t because of the shortage of raw material ingredients such as protein sources, minerals and vitamins and also the limited market for concentrate feed.

Traditionally, ruminant production in Vietnam is not based on growing pasture but mainly on use of crop by-products, especially rice straw. Natural and even cut-and-carry grasses, however, play a small role as well.

Veterinary Services

In some areas, there are quite good veterinary networks but, in general, veterinary services are still lacking in a country where tropical disease is sometimes serious. Recently the Vietnamese government has issued 'The Veterinary Code'. All institutions from the top to the grass-roots level and all economic sectors are requested to follow this code strictly to improve animal health care and also to protect the environment.

Constraints to the Development of Animal Production in Vietnam

Traditional animal production systems are still popular in the country and have the following characteristics:

- Use of indigenous breeds with small body size and low productivity but which are suitable for local conditions and adapted to poor feeding.
- Deficit of protein sources in the diet in a large part of the country, a limiting factor for animal production.

- Lack of green fodder of high quality such as legumes, another weak point in animal production.
- Poor disease control and infrastructure where many measures at different levels are needed.
- Limited capital and facilities which will inhibit development in this area for a long time.
- Weakness in research capacity and in extension services resulting in slow technological transfer to smallholders.

Opportunities for Development of Animal Production in Vietnam

- The achievements of the intensive farming systems obtained in rice production create a sustainable base for animal production development.
- A series of practical examples and demonstrations with appropriate technologies will be accepted and developed by farmers. This will encourage change in traditional rearing systems by using new breeds, compound feed and better management for higher profit.
- There are some important ready-in-the-hand infrastructures for further development such as a set of exotic breeds and strains of animals, modern feed mills and a veterinary network.
- Good research staff and extension workers in animal production are being trained in different zones in the country. They understand the prevailing local conditions very well and are able and ready to be retrained to meet the new needs being generated through practice.

National Scientific Projects (1991–95)

Since 1991 a National Animal Production Research Project has been conducted and it has lasted up to 1995. The objective of this project is to make an overall study on breeding/feeding health care of some important animals including pigs, cattle, chickens, ducks, goats and deer. This project is concerned with experimental research and also with the establishment of pilot demonstration studies designed to shorten the gap between research and production.

The contents of the overall research project are as follows:

- Study scientific and technical measurements to stabilise and improve the value of some high yielding breeds.
- Study suitable technical animal husbandry procedures for southern provinces to define the preferred pig crossing formula—including breeding programs to obtain more than 50% of lean meat in the carcass.
- Complete the appropriate technologies for rearing fattening crossbred pigs in the north to obtain a lean meat level in the carcass of 42–45% and also to continue crossbreeding studies for a lean meat rate of 46–50%.
- Study the technologies to complete the current crossing formulae (HF × improved local) and implement new breeding programs in the dairy industry in the north.
- Study the desired crossing formula of dairy cattle for Ho-Chi-Minh City in southern provinces.
- Identify new crossing formulae between local Yellow cows and some exotic bulls such as Hereford, Shorthorn, Limousin for instance, and complete the feeding procedures for raising Charolais crossbred cattle.
- Study the adaptation and the production performance of new duck breeds: Khaki Campbell, Super meat, Shavas, Pekin and three way crosses.
- Determine production performance of high egg-yielding Moravia Goldline poultry and some new crosses.
- Study protein level needs and suitable rations for newly imported animals and poultry.
- Study the technology of producing crude lysine, trace minerals, vitamins, enzymes and other additives for animal and poultry feeding.
- Develop appropriate technologies for exploiting and making better use of leguminous trees and agricultural by-products in animal feeding.
- Study the production technologies to increase quality and range of vaccines for improved animal health.
- Study prevention of infectious diseases in animal and poultry in Ho-Chi-Minh City and southern provinces.
- Study application of biotechnology to produce antigen and antiserum to allow quick diagnoses of some diseases in poultry and livestock.
- Study factors that cause respiratory and digestive diseases in pigs and establish a treatment regime for drug use as well as a preventive method for *Mycoplasma* infection.
- Study trypanosomiasis in cattle and buffalo and the method for treatment under tropical conditions of Vietnam.
- Study the factors causing reproductive loss and obstetric diseases in pigs, cattle and buffalo and the method for prevention and treatment of these diseases.
- Study bacterial and fungal toxic effects in compound feed and feed materials. Study methods to limit and reduce the pollution caused by animal production in tropical regions.

- Study technologies for processing animal products namely pork, beef and chicken.
- Study the processing and use of slaughterhouse by-products such as hair, feather, blood, bone and rumen content as supplementary animal feed.
- Study the biological features and production performance of Bach Thao dairy goat breeds and their role in genetic improvement of local breeds.
- Study biological characteristics and production performance of the Sika breed of deer and measures necessary to increase velvet and meat production.

Additional to this National Animal Production Research Project is a specific project on livestock genetic conservation to retain the diversity of fauna in Vietnam.

Although our country lacks resources, we still place high value on the protection of traditional animal breeds.

Recently a proposal made by the Ministry of Agriculture for a large National Project in cattle improvement, through crossbreeding and better feeding, was approved and will be carried out throughout the whole country.

Orientation of Research Work in Animal Production in the Period 1995–2000

To meet the demand of industrialisation and modernisation of the country, animal production research should make a major contribution.

The major constraints of limited investment and a deficit of skilled staff have to be overcome rapidly. Vietnam must avoid repetition of research work and make a major effort to study the experience of international colleagues. Combining local research findings and overseas experience is an urgent need.

The following problems should be addressed in the next quinquennium:

- The link between animal production research and marketing should be established. Efforts should be made to assist smallholders to develop sustainable agricultural systems.
- Better use should be made of heterosis in animal breeding programs. The program in pig production should aim to increase the lean meat content of the carcass to 45–50%.
- Cattle improvement programs in the whole country need to be expanded. A large herd of crossbred cattle (about 30% of total herd) is needed to improve body weight and to create a foundation for further crossing for beef and dairy production.
- An improved feeding system needs to be developed for intensive poultry production. Parallel to improving the traditional scavenging system in the countryside, it is necessary to import good strains of chickens and ducks for both broiler and egg laying purposes.
- Encouragement is needed to use nutritionally-complete compound feeds in animal production to obtain higher efficiency of feed conversion.
- Strong efforts in the prevention or control of dangerous diseases such as foot-and-mouth disease (FMD) and leptospirosis of ruminants and pigs are a pressing need.

Animal Husbandry Advances which Contributed to Major Livestock Development in Vietnam

Tran The Thong*

Abstract

Over the last 30 years, animal husbandry research in Vietnam has been carried out successfully by agricultural research institutes, universities and research centres in collaboration with other research institutions both within and outside the country. All the animal research results are approved by the Animal Husbandry and Veterinary Section of the Committee of Science and Technology of the Ministry of Agriculture before being released as technical advances for production.

Animal husbandry in Vietnam is carried out for the most part on smallholder farms. Industrial livestock production on state-run farms and large-scale private farms is developing, but is still only a minor part. Livestock research activities as well as the dissemination of techniques accordingly has focused on these two different components.

The following are some advances in animal husbandry which have contributed actively to livestock development in Vietnam additional to progress in veterinary sciences.

Pig Research

EXTENSIVE technical progress in pig husbandry has been achieved due to strong research activities implemented in this field.

A basal survey determined the pig numbers, evaluated breeding stock and their distribution in different agroecological regions and provinces. This helped formulate a sound improvement plan according to economic conditions and customs of each region. The main local pig breeds are: Mong Cai, I, Lang Hong, Lang Thai Binh, Meo, Muong Khuong, White Phu Khanh, Thuoc Nhieu, Ba Xuyen, Moi and Co. The exotic breeds are: Yorkshire, Landrace, Duroc and DE.

Crossing programs popularly used

- Yorkshire × I, Yorkshire × Mong Cai, Landrace × Mong Cai, Landrace × I (40–43% of lean meat)
- Yorkshire × Mong Cai × Landrace (¾ exotic blood; 45–47% of lean meat)
- Yorkshire × Thuoc Nhieu, Yorkshire × Ba Xuyen (45–47% of lean meat)
- Yorkshire × Landrace × Duroc (55–56% of lean meat)
- The local breeds such as Mong Cai, I, Thuoc Nhieu, and Vietnamese Yorkshire have been approved as national breeds
- Many Yorkshire, DE, Landrace, and Duroc have been imported from USSR, Japan, France and Germany

Artificial insemination (AI)

AI of pigs has been applied for the last 30 years. The level of AI in the sow population in the North, has reached 80%. Each province now has at least one AI station. Many kind of extenders which can keep pig semen viable for 2–4 days have been studied in research institutions and universities.

Pig genetics

Since 1977, the Individual Testing Method for boars has been applied with the cooperation of INRA (Institut National de Recherche Agronomique) France. Recently PIGBLUP software has been used to evaluate the genetic value of pigs in cooperation with Australia.

* Institute of Agricultural Science of South Vietnam, 121 Nguyen Binh Khiem, District 1, Ho-Chi-Minh City, Vietnam.

Animal feed

More than 200 kind of plants, tubers, fruits and agro by-products used in animal feeding have been collected and analysed for their chemical composition. The results were published as teaching documents for use in universities and for animal husbandry technicians. Formulated rations for pregnant sows, lactating sows, piglets, fattening pigs and boars are available. Cooperation with overseas agencies has continued to produce and to adequately use feedstuffs in pig feeding with high economic efficiency and performance (e.g. with Ajinomoto and Sumitomo—utilisation of lysine and methionine in animal feeding; with Proconco and CP Group—producing mixed feed). Processed grass meal and micro-element premixes for pig feeds are now available. Biological control methods to minimise fungus on maize grain and peanut cake have been applied. Application of software programs to formulate rations on the basis of available local feedstuffs has also commenced.

Pig husbandry techniques

Technical guidance for piglet care (electric heating, stable temperature, keeping piglets on high, dry wooden slats and use of starter feed) is now available. These steps have considerably reduced diarrhoea and provided for faster growth permitting early weaning at 28–30 days and piglets reaching 18–22 kg by 60 days.

Pig housing

Well-ventilated iron fences and high slat-floors with strips for dejection escape have been used in pig raising (including small farms using available material).

Results

The final result is the development of pig husbandry under intensive conditions. The application of the above technical advances has achieved the following types of result:

- weaning at 28–30 days and piglets reaching 18–22 kg after 60 days;
- increase in number of litters to 2.1–2.2 litters/sow/year;
- achievement of 90 kg of liveweight after 180 days;
- increase in piglets/sow/year to 16–18 piglets;
- increase in rate of feed conversion to 3.2;
- lean meat/carcass: 55–56%;
- back fat thickness: 20 mm; and
- crossbred pigs with 50–75% of exotic blood now comprising more than 50% of total population.

The Ministry of Agriculture and Food Industry is encouraging the development of intensive pig production and recommending the raising for export of three-way cross pigs and exotic breeds with high lean meat content (45–55%) in areas around the big cities, industrial zones and pig producing areas.

Cattle Research

Technical progress in cattle husbandry is judged second to that of pig husbandry.

The basal survey helped to record the distribution of the cattle population, breeds, herd quality and rearing techniques. Thus a sound improvement plan was applied to beef and dairy cattle according to the economic condition of the various locations.

The main cattle breeds in Vietnam are:

- local—Vietnamese Yellow, crossed Sindhi, Lang Son, Cao Bang and Phu Khanh; and
- exotic—Holstein, Brown Swiss, Zebu, Brahman and Sahiwal.

The Moncada Cattle Breeding Centre provided by the Government of Cuba was established nearly 30 years ago to produce pellet and straw semen. Five years ago, straw semen of high yielding dairy cattle from France was imported and used in Ho Chi Minh City for local dairy improvement, which brought promising results.

Pure Zebu bulls (Red Sindhi, Sahiwal and Brahman) have been used for 'Zebulisation' of local stock, that is, to increase the Zebu content. The local bulls have been replaced by Zebu crosses for mating with local cattle in remote zones where there is a lack of transportation.

Biological characteristics and milk production of F_1, F_2 Holstein have been studied to develop suitable rearing techniques for each kind of animal.

Milk quality has been analysed for nine components with a view to evaluating its quality thus serving as the base for determining milk price and improving dairy production.

Technical progress in the area of animal feed includes: ensilage of rice straw with urea (2–4% of urea); utilisation of molasses-urea-multinutrients block (MUMB); and intensive growing of *Pennisetum*, *Panicum*, *Stylosanthes*, and *Leucaena glauca* in smallholder farms—with guidance in growing techniques covering planting, fertilisation, density and harvesting.

Results

The final result is that Vietnam actually has a cattle population, not large, but with rather good performance and a promising rate of development. Around Ho-Chi-Minh City, especially, more than 45 000 L of milk are produced daily. The VINAMILK Company

in Ho-Chi-Minh City has a sterilised milk processing plant producing ultra high temperature (UHT) milk. Dairy cattle production in Hanoi and other provinces is under development. Song Be province has collaborated with the Friesland Company in the Netherlands for dairy production and milk processing. The draught cattle herd is gradually being transformed into one of beef cattle or dual purpose animals (milk and meat). The Ministry of Agriculture and Food Industry also has a plan for further beef development.

Buffalo Research

Technical progress for buffalo has been less than for cattle. The basal survey determined the distribution of buffalo population in each region and identified the origin of buffalo in Vietnam (swamp buffalo with average body weight of 300 kg). Biological characteristics of local and Murrah buffaloes were studied. Adaptive research of Murrah buffalo was carried out to cross with the local one for producing crossbreds with milk production of 4–5 L/day and 6–7% of fat. Crossed buffaloes have good vigour and are suitably powerful for draught.

Results

The final result indicates that dairy buffalo development in Vietnam has had to cope with difficulties because of the extensive rearing methods used for it and that buffalo cows frequently manifest silent heat. Buffalo meat is popular in Vietnam.

Poultry Research

Chickens

Survey activities and research work have been carried out on some common local poultry breeds in Vietnam, such as Ri, Ho, Dong Cao, Trui, Mia, Tau, Ac and Tre. The Ri breed has formed the major portion of flocks in every region, because it is a dual purpose bird which is well adapted and has the ability to scavenge, though it has a small body size:

- many exotic egg and meat stocks were imported, namely AA, White Rock, New Kich, Avian, Cob500, Hubbard, High line, ISA Brown and Goldline 54—the Union of Vietnam Poultry has many nucleus breeding centres where modern techniques on breeding, feeding and management are carried out;
- the 'three-yellow-poultry' breed (Tam Hoang) has developed quickly into production;
- biological characteristics of some high yielding poultry breeds have been studied;
- utilisation of the selection index to improve meat and egg performances has occurred; and
- backyard layer systems have developed for rural farmers.

Feed

Research has been carried out on metabolisable energy and protein balance of the ration, utilisation of shrimp head meal to replace fish meal and generally suitable feeding regimes for poultry from feed produced in Vietnam have been studied.

Results

The final result is that Vietnam actually has a rather well-developed intensive poultry industry with egg production of 240 eggs/hen/year and an egg weight of 55 g. The total poultry flock of Vietnam is now about 100 million birds of which there are nearly 10 million laying hens.

Ducks

Hatching eggs in warm rice husk and accelerating duckling growth for one month before releasing to the fields for picking feed are the two technical advances which are still applied and provide benefit to duck raising in Vietnam:

- the basal survey gave data on the total duck flock, duck quality and their distribution—Vietnam has two distinct duck flocks (egg and meat stocks), Bau, Co and Tau Ran;
- studies on free range raising techniques (in the rice field after harvesting) have been conducted and 98% of the meat flock are raised by this method;
- studies on the time of marketing aim to give higher economic efficiency;
- high yielding breeds (meat and egg stocks) have been imported for adaptive research, namely—Beijing, Cherry Valley, Czechoslovakia duck, Super Meat and Khaki Campbell;
- crossbred ducks have ability in free-ranging and scavenging for feed similar to the local ones but the local duck has a body weight of 1.5 kg and the crossbred duck 2.5 kg;
- the VN_1 meat line has been developed; and
- the Khaki Campbell breed has manifested an advantage under Vietnam conditions.

Results

The final result is an improvement in the duck flock, both meat and egg, of Vietnam. Duck raising gives high economic efficiency. The state-run duck breeding farms have contributed significantly to the improvement of duck husbandry in Vietnam.

Goat Research

Surveys on goats have been conducted over a lengthy period and the goat population, goat quality and their distribution have been studied in detail in the mountain, plain and coastal areas. Meat goats comprise the

majority of the herd and they are raised extensively, feeding on plant leaves in the mountains.

Goat gelatin is produced as a medicine for older people.

The semen of Alpine and Saanen goats from France and some Indian goat breeds has been imported into Vietnam recently.

The Bach Thao goat is the best dairy goat in Vietnam with an average milk production of 1 L/day. Using semen of Alpine and Saanen goats to inseminate local goats produced an F_1 which gives an average of 1.5 L/day in the first lactation. The biological characteristics of Bach Thao goat have been studied.

Goat farmers have been trained in goat feeding, management, housing and veterinary control.

Results

The final result is that the Ministry of Agriculture and Food Industry has permitted the use of Bach Thao and Indian goats for local stock improvement. The Ministry of Agriculture have also approved the establishment of the Bach Thao Breeding Area as the farmers' goat breeding zone and two Nucleus Goat Centres at Son Tay and Binh Thang.

Agricultural Extension

Information on technical progress in animal husbandry has been quickly and efficiently disseminated due to an effective extension network. The agricultural institutions, universities and departments have participated actively and effectively in extension work. In 1993, the Ministry of Agriculture and Food Industry officially decided to establish the Agricultural Extension Department. Since that time, each province and district has had its Agricultural Extension Centres. Each commune also has its 'Advanced Farmer Club'. In the past, the Vietnam Association of Garden-Fishpond-Livestock (VACVINA), Animal Husbandry Association, Veterinary Association, Farmers' Association, Women's Association and Youth Association have helped actively in the development of agriculture in rural areas. Each association conducts its own reviews which are delivered directly to farmers to guide them in the application of techniques and to answer their questions. The agricultural institutes, universities and centres have published many leaflets with comprehensive techniques. Many training courses and field days have been organised with participation of farmers to discuss and to gain experience.

Agricultural extension in Vietnam seeks to be a bridge to link science and production, scientists and farmers.

Conclusions

Animal husbandry in Vietnam has developed markedly due to the application of technical progress. Animal populations of all kinds have increased. In 1994, there were 15.1 million pigs, 3 million buffaloes, 3.4 million cattle, 142 million fowls and 1.15 million tons of meat of all kinds produced. The quality of the livestock population has been improved considerably. Among 19 agricultural extension programs, there are six programs in animal husbandry. In 1994, the total funds allocated for agricultural extension was VND13.3 billion. This does not include provincial funding.

It is our hope that animal husbandry in Vietnam will keep pace with the Southeast Asian countries assuming it receives stronger support from the Government and has opportunities to cooperate with international organisations.

Approaches to Research

A Scoring Procedure for Assessing Research Priorities*

N. H. Sturgess†

Abstract

Priorities are required at each level in the research chain where decisions about the allocation of research resources are made. It is proposed that a flexible scoring method might find application in Vietnam for priorities amongst very broad areas of research opportunity and for research programs within those broad areas.

The proposed scoring method uses four criteria to assess priorities: the potential benefits of the research and Vietnam's ability to capture those benefits (taken together these two constitute the 'attractiveness' of the research); and the technical potential of the research and Vietnam's capacity to conduct the research (taken together these two constitute the 'feasibility' of the research). Application of the methodology involves tapping the collective wisdom of groups of assessors who have the appropriate expertise and experience to set the course of research in animal sciences in Vietnam. The essence of the method involves the sharing of information by the expert assessors, their active participation in debate and scoring the research topics according to the four criteria.

The Criteria

IN assessing research priorities, the key objective is to gain an understanding of **the return to Vietnam** from each of the designated Areas of Research Opportunity (AROs) at Level 1, or from each of the research programs at Level 2. This is done by ranking the AROs (programs) using two main considerations, namely, the *attractiveness* of the research and its technical *feasibility*.

As shown in the assessment framework (Fig. 1) each of these considerations combines two criteria (see box opposite):

The four criteria are designed to be general and independent. Therefore, double counting must be avoided; for example, one should not reduce the potential benefits because the R&D capacity is low. Assessment of the potential benefits must be done independently of the capacity to realise them, that is, when assessing the potential benefits it is assumed that the research is successful.

Attractiveness

combines the *Potential Benefits:*

- of successful research from economic, social and environmental perspectives

with *Vietnam's ability to capture the benefits:*

- by converting technological progress into commercial or other gains

Feasibility

combines the *R&D Potential:*

- or what research could potentially accomplish by advancing scientific knowledge

with the *R&D Capacity:*

- or Vietnam's capacity to achieve the research goals in a timely way.

The number and type of factors which an assessor considers for each of the criteria are decided by the assessor and will depend on his or her knowledge of the area of research opportunity or the sector of the economy in which it lies. It must be remembered that the assessors will be highly intelligent, creative people and should be free to exercise their consider-

* This paper is a summary of the essential elements of the methodology put forward in the larger publication, 'Approaches to Assessing Research Priorities', which was presented to participants at the Workshop.

† Read, Sturgess & Associates, 1383 Mt Dandenong Tourist Rd, Mt Dandenong, Victoria 3767, Australia.

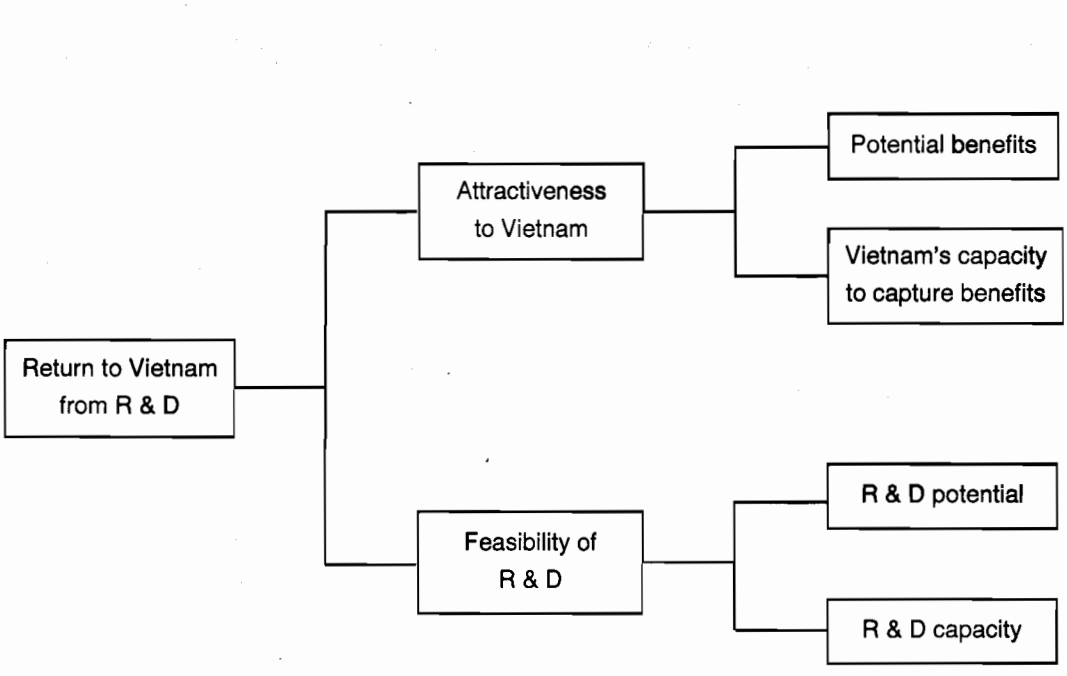


Figure 1. The assessment framework.

able judgement when allocating scores to the various criteria. If specific dimensions were laid down for each criterion, one could probably do without the assessors and perform the scoring in a mechanical fashion. Furthermore, there would be a loss of the vital characteristic that assessors share data and knowledge as they discuss the various criteria and the reasons for their scores. Nevertheless, it is important that all people in the group charged with determining priorities have the same understanding of the criteria. The following are illustrative examples of some of the dimensions which the assessors might consider under each of the criteria.

Potential Benefits are the maximum economic, social and environmental returns from technological improvement which might flow from the research topic. The total benefits include both the direct benefits to the sector of interest and benefits which could flow to other sectors. As appropriate, potential benefits would be considered in terms of national policy objectives.

Some economic dimensions which would need to be considered in the assessment of potential benefit are:

- size of the market;
- contribution to increased productivity;
- projected market growth; and
- export potential, import replacement.

Some social dimensions might include:

- income contribution to disadvantaged groups;
- contribution to infrastructure development;
- effects on community health; and
- improved social amenities.

Environmental dimensions might include:

- contribution to reduced soil erosion;
- issues of waste disposal;
- effects on soil salinity; and
- effects on water table levels.

When considering the potential benefits the assessors should also be mindful of any undesirable

effects (negative benefits) which might be produced by a technological advance from the research in question.

Ability to Capture the Benefits is designed to take into account the efficiency of technological transfer and adoption (relative to a complete capture of the benefits by Vietnam), and includes consideration of the extent to which foreign competitors may reduce the benefits to Vietnam by adopting the research results. In relation to the first of these matters, it reflects the ability of Vietnam's extension service, farmers and the industries that service agriculture to convert technical progress into commercial and other returns, that is, the potential benefits considered above.

Some relevant questions which might be considered by each assessor include:

- Is the technology socially and politically acceptable?
- Are there adequate skills amongst potential disseminators and/or potential users?
- Is the farming resource base adequate for adoption?
- Will the technology assist Vietnam's competitors on international markets?

R&D Potential is a measure of the potential to change the operation of the technologies affected by the research topic. This is the one aspect of the methodology that has a very specific connotation. In considering the R&D potential of the topics, the assessors must consider the notion that no technology can be advanced without limit.

The so-called 'technology S-curve' will be familiar to all agricultural and biological researchers by its similarity to the well-known law of diminishing returns. The performance of any technology, say, the internal combustion engine or tillage implements, increases slowly in the initial stages as research effort is applied, then more rapidly until the rate of increase in performance begins to decline. Eventually further research effort will bring no further increase in performance. For example, the R&D potential (gains in performance) from further research effort on the design of tillage implements may be small. Even if that were the case, it does not necessarily mean that such research should not be undertaken. Such research may proceed if the potential benefits from the research, and the capacity of the research system to undertake the work, are both judged to be high relative to the benefits from other research topics.

In short, the assessor's view of R&D potential is an attempt to place the technology that might flow from the research topic on its S-curve. This might be done by asking the question: 'how close is current technology to its full potential?'. As with the other criteria used in the assessment, this is obviously a matter of judgement.

R&D Capacity is a measure of Vietnam's efficiency in realising the R&D potential and achieving the benefits of the research in a timely way.

Some questions to be considered by the assessors might include:

- Is there a critical mass of research effort?
- Does Vietnam have the skills and facilities to deliver the R&D?
- Should the research be done in Vietnam or elsewhere?
- Is the likely time frame for effective application reasonable relative to the challenges in the area of research?

Derivation of Priorities

The average score of the assessing group for potential benefits to Vietnam is multiplied by the group's average score for Vietnam's ability to capture those benefits. This multiple gives a group score for the attractiveness of the research topic. Similarly, the group's average score for R&D potential is multiplied by the corresponding score for R&D capacity to obtain the group's assessment of the feasibility of the research.

These groups' scores for the criteria can be plotted on 'screens' to indicate the trade-offs which must be made between the criteria. The single screen, which acts as a final summary of the whole process (Vietnam's overall R&D return), is a plot of the group's scores for the attractiveness for each research topic against the group's corresponding scores for the feasibility of each research topic. A generalised example of such a screen is shown in Figure 2.

The logic of the process is that Vietnam should place a high priority (strong emphasis) on research topics (whether AROs or programs) that the assessing group has characterised as highly attractive and highly feasible, that is, research topics that are located in the top right corner of the screen. Conversely, research topics that are judged to have both low attractiveness and low feasibility (bottom left corner) should have low priority and receive only limited support. Research topics that lie in a band from the top left to bottom right corners because they are judged to have:

- medium attractiveness and medium feasibility, or
- high attractiveness but low feasibility, or
- high feasibility but low attractiveness,

are those for which selective emphasis must be exercised. This would depend on how those making final decisions on the allocation of research resources balance attractiveness and feasibility.

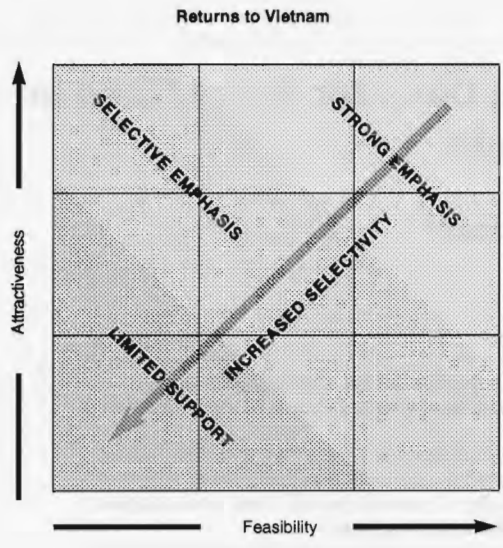


Figure 2. Screen showing returns to Vietnam.

In considering those research topics for which selectivity is required, the trade-off screens for attractiveness (return plotted against ability to capture) and feasibility (R&D potential plotted against R&D capacity) can assist the decision- makers. For example, a research topic that has high potential benefits, high R&D potential but low R&D capacity might be considered for additional funds on the basis of where it might be moved to on the return screen through that additional funding. Furthermore, discussion of this possibility might indicate the type of additional funding that would be appropriate.

It is arguable whether the group should actually prepare a list of the research topics in order of priority (or a list of priority groups, say, high, medium and low) or whether the position of the research topic on the 'return to Vietnam screen' is taken as the completion of the priority exercise. The placement of the topic on the screen is then taken into account along with all the other relevant issues when devising action plans and allocating resources. The latter, of course, is the reason for assessing priorities and must occur. However, the group will probably want to prepare a priority listing of research topics to mark the completion of this intermediate phase in the allocation of research resources. It must be clearly stated that such a list does not imply a particular allocation of resources, rather it will be used to guide the allocation.

Application of the Methodology

There are six main steps involved in the process of applying the methodology at any level within a research organisation. These steps are:

1. appointing the group of assessors who are to have the task of determining the priorities;
2. a preliminary meeting of the group to agree on the AROs (or programs at Level 2);
3. a period for the preparation of supporting information for each ARO (program);
4. preliminary scoring of the AROs (programs) against each criteria by each assessor independently of the other members;
5. the meeting of the group at which scores are collated, discussed, revised (if necessary) and finalised; and
6. the follow-up stage when priorities are used to prepare strategic and operational plans for each ARO (program), including plans for the allocation of research funds and manpower.

The first five of these steps are discussed in detail in the set of notes provided at the Workshop. Step 6 reflects the reason for assessing research priorities. The time available for this Workshop did not permit a consideration of this follow-up stage and the allocation of research resources.

A Glass of Milk and an Egg a Day...for Every Child in Vietnam

J.A. Gartner*

Abstract

An understanding of the interlocking relationship between science and systems is essential if animal scientists are to contribute effectively to a social purpose such as improved nutrition for the children of Vietnam.

The history of the scientific ethic and method is charted briefly to show how the systems approach grew out of the inability of scientific analysis to cope with the emergence of new phenomena at higher levels of complexity in the hierarchy of natural systems. Even more complex systems are those involving people; an agricultural system is one of these.

It is argued that the systems approach forms a continuum with the scientific approach, which ranges from the testing of simple hypotheses to build knowledge to the testing of complex hypotheses to create systems. These comprise an hierarchy of variables about which choices have to be made when attempting to improve them or to design and construct new ones. To choose is to reject. Thus the process of improving or designing a system is a form of synthesis which involves the rejection of other possibilities until a whole entity emerges from the choices made. This entity has its own properties, which are irreducible if it is to retain its identity as a system.

Two examples to illustrate the argument are given. The first investigates prospects to expand dairying in the province of Ho-Chi-Minh City. The second concerns a conventional field experiment on one component, grass, of a fish-feeding sub-system. This was run in parallel with the testing of hypothesised improvements to its supra-system, a fish production system, which was integrated with its supra-system, a farming system.

THE title of my paper reflects the dream of one of my former Vietnamese students at the Asian Institute of Technology (AIT) in Bangkok, Thailand. And it defines one possible purpose for research in the animal sciences, in this case a social one, concerned with improved nutrition for the children of Vietnam. The dream represents one goal along the way to achieving that purpose. Having dreams and defining purposes create opportunities for people who are interested in problem-solving and situation improvement. Here I define a problem as 'a difficult question' or 'an unsatisfied need'.

There are certainly plenty of opportunities for animal scientists if 'a glass of milk and an egg a day for every child in Vietnam' is to be achieved. And there is plenty of work for those who can design, construct and operate publicly-acceptable animal production systems based on the provisional facts of **science**. The theme of my paper, then, is the interlocking relationship between **science** and **systems** in attempts to achieve social, economic and political purposes. Much of what I have to say comes from working with students, rural people, professionals in agriculture, public institutions and donor agencies throughout Southeast Asia for nearly 15 years.

* Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, Cambodia.

Some Reflections on Science

Few people discuss the history of science today and fewer discuss its philosophy and the impact it has had on Western and other civilisations. We need to revisit the past and reflect a little in order to understand how systems thinking grew out of one of the intractable problems confronting the scientific method when faced with complexity in emergent systems, particularly those of human society.

It all began about 2500 years ago with the Greeks when they began to argue 'for the sole purpose of arriving at the truth and with argument as their chief

weapon; argument used deliberately, consciously, and carefully developed into a technical method' (Checkland, 1984). About one hundred years later, Aristotle displayed a clear understanding of the temporary nature of scientific hypotheses and laid the foundation of the ruling ethic in science when he wrote: 'we must partly investigate ourselves, partly learn from other investigators, and if those who study this subject form an opinion contrary to what we have now stated, we must esteem both parties, indeed, but follow the more accurate' (cited in Checkland, 1984). This is the great code of behaviour in scientific debate even if it is not always displayed!

This ethic has sustained Western civilisation for centuries and allowed it to recover from its errors and excesses. Indeed, it has provided confidence in the idea that things can be changed by reason as well as by force and that, depending on one's point of view, things can be changed for the better, in contrast to the idea that all is known, nothing can be changed, and everything will remain as it always has been.

Our present world could have been quite different. The scientific outlook may never have survived, and the modern scientific method may never have evolved, if the Greek general Ptolemy had not taken ancient Greek texts with him when he conquered Egypt about 1500 years ago. The texts were preserved in the great library of the city of Alexandria, and later translated by the Arabs. Through these translations, Greek science became available in the medieval universities and monasteries of Europe about 800 years ago. From these centres of learning it developed into **science** as we know it today. At about this time Angkhor Wat in Cambodia was being built. The Khmer civilisation was at its height and Khmer kings ruled territory from Burma to Vietnam. Angkhorian inscriptions glorify the all-powerful, all-knowing monarch who was regarded as a divine being. In contrast to the scientific ethic, his authority could not be questioned. This made it difficult for the civilisation to adapt to change in its internal and external environment and precipitated its ruin. **Science** has better explanations than monarchs, religions or ideologies for most natural phenomena.

The power of science

In contrast to belief, opinion, preference and speculation, modern **science** has the power to acquire publicly-testable knowledge of the world, by three processes: *reductionism, repeatability* and *refutation.* We may reduce the complexity of the variety of the real world in experiments, the results of which are validated by repeatability, and we may build knowledge by the refutation of hypotheses (Checkland 1984).

The Greeks gave us *deduction.* Medieval scholars then laid the foundation of *induction* which was first described systematically by Francis Bacon at the beginning of the Scientific Revolution, about 400 years ago. During this time of dramatic change, René Descartes completed the foundation of the scientific method when he taught us *reduction* or, in modern language, *analysis.* Since that time scientists have accepted this way of carrying out scientific research. It was clarified further in this century by the western philosopher, Karl Popper (Magee 1973) who argued that a hypothesis refuted is a more valuable experimental result than one in which the hypothesis survives. This view replaced induction as the new hallmark of science, the line of demarcation between science and non-science.

Some Thoughts on Systems

I have suggested (Gartner 1993) that the first systems man was the Greek, Heraclitus, who participated in the speculations that were the beginnings of **science.** His idea of continuous change conflicted with the human need for certainty and his idea of 'oneness' was crushed by the dominance of deductive argument. The latter idea reappeared about 150 years ago with the concept of *holism.* It was derived by biologists to overcome the problem of the *emergence* of new phenomena at higher levels of complexity in the *hierarchy* of natural systems, with which scientific reductionist thinking could not cope.

The most complex systems are those involving people; an agricultural system is one of these. **Systems** thinking in agriculture began in the 1960s and it is not surprising that some major contributions came from animal scientists because animal production systems are more complex (that is, of a higher order) than plant production systems. Thirty years or so is a mere moment in the process of developing a systems approach to agricultural development when one considers the great sweep of time covered by the history of **science.**

Systems thinking starts from noticing the unquestioned Cartesian assumption: namely, that a component part is the same when separated out as it is when part of a whole (Checkland 1984). The questioning of this assumption has been painful for some people, and many have resisted it energetically. I think they miss out on a great opportunity. My purpose is to persuade you to accept the challenge and, at least, entertain the idea of it. If you embrace the question I believe it will make your work more rewarding and allow you to see where it fits in a study of the whole.

A system is a complex hypothesis that can be tested and refuted. In so doing it can be improved. This has led me to the view that a systems approach forms a continuum with a scientific approach which ranges from the testing of simple hypotheses to build knowledge to the testing of complex hypotheses to

build systems. These comprise a hierarchy of variables about which choices have to be made when attempting to improve them or to design and construct new ones. To choose is to reject. Thus the process of improving or designing a system is a form of *synthesis* which involves the rejection of other possibilities until a whole entity emerges from the choices made. This entity has its own properties which are irreducible, if it is to retain its identity as a system.

I *believe* we shall end up with refutation as the link between **science** and **systems** in a chain that moves through a spiral until we have no more questions to ask and no more answers to refute. The idea of refutation is difficult for many to understand and accept. Popper (1959) best summarises it when he says: '*The wrong view of Science (and Systems—my insert) betrays itself in the craving to be right*'.

Science and Systems in Action

The central questions are: what must we do to manage *what is* (the initial state in systems theory) and to develop *what could be* (what we want in systems practice) to achieve our purposes and immediate objectives? The following examples imply that to win support, research programs and projects in animal science need to be relevant to the agricultural systems they pretend to understand and improve, and in the context of government policies and plans and the mandates of national and international development agencies.

The examples suggest only the first parts of the iron-clad format in which a traditional scientific, and, I now believe, a systemic, investigation must be reported for public scrutiny and debate. Any RESULTS and DISCUSSION will be incidental to the components of INTRODUCTION AND MATERIALS AND METHODS. The versions you read are the orderly ones, written in hindsight, of the action determined by foresight, which is usually quite chaotic.

A glass of milk

This example comes from the unpublished doctoral thesis of Nguyen (1994) who investigated prospects to expand dairying in the small-scale farming systems of Ho-Chi-Minh-City (HCMC), a province of Vietnam.

Government policy

The livelihood of more than half a million people in the peripheral areas of HCMC depends on agriculture. During the late 1970s the policy of the central government of Vietnam (GoV) and the local government of HCMC (LG) was to set up state farms in rural areas surrounding the city and to encourage farmers to form themselves into production brigades in agricultural cooperatives using a work-based contract system. Agricultural production stagnated. Policy reforms in the 1980s led to marked increases in crop production, especially rice. Prices fell. Farmers looked to diversify production. Dairying was one opportunity identified because urban demand for milk was generating good margins for suppliers of reconstituted milk from imported powder.

During the early 1980s, a few farmers began to engage in dairying on a small scale. Selling fresh milk from 1–3 cows per household greatly improved cash flow and net income. The GoV and LG moved to promote family dairying to bridge the gap between supply and demand and to save millions in foreign currency paid out to import milk powder. In the period 1986–90, the dairy herd in HCMC increased nearly 80%, particularly in three districts (Go Vap, Tan Binh and Hoc Mon) adjacent to the inner city. This occurred even though LG had set vegetable production for city inhabitants as the first priority in these districts. Moreover, land adjacent to the inner city was under pressure to be urbanised.

The first barriers to expansion in dairying were being confronted at the time this research commenced in 1990. These were the conflicts between competing enterprises for a finite resource, land, in a particular location, and for a mobile resource, labour, which was becoming more expensive. It was concluded that dairying based on crop and industrial by-products, supplements of concentrate during lactation, and 'roadside' grasses would lose in these conflicts and be forced to move to small-scale farming systems further from the city. It was also concluded that greater attention to the *deliberate* production of green forage was needed but that the application of research results was constrained by the high price of imported pasture seed and its availability in the market place. The use of perennial forages was thought to be particularly important because more than 80% of agricultural lands in HCMC rely solely on rainfall for crop production.

These conclusions, in effect, were working hypotheses, derived from secondary data and discussions with professional colleagues, to describe the existing and predicted situation in dairying. Assuming these to be 'true', a program of field experiments, farm surveys and abstract modelling was devised to test key issues involved if dairying was to be presented as an additional or alternative enterprise on farms distant from city limits.

Identification, classification and description

At national and provincial levels in the hierarchy of systems, the government wanted to promote dairying to achieve its *public* objectives. These were: to increase employment opportunities in rural areas and

to earn foreign currency, measured as export earning or import saving. But would farmers beyond the city limits be interested in taking up dairying if it did not meet their *private* objectives which were unknowns? How to find out? Simple! Go and ask the farmers. But *which* farmers operating *what* farming systems? A classification of existing farming systems in HCMC relative to the purposes of the research was created (Fig. 1). An *exploratory survey* to obtain primary data about these systems was conducted on 272 farms in August–September 1991. Most of the farms in the surveyed area were less than 1 ha and 78% were operated under rainfed conditions.

More than half the agricultural land in HCMC is lowland paddy which is subject to flooding for 2–4 months in the rainy season and the intrusion of saline water in the dry season. Few farmers were found raising dairy cattle; the area was deemed not suitable for dairying. The systems chosen for further investigation were in the uplands of Cu Chi, Thu Duc and Binh Chanh districts and in the transitional paddy lands of Cu Chi, Hoc Mon, Binh Chanh and Thu Duc districts.

Survey

A structured survey of 70 farm households was carried out in December 1992 to describe the identified farming systems in more detail; this included an assessment of farmers' objectives and aspiration levels. For modelling purposes, the objectives were summarised as: maximising gross margin and ensuring self-sufficiency in rice and minimising risk and hired labour. A farm close to the median of each data set was chosen as *the representative farm* for each of the farming systems to be modelled: rainfed upland, rainfed irrigated, rainfed transitional paddy, irrigated transitional paddy. These data were used as the base farm plan into which dairy cows might be introduced to test the overall hypothesis that private and public objectives could be harmonised.

Abstract modelling

Obviously, there were differences between what the government wanted and how a private farmer might respond relative to his own objectives. There were also similarities. The priorities and weights given to these in decision-making are complex. To examine these differences and similarities, and the potential for synergy, a Multi-Criteria Decision-Making (MCDM) model was constructed. MCDM has evolved as the general name for a suite of mathematical modelling techniques to test a range of scenarios for outcomes relative to objectives. Goal Programming (GP) is one of these. It was used in this investigation because it could take into account a farmer's objectives which can be summarised further into a question: What *reward* do I get for the *risk* I take and the *effort* I make?

The existing farm plans were *optimised* with and without a dairy cow and compared. After that *a sensitivity analysis* was conducted on farms planning to introduce dairying, to evaluate the effects that

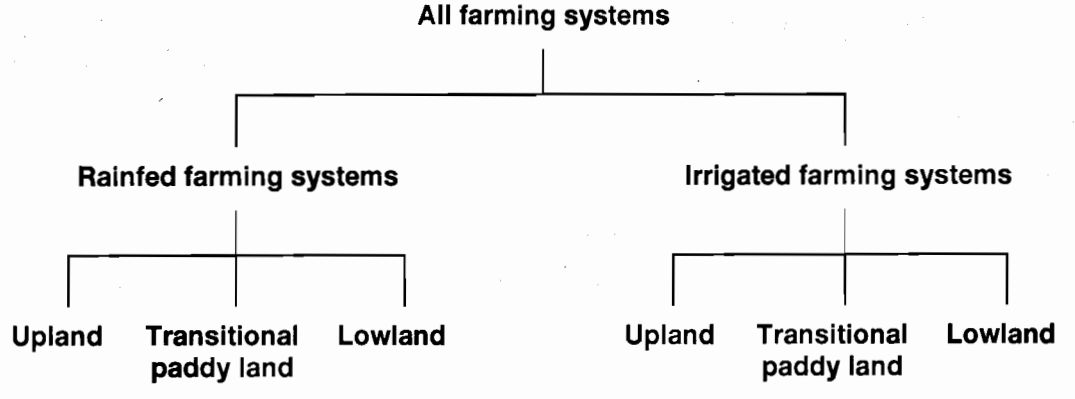


Figure 1. A classification of farming systems in the province of Ho-Chi-Minh City, Vietnam (adapted from Nguyen 1994).

different policy decisions and farmer choices might have (in concert or in conflict) on public and private objectives. The combination of priorities and weights assigned to a model's objectives were varied as well as some of the fixed variables in the systems. These were: farmers' aspiration levels for gross margin and minimum income; price of milk; interest rate on a loan to buy a dairy cow; wages of hired labour; and other animals in the livestock sub-system of a farm.

Field experiments

Centro (*Centrosema pubescens* Benth.) and guinea grass (*Panicum maximum*) are well known perennial forages deliberately grown in various parts of the tropical world to feed beef and dairy cattle. Home-grown seed is one solution to the problem of pasture seed supply for small-scale farmers who want to produce milk from forage in the humid tropics where problems of storage life and distribution are acute. This activity can lead to a modest farm-to-farm seed trade within a farming community. Three field experiments (conforming to the traditional method of agricultural science) were designed in this context to evaluate the seed and forage potential of centro and guinea grass cv Makueni, grown alone and in combination. They provided primary data for the GP models to test whether seed crops of these species could compete as cash enterprises with other crops in modelled farm plans.

In the first experiment centro was grown for three seasons on different support systems to maximise the potential of limited space and to facilitate hand-picking. Herbage residues were measured and analysed for their nutritional value as ruminant feed. The second and third experiments measured, over two seasons, the trade-offs between a catch crop of seed and green forage yield as influenced by the management practices of defoliation and closure date.

This program of work to investigate prospects to expand dairying in HCMC involved the old hallmarks of **science**, *deduction* and *induction*, the three processes of the modern scientific method, *reductionism*, *repeatability* and *refutation*, the twin ideas of *hierarchy* and *emergence* in **systems**, and the primary questions of the systems method: '*Who is involved?*', '*What system is to be improved?*' and '*What constitutes an improvement?*'.

An egg a day...or a fish

An egg and a fish represent small 'parcels' of concentrated nutrients which are almost interchangeable in the context of the nutrition of a farm family. I do not have any egg stories but I do have a fishy one! It comes from Gartner and Aguirre (1995) and concerns a conventional field experiment on one component (grass) of a fish-feeding sub-system run in parallel with the testing of improvements to its supra-system, a fish production system, which was integrated with *its* supra-system, a farming system. The primary purpose of the farming system was to produce food for the family; its secondary purpose was to sell surplus products in local markets.

In the 1980s, the idea to integrate aquaculture with agriculture on small-scale rice farms in Thailand focussed specifically on the use of inputs produced on-farm. Much scientific research had been done and some hypotheses to include buffalo manure as a pond fertilizer and rice bran as a feed stock had been tested. These were extended to include the *deliberate* production of grass to feed a herbivorous fish species cultured together with other fish species in the system.

The fish production system was designed and constructed in 1986 from the provisional facts of aquaculture science and tropical pasture science, which, hitherto, had been quite separate. It was tested in the context of a 2.5 ha rice farm operated under rainfed conditions; other cash crops were grown and buffalos were raised. Each year thereafter, for the next three years, system design was adjusted to incorporate solutions to problems revealed by the work of the previous year and by other research. These included the use of a predator fish (*Channa striata)* to control reproduction in *Oreochromis nilotica*, the principal fish species used; the testing of *Ctenopharyngodon idella* as an alternative to *Puntius gonionotus* as the herbivorous fish in the polyculture; the use of inorganic chemicals to fertilise a pond; and the nursing of fish fry in happas prior to their release in open water. The major problem that emerged, however, was the acceptance and consumption of para grass (*Brachiaria mutica*) which was chosen as the principal feed stock for herbivorous fish. It became obvious that the culture of grass on pond dykes should be treated seriously as a sub-system of, and not an addendum to, the fish-feeding sub-system.

The point of this example is that it took three years (1987–90), to establish with confidence ($P<0.05$), the desired provisional facts about how the perennial plant, para grass, would respond to nitrogen (N) fertilizer when grown in a formal field experiment on an acid sulfate soil under rainfed conditions in a particular location. Thus, a great deal of work was involved to obtain *one value for one variable* in the fish-feeding sub-system: the rate at which N should be applied to maintain a specified quality (N%) in a particular quantity of grass over a given period of time. But knowledge and experience gained from a field experiment designed to investigate growth responses of a specific system component is not enough *to manage* the component in the context of the whole system. The actual experience of choosing from

among relevant 'bits' of knowledge and opinion to design a grass management system for the specific purpose of feeding herbivorous fish is essential; to test the design physically is doubly essential if it is to be refined and explained to farmers. The *first* test of a designed system was undertaken in 1989–90 as the last project in the overall program of work entitled 'Improving a fish production system on a small-scale, rainfed, rice farm'.

Participation and persistence

With these examples I have tried to demonstrate how the dual activities of scientific experimentation and systems design and testing, represent a continuum between the polar positions of reduction in **science** and emergence in **systems**, and how they involve the testing of simple and complex hypotheses. This has implications for the process of agricultural (and aquatic) research, extension and practice. It is important that existing and/or potential *owners* of a system *participate* in its evolution in order to understand and refine it. In so doing they assimilate knowledge and accommodate only what is essential to manage the improved system. *Persistence* is required until chaos is ordered and complexity is rendered simple. These are the overarching themes in scientific experimentation to answer difficult questions, and in attempts to improve a system until needs are satisfied and management becomes a habit—and we knew what to, and how to do it, all the time!

References

Checkland, P. 1984. Systems thinking, systems practice. Chichester, John Wiley and Sons.

Gartner, J.A. 1993. Postgraduate education in agricultural systems: the AIT experience. In: Penning de Vries, F.W.T., Teng, P.S. and Metselaar, K. ed., Systems approaches for agricultural development. The Netherlands, Kluwer Academic Publishers, pp. 484–504.

Gartner, J.A. and Aguirre, E.M.C. 1995. Improving a fish production system on a small-scale, rainfed rice farm: an incremental process. Studies in Agricultural and Aquatic Systems, Bangkok, Thailand, Asian Institute of Technology (in press).

Magee, B. 1973. Popper. London, Fontana/Collins.

Popper, K.R. 1959. The logic of scientific discovery. London, Hutchinson, 281 p. (First published in German, 1934).

Nguyen, T.T. 1994. The development of small-scale dairy production systems in the Province of Ho Chi Minh, Vietnam. Unpublished Doctoral Thesis, Bangkok, Thailand, Asian Institute of Technology.

Farming Systems Research (FSR): a Brief Review and Example

R.J. Petheram*

Abstract

In the 1970s and 1980s many agricultural institutions in tropical countries commenced FSR programs. FSR-based cropping systems research is more common than livestock-orientated FSR, but there is a growing literature on methods directed to livestock. FSR places strong emphasis on participation by farmers at all stages of research.

The rationale for FSR is discussed and some common features of the philosophy are drawn from a number of programs. A generalised procedure for FSR is presented, and an example of FSR amongst cattle rearers in Indonesia is provided.

The FSR in Indonesia placed emphasis on moving as quickly as possible towards conducting trials on farms. Some lessons learned were that farm trials must be simple and that the most valuable results of trials with livestock are not obtained from statistical analyses, but arise from close farmer contact and farmer opinion and adaptation of the ideas to suit their special needs.

The example further showed that internationally funded FSR projects can be an effective way of using limited funds to achieve multidisciplinary cooperation, and to bring benefits for farmers in priority regions.

The introduction of FSR needs careful consideration in terms of structure and relationships to discipline-orientated research programs. Major requirements for successful FSR are sound training in FSR for scientists and administrators, strong leadership and an incentive system that recognises the importance of participatory activities of scientists with farmers.

Approaches in Agricultural Research

In most countries, agricultural research has traditionally been organised on the basis of 'disciplines' (e.g. breeding, nutrition) or 'commodities' (e.g. pigs, poultry). Also, research has been conducted mainly on experimental stations.

In the 1970s and 80s, many international research organisations (e.g. IRRI, ICRISAT, CYMMYT) introduced programs of FSR (Anderson and Dillon 1985). This trend was subsequently followed by national research institutions in many countries although the terminology and names of programs vary widely. This paper provides a brief summary of the now extensive literature on FSR.

* Victorian College of Agriculture and Horticulture, Longerenong Campus, RMB 3000, Horsham, Victoria 3400, Australia.

What is farming systems research?

FSR is not a new discipline but a concept of research that differs from traditional agricultural research in approach and organisation. It involves the application of methods and knowledge from various disciplines, first to define the constraints to 'improvement' to existing farming systems, and then to overcome these in a process involving the participation of farmers (Dillon 1976; Simmonds 1985).

The activities of FSR can vary widely, from land classification to rapid surveys, and from farm trials to computer modelling (Sands 1985).

FSR may be viewed as both a philosophy and a procedure arising from that philosophy. Some main features of the philosophy are listed below.

- FSR starts with the farmer as its client. It attempts to understand the predominant factors of a farming system: biological, economic, social, political; and then seeks solutions to the main constraints (Casey and Barker 1982).

- A farming system is a farm or group of farms operating similar enterprises, with similar goals, resources and environment.
- FSR views the farm as a whole, recognising and emphasising the interrelationships between elements of the system (Dillon and Anderson 1984).
- It attempts to understand 'what, how and why farmers do what they do', and what effect change would have on the farmers' system and welfare (Casey and Barker 1982).
- FSR involves different types of experimentation, which allow people from different disciplines to work together with a common aim—'improvement' of the system.
- FSR rearranges the environment in which research is conducted (Nygard 1982) with the aim of improving relevancy and efficiency.
- However, FSR is neither a panacea nor a substitute, but is a complement to strong disciplinary research (Rohrbach 1981).

The main aim in FSR is improved benefits for farmers from their farming enterprises. Other common aims are greater overall productivity and the development of more sustainable farming and systems.

FSR and the small-scale farmer

It is suggested that the move towards a FSR approach in tropical countries is occurring because agricultural programs in the past have provided few benefits for small-scale farmers who have little land or influence. Research has often focussed on large-scale producers and not accepted that traditional practices of small farmers are sound, needing only modification.

The concepts of FSR developed almost simultaneously in a number of institutions, as an approach to give 'voice' to small-scale farmers and to take a more holistic view of their situations. Dillon (1976) stated that, in the long-term, it would be the greater cost-efficiency of a systems approach that would be the strongest motive for change from emphasis on discipline-orientated research, towards FSR.

The organisation of FSR

FSR is usually introduced in efforts to improve the efficacy of research through better focussing on farmers' problems (Dillon and Anderson 1984). Merrill-Sands et al. (1991) studied factors affecting the success of 'institutionalising' farmer-orientated research across 17 organisations.

Difficulties discovered were lack of:

- understanding of FSR concepts by administrators;
- recognition for scientists working with farmers; and
- necessary long-term support.

The FSR approach facilitates:

- the formation of multidisciplinary teams;
- involvement of specialist scientists with farmers, in situations where these two tasks are difficult to achieve;
- component-orientated FSR such as cropping, livestock, agroforestry, draught animal power, forage and aquaculture-orientated FSR programs; and
- flexible programs where farmers overcome problems/constraints such as human health in addition to achieving cooperative agricultural research goals.

FSR has been practised more widely on cropping than on livestock systems and advances in crop production have vastly outpaced those in livestock enterprises. Various authors have discussed the commonalities and difficulties in livestock and crop-orientated FSR (de Boer et al. 1993).

A Procedure for Livestock-orientated FSR

A generalised procedure for FSR used by many research organisations is shown in Figure 1. Although the flow of activities is shown as a straight line, the procedure is really cyclical and continuous.

Time-scale and scheduling of FSR activities

The methods used at each stage of FSR, and the time and emphasis spent on each, depend upon the nature of the farming system, the secondary data and research resources available, and the level of support from extension and other agencies.

Where few secondary data are available concerning the region and system, a longer period may be needed to collect data on which to base the selection of farmer domains and research sites, and in the diagnosis of constraints than when secondary data are readily available. Some early FSR programs placed major emphasis on the collection and analysis of extensive baseline data. Modern FSR programs have evolved more efficient methods, which can lead to an early start to the design and testing of ideas for improvement. Generally, it is in working with farmers to test ideas on farms that their real problems are revealed, and a true perspective gained of what research is relevant. (Horton 1983).

Figure 2 shows a typical schedule of activities for the initial stages of FSR, based on two programs of livestock-orientated FSR in Indonesia. The time scale of two years is arbitrary, and represents only the start of a longer-term program of research and development.

Activities in Livestock-orientated FSR: an Example from Madura

The stages of the FSR procedure are discussed briefly below under the headings shown in Figure 1.

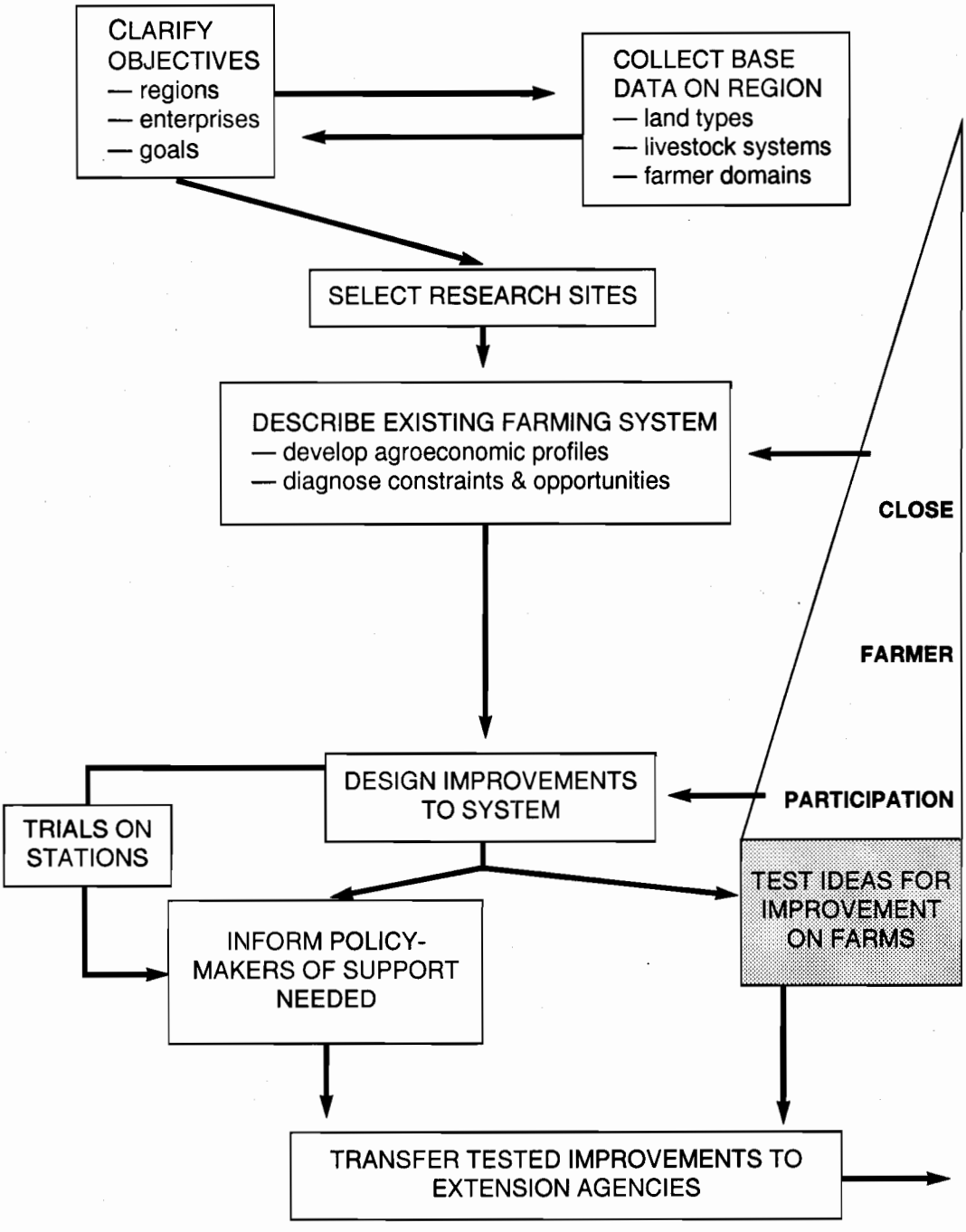


Figure 1. A general procedure for far systems research, emphasising the increasing importance of participation and on-farm testing with time.

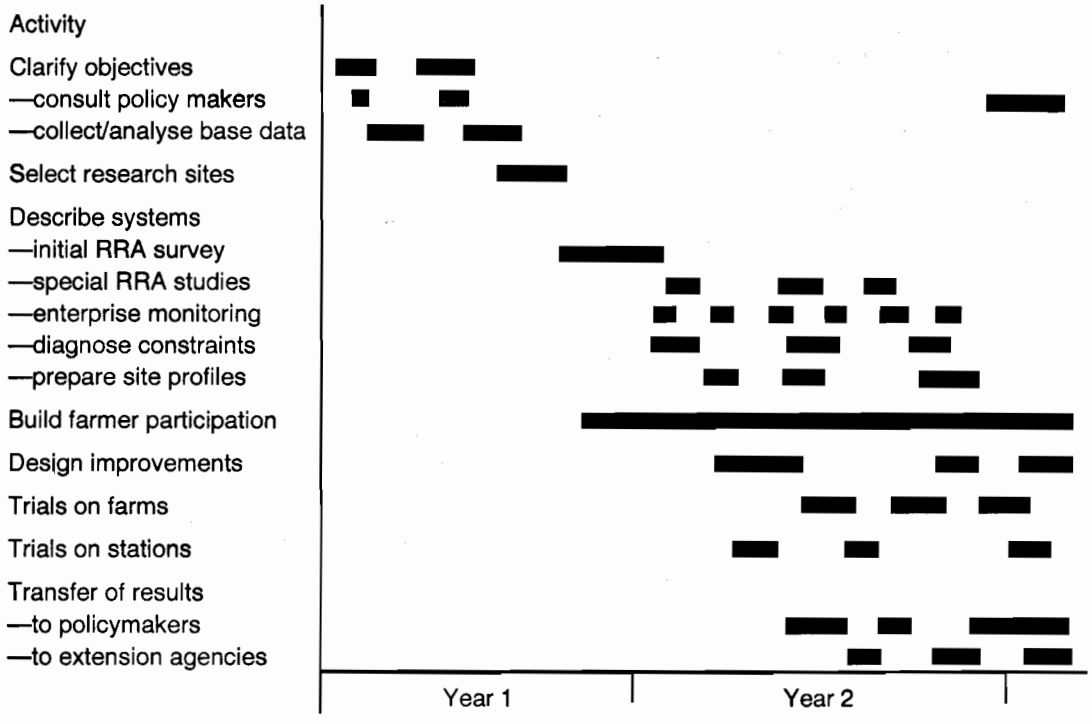


Figure 2. Approximate sequence of activities in livestock-orientated FSR.

An example is used of a program of FSR in Madura, involving scientists of the Research Institute for Animal Production in Indonesia.

Clarification of objectives and analysis of regional data

The first step in FSR is to identify the farmers (and farming systems) for whom improvements are to be formulated and define objectives clearly at the start. If FSR programs (and research sites) are aligned with national development aims and projects, they are much more likely to obtain the support that they need for success.

Thus, FSR scientists must be prepared to deal with policy makers, in planning research and selection of sites. Most forms of regional statistics require careful study and processing before they can be used to justify plans and selection of sites for research. Data tabulation, checking, analysis and mapping can therefore constitute an important first stage of FSR.

In the example from Madura, FSR was conducted in collaboration with the Livestock Services Department in a dry district of East Java. That department's aims of 'improving the livelihood of small-scale cattle rearers' coincided with those of the FSR Program of the Research Institute for Animal Production, which had a mandate to work towards livestock development in drier areas. Early FSR activity involved a joint study of land, climate, farming and cattle production on the island of Madura. This helped to clarify objectives and selection of research sites.

Selection of sites for FSR

An FSR site is an area comprising a number of representative farms and requires clear prior definition of aims and farmer domains of interest. Site selection criteria are established to fit objectives and resources of the project (Santoso et al. 1987).

In the Madura study FSR was studied in two main land-use-types in the district. Four criteria for selection of two villages were:

- high cattle density (over 50 head/km^2);
- existence of a cattle credit scheme;
- collaborative attitude of farmers; and
- reasonable access from district centre (one hour).

Using these criteria and data on climate, land use and cattle numbers, one rainfed village and one irrigated village were selected. Setting objectives, liaising with policymakers, meeting with village leaders and site selection took about four months.

Description of farming systems (research sites)

The descriptive (or 'diagnostic') phase is to develop, an 'agroeconomic profile' of each research site, to help explain the situation to policymakers and the specialists needed to design and test possible improvements. The profile should include only key information for understanding and diagnosing farmers' problems and opportunities for making recommendations.

Time-consuming methods such as formal surveys and long-term monitoring of farmer activities are avoided, and rapid ways of gathering data sought. Rapid rural appraisal (RRA) or participatory rural appraisal (PRA) are terms applying to a range of techniques, developed to obtain key information efficiently in complex situations (Carruthers and Chambers 1981, Farrington and Martin 1988, Young 1993).

In livestock FSR, the description stage embraces both conventional methods and special RRA methods for livestock. Usually, more than one method is used to obtain data. From this an agroeconomic profile of each FSR site is obtained which serves to provide research workers, as well as policy makers and funders, with a site description including diagnosis of constraints and opportunities.

Initially, RRA methods were used to obtain information on rearing and feeding and estimates of growth and reproduction. The first RRA survey was followed by studies on problem areas, for example, reasons for non-rearing, soil sampling and analysis. Farmers were sought to take part in a one year production monitoring program. Some of these farmers later took part in farm trials in the villages.

At an early stage in Madura, the RRA data were used to diagnose some major constraints amongst cattle rearers, which were:

- inability of farmers to feed cattle to attain high prices in (Jakarta) markets;
- poor quality of dry season feed; and
- a lack of credit for cattle purchase and feeding inputs.

An initial agroeconomic profile was produced after eight months, for use in design and testing of ideas on farms and stations. This profile was developed further as more information became available from enterprise monitoring and later from farm trials. It became an authoritative document on cattle farming and the surrounding system, for use by local scientists and administrators.

Design of possible improvements

The main aim in the design stage of FSR is to generate in existing systems, improvements which are practical and attractive to farmers. Design therefore involves assembling a pool of ideas and then screening these for physical and economic feasibility, social acceptability and likely effects on the surrounding system.

Prospective 'improvements' for farmers may include mechanical, biological, chemical or managerial changes to systems, as well as institutional changes such as improved marketing. Various authors have discussed the special features of improvements to suit the needs of livestock rearers (e.g. de Boer et al. 1993).

In Madura, the FSR scientists and extension staff discussed the main constraints identified in the village profiles. Priority was given to poor dry season feed quality and supply, and a list of possible improvements was produced. These were screened amongst farmers and village officials, to produce a short-list of ideas, including:

- new forage species for special areas of land;
- feed supplements based on local by-products;
- inclusion of feed supplements in a credit package; and
- privatisation of communal forage areas.

The possibilities listed were selected as a means of initiating some early (best-bet) interventions in the villages, with a view to showing farmers the commitment of the FSR program. As the program progressed, further ideas for improvement were identified and listed in the site profile (Fig. 2).

Testing ideas for improvement on farms

Designing statistically sound experiments with livestock on-farm is difficult, given the small numbers of animals on farms and the high variation between enterprises. In general, publications that have dealt with livestock farm trials (e.g. Nordblom et al. 1985) tend to reflect unrealistic situations and trial designs.

Farmer participation in the design and management of trials has been strongly debated in the FSR literature (e.g. Ashby 1985; Farrington and Martin 1988) and farm trials have been classified according to the degree of involvement of farmers:

- researcher designed and managed farm trials;
- researcher designed and farmer-managed trials;
- jointly designed and farmer managed;
- farmer designed and managed trials.

In farm trials with ruminants, a major difficulty is the perceived need for a larger number of animals than are available on single farms. The use of farms with high numbers of stock biases the type of farm, while the inclusion of too many farms leads to

unrealistic work in supervision of trial. Experience with trials in Java suggest that trials should be kept simple, but that they can include a range of studies, such as:

- studies of existing innovative enterprises (productivity and profitability);
- adaptation trials, to test the practicality of an idea and adapt it for local use;
- trials with two treatments involving selected animals on several farms; and
- demonstration trials, using model enterprises on selected farms.

Since the achievement of statistically significant results in farm trials with livestock is seldom possible, it should not be the aim. The main values of farm trials arise from (a) learning about the practicalities of using the technology and (b) assessing farmer opinion of the ideas being demonstrated. If monitoring studies have provided information on the normal range of village performance, then control groups may not be needed. Farmers themselves are usually the best judges of potential value of a new technology for their own stock. However, portable scales and other objective measuring devices are essential tools in farm trials.

In the case of the FSR program in Madura, the first idea arising from the design stage was taken up with forage specialists, where farmers were particularly interested in trying new forages. Forages for six improved legume and grass species including those for shady areas around houses and fields, and on the banks of dryland rice fields were offered as seed and other planting materials. Farmers were shown pictures of the species and were asked to plant these as they saw fit within their available land areas. One cultivar (Hamil Grass) proved very successful, in shady areas on one farm. After field days were held on this farm, hundreds of farmers planted this cultivar on their farms. The real value of this innovation could only be tested by a follow-up study several years later.

The idea of feed supplements was discussed with Livestock Services personnel and administrators of an existing credit scheme. A series of farm trials was developed, to be run with farmers in the credit scheme. Three treatments (plus control) were tested, based on ricebran, molasses and urea, as supplements to local forages. These were applied across two villages, using a young bull on each of 58 farms. Supplements were mixed and supplied to farmers every 30 days during the two 80-day treatment periods (wet and dry season) which were separated by a break of one month. The animals were reallocated to treatment groups, ensuring that no animals were in the control group twice. There were no significant differences in growth rate between treatments, although there was a difference between villages during both seasons. A simpler (two treatment) trial would have been more valuable. Various reasons for poor performance on supplements were revealed , including the finding that rice bran used varied markedly in quality between farms.

Despite the lack of significant improvement in growth of cattle, farmers liked the supplements and requested one be included in a cattle credit package. They felt that the supplement increased the probability of their making a profit and this was verified by later experience of the credit scheme.

The results of the two farm trials outlined from Madura emphasise the need to design only simple farm trials, and to assess farmer opinion of the ideas being tested. Retrospective studies of introductions should be the main criteria of success.

Experiments on research stations in FSR

In the case of FSR in Madura, there was previous information on Madura cattle and on potential supplements (rice bran, molasses and urea) but not on the value of local forages. Laboratory studies were therefore conducted on unusual feeds. Later work with farmers revealed further research needs such as studies for simple testing of hull contamination in rice bran sold in villages.

Transfer of ideas to policy makers and extension agencies

Not all ideas generated at the design stage of FSR are amenable for testing on farms. Many will need to be accepted by policy makers, and may then involve a long-term strategy of training and other support. For example, the fourth idea listed from the Madura FSR study, concerning private forage areas, was considered a longer-term issue to be discussed with policy-makers and village authorities. The involvement of extension agents in the FSR process, especially at the design and testing stages, greatly enhances the chances of benefits accruing to the farmer clients.

A consistent finding in reviews of FSR is that close farmer participation at all stages of research is a most important ingredient for success (e.g. Merrill-Sands et al. 1991; Young 1993). However, this requires commitment of specialists in the FSR process. For specialists, this means a major shift in self-perception and role. Social scientists in FSR teams can assist in strengthening this aspect of research.

Innovation in achieving participation is essential for FSR workers. In the Madura study, farmer participation was greatly aided through an extension agency and an existing cattle credit scheme, and by forming farmer groups in each village. At an early stage of FSR a range of 'best-bet' ideas were sought as a means of gaining farmer confidence and commitment

of scientists to the program. For example, seeds of promising new varieties of maize and beans were given to farmers to try on their fields. Animal health advice was sought for sick animals, and scientists worked with farmers in planting forage species on their land. Video filming of social and farming activities, farmer visits to other areas and scientists staying in villages, were other 'techniques' found to be valuable in gaining the close participation of farmers.

Some Conclusions on Introducing FSR

It is important that FSR is introduced in a way that is complementary to traditional research (Norman and Gilbert 1981).

Traditionally-trained agricultural scientists sometimes see FSR as 'work for extension services'. However, most developing countries cannot afford to leave this most critical and difficult aspect of agricultural development to extension agents alone, especially as research scientists are often the best educated human resource available to the agricultural sector.

In introducing FSR, staff with a strong systems perspective and people-orientation must be selected, and training provided to all scientists and administrators in the concepts of FSR. International studies reveal that there is no ideal format for the introduction of FSR, but that there should be:

- an identifiable structure, to encourage multidisciplinary research;
- leadership by a person with a holistic view of farming;
- very strong linkages to national priorities and development projects;
- access to, or capacity for, skilled disciplinary research;
- adequate recognition for participating scientists including support for publication and career development;
- opportunity for peer review; and
- flexibility in staffing, so that current FSR activities determine staffing, rather than the reverse.

Implicit in these recommendations is the major need for a budgeting and incentive structure that encourages, rather than discourages, both a team approach to research and direct involvement with farmers (Merrill-Sands et al. 1991). Recent literature stresses the importance, in livestock-FSR (including foreign-funded FSR projects), of working closely with policy makers, so that there is agreement on aims and on government support for the interventions needed for farmers to derive full benefits (de Boer et al. 1993).

The example outlined of a FSR program in Madura showed that the provision of funding for a small FSR-orientated project can be an effective way of directing research efforts towards tackling the problems of small-scale farmers in regions, and farming systems, of national priority.

In addition to farmer benefits, the project provided the local extension service with essential equipment, training in FSR methods and closer contacts with research specialists. The improved contact, the knowledge gained by scientists of farmers' problems and the greater equity amongst farmers should surely be a step towards sustainable development—the stated goal of most governments today.

References

Anderson, F.M. and Dillon, J.L. 1985. Farming systems research at the IARCs and other international groups. In: Remenyi, J.V. ed., Agricultural Systems Research for Developing Countries, ACIAR, Canberra, 26, 141–147.

Ashby, J.A. 1985. The effect of different types of farmer participation in the management of on-farm trials: a comparative evaluation, International Fertiliser Development Centre, Alabama.

Carruthers, I. and Chambers, R. 1981. Rapid appraisal for rural development, Agricultural Administration, 8, 407–422.

Casey, F. and Barker, R. 1982. A course in farming systems research: The Cornell Experience, Department of Agricultural Economics, Cornell University, Program in International Agriculture, Ithaca, New York.

de Boer, J., Knipscheer, H. and Kartamulia, I. 1993. Constraints to technology transfer for animal science research in Indonesia, Livestock Services for Smallholders: A Critical Evaluation, Proceedings of a Seminar, Yogjakarta, 15–21 November 1992, 357–359.

Dillon, J.L. 1976. The economics of systems research, Agricultural Systems, 1, 5–20.

Dillon, J.L. and Anderson, J.R. 1984. Concept and practice of farming systems research, in Mertin, J.V. ed., proceedings of Conference on Agricultural Research in East Africa, ACIAR, Canberra, 171–186.

Farrington, J. and Martin, A. 1988. Farmer participatory research: a review of concepts and practices, Agricultural Administration (Research and Extension) Network, Discussion paper No. 19, Overseas Development Unit, Regents College, London, U.K.

Horton, D.E. 1983. Social scientists as agricultural researchers; lessons form the Montaro Valley Project, International Potato Centre, Lima, Peru.

Merrill-Sands, D.M., Biggs, S.D., Bingen, R.J., Elwell, P.T., McCallister and Poats S.V. 1991. Institutional considerations in strengthening on-farm, client-oriented research in national agricultural research systems; lessons from a nine country study, Experimental Agriculture, 27, 347–373.

Nordblom, T.L., Ahmed, A.K.H. and Potts, G.R. eds 1985. Research methodology for Livestock On-farm Trials, ICARDA, Aleppo, Syria.

Norman, D.W. and Gilbert, E. 1981. A general overview of farming systems research. In: Shaner, W.W., Philipp, P.F. and Schmehl W.R. eds., Readings in farming systems research and development, USAID, Consortium for International Research and Development, Washington DC, 18–34.

Nygard, D. 1982. Tests on farmers fields. the ICARDA experience. In: Proceedings of Symposium on Farming Systems Research in the Field, Manhattan, Kansas, USA.

Rohrbach, D. 1981. Issues in developing and implementing a farming systems research program, Office of International Development and Cooperation, USAID, Washington.

Sands, D.M. 1985. A review of farming systems research, Paper prepared for the Technical Advisory Committee of CGIAR, Washington D.C., February 1985.

Santoso, Sumanto, Rusastra, W., Peacock, C.P. and Petheram R.J. 1987. Selection of sites for research on draught animal power systems in Indonesia. In: Petheram, R.J. and Teleni, E. eds. 1995 Studies in Draught Animal Power, ACIAR Working Paper No. 44, 31–38.

Simmonds, N.W. 1985. Farming systems research—a review, World Bank Technical Paper No. 43, World Bank, Washington D.C.

Young, J. 1993. Alternative approaches to the identification of smallholder problems and opportunities. In: Daniels, P.W. and Wilson, M. ed., Livestock services for smallholders: a critical evaluation, Indonesia Inter-national Animal Science Research and Development Foundation, Box 1093, Bogor, Indonesia, 123–130.

Overviews of the Major Farm Animal Species in Vietnam

Some Results of Study of Beef and Dairy Cattle in Vietnam

Nguyen Van Thuong*

Abstract

Yellow cattle, the native cattle of Vietnam are numerous and mainly used for draught power. However the demand for draught power is declining and higher productivity in meat and milk from these small yellow cattle is increasingly required. Cross-breeding is the method being studied and implemented to achieve this objective.

Red Sindhi bulls have lifted milk yield and growth in their crossbred progeny. More recently Holstein Friesians have been imported for dairy improvement through their crossbreds whilst the use of Charolais and Santa Gertrudis bulls has also effected an increase in growth rate of progeny.

Experience so far indicates that a three-breed rotational breeding (two tropical and one temperate breed) is strongly recommended for improvement in body size and productivity of native cattle.

THE population of yellow cattle (YC) which are the native cattle of Vietnam is about 3.5 million. They are used mainly for draught power. In association with industrialisation and modernisation of the country, the requirement for draught power is reducing annually. So cattle production has to be turned into specialised beef and dairy industries. Unfortunately, YC with their small body size and low performance have not met the increasing demand for beef and milk to meet the above requirements. It is necessary to improve this performance.

Results and Discussion

Native cattle breed

Native cattle have a small body size and low performance as can be seen in Tables 1 and 2.

As shown, the body weights of native YC and native YC selected cows at maturity are 140–160 and 180–200 kg respectively. The body weights of YC and YC selected bulls at maturity are 200–250 and 250–280 kg respectively. Using the Red Sindhi bull as the sire line has improved the performance of the offspring. The body weight of the Red Sindhi crossbred cows (YC cow × Red Sindhi bull = Laisind) is 35–40% higher than YC, whilst milk yield/lactation of the crossbred or Laisind cow is twice that of the YC cows (790–950 versus 300–400 kg). The dressing percentage of Laisind cattle is also higher by 5% (49% as against 44%) and the draught power of the offspring also higher.

Dairy cattle research

Holstein Friesian (HF) cattle imported from China in 1968

These cattle were first reared in Ba Vi and then transferred to Moc Chau state farm, the main reason being that disease outbreaks caused by protozoa transmitted by ticks and characterised by fever and sudden death occurred in Ba Vi, where the temperatures are higher especially from April to October.

The data in Table 3 indicates that the milk yield/lactation of pure Holstein Friesian (HF) cattle reared in Ba Vi where the average temperature is 25°C was 1900 kg. However this figure was 3000–3200 kg in Moc Chau where the average temperature was lower (18.2°C). The temperatures recorded in the table were obtained from the regional meteorological stations located at Ba Vi and Moc Chau State Farm. The absolute minimum and maximum air temperatures recorded over the observation period are shown.

Since 1970, 2000 HF milk cows have been imported and reared both in Moc Chau and Lam Dong. The milk yield and milk fat of these cows have reached 3700–4100 kg and 3.2–3.6% respectively. From the above data it can be concluded that pure

* Animal Husbandry Association of Vietnam, Ai Phuong Mai Dong Da, Hanoi, Vietnam.

Table 1 Mature weight of native YC and Sindhi crossbred cattle.

	Native YC				Red Sindhi Crossbred			
	Non-selected		Selected		Bull		Cow	
	Bull	Cow	Bull	Cow	Mean	Range	Mean	Range
No. of animals			539	2163	15	15	262	262
Body weight (kg)	200–250	140–160	250–280	180–200	416	314–440	275	200–370

HF can be reared in Vietnam but they adapt well only to areas with an average temperature of below 21°C. The milk yield of HF will be higher if their feed is adequate.

Dairy crossbreeding program data on milk productivity and growth of four dairy crosses.

Production data from the third lactation of cows of four dairy crosses are shown in Table 4.

The results obtained show that F_1 progeny (HF bulls × native, Laisind and Red Sindhi cows) have higher body weight and milk yields compared with those of Red Sindhi crossbred cows The milk yield of the third lactation of the F_1 (HF bull × Red sindhi crossbred cow) and (HF bull × YC cow) were 2081 and 1329 kg respectively. The F_1 (HF bull × Red Sindhi crossbred cow) has the highest milk yield/lactation (2375 kg).

From a consideration of these results, it is recommended that rotational breeding of three breeds (HF bulls × Red Sindhi × YC) is the best alternative for creating dairy crossbred cattle in Vietnam.

Dairy back-crossing program

With the aim of creating dairy cross cows of 50–75% HF blood, F_1 cows (HF bull × Laisind cow) and (HF bull × Red Sindhi cow) were back-crossed with HF bulls with production as shown in Table 5.

It was found that the milk yield of the groups with 75% HF blood was higher than that of the groups with 50% HF blood (2628 kg and 2428 kg compared with 1882 kg). It was also observed that the milk yield of the F_2 (75% HF, 25% Red Sindhi) was higher than that of the F_2 (75% HF Red Sindhi crossbred). Thus the higher level of Red Sindhi blood will give more milk production. The lactation milk yield of pure HF and crosses was significantly increased due to selection and improved feeding systems. Today the milk yields/300 days of pure HF, F_1 (50% HF), and F_2 (75% HF) are 4100, 2640 and 3250 kg respectively. The dairy cattle population in HCMC and Hanoi is now about 11 500 head with an annual milk production of 17 000 t.

Table 2. Performance of native YC and Sindhi crossbred (Laisind) cattle.

	Native	Red Sindhi Crossbred (Laisind)
Body weight (kg)	200	275
Dressing percentage (%)	44.21	49.66
Muscle percentage (%)	35.30	40.69
Milk yield/lactation (kg)	300–400	790–950
Milk fat (%)	>5.5	5.1–5.5
Draught capacity (kg)	640–1150	740–1350
Pulling capacity (kg)	142–247	142–307

Beef cattle research

Two experiments were carried out to evaluate meat production of crossbred cattle with results as shown in Tables 6 and 7.

Under the same feeding conditions, the body weight of Santa Gertrudis × Laisind calves at 22 months of age was the highest (259 kg) but dressing and muscle percentages were not the highest (48.2% and 40.6%). The body weight and dressing percentage of Red Sindhi × (HF × Laisind) calves were higher than those of Santa Gertrudis × (HF × Laisind) and Charolais × (HF × Laisind) calves. It appears that rotational breeding (3 breeds) should be applied to obtain higher meat production.

The results of a second experiment examining age effects on weight of four crosses are shown in Table 7.

From these data it can be concluded that among crosses, Charolais × Laisind crosses were the best in terms of body weight at 24 months and average daily gain (ADG). The ADG of these crosses was 336.69 and 305.14 g/head/day, respectively. These was no significant difference in body weight and ADG of Santa Gertrudis and Brown Swiss crosses.

Table 3. Milk production of pure HF reared at Ba Vi and Moc Chau state farms.

Location	Climatic conditions				Milk yield/lactation (kg)					
	Temperature °C			Relative humidity	Lactation					Milk fat
	Min.	Mean	Max.	(%)	1	2	3	Max.	Min.	(%)
Ba Vi	5.4	25.3	39.5	84.0	1982	1921	1937	4093	669	3.3–3.4
Moc Chau	0.2	18.2	35.0	90.0	2376	2996	3258	6247	451	3.3–3.4

Table 4. Body weight and milk yield of third lactation of dairy crossbred cows.

	Red Sindhi crossbred cow	F_1 (HF bull × YC cow)	F_1 (HF bull × Red Sindhi crossbred cow)	F_1 (HF bull × Red Sindhi cow)
No. of animals	15	15	15	15
Body weight (kg)	329 ± 10.1	323	387 ± 12.1	354 ± 3.0
Milk yield.300 days (kg)	1032 ± 58.9	1329	2081 ± 11.28	2375 ± 18.5
Total milk yield (kg)	1153 ± 51.6	1330	2176 ± 14.2	2881 ± 31.7
Lactation period (days)	312 ± 30.6	–	309 ± 33.0	334 ± 30.9
Milk yield/day (kg)	3.44	4.42	6.90	7.90

Table 5. Body weight and milk production of different genetic groups.

Genetic group	Age at first calving (months)	Body weight (kg)	Milk yield/300 days (kg)	Milk fat (%)
F_1 50% HF 50% Laisind	37.5 ± 3.4	331 ± 22	1882 ± 97	3.89 ± 0.11
F_2 75% HF 25% Laisind	30.6 ± 8.0	358 ± 12	2428 ± 112	3.9 ± 0.14
F_2 75% HF 25% Sindhi	33.3 ± 2.2	392 ± 11	2628 ± 224	3.8 ± 0.28

Table 6. Meat production of crossbred cattle (experiment 1).

Sire	Dam	Body weight at 22 months of age (kg)	Slaughter weight (kg)	Dressing percentage (%)	Muscle percentage %
Red Sindhi	Red Sindhi crossbred	219 ± 09.1	218	42.0	30.4
Santa Gertrudis	Red Sindhi crossbred	259 ± 14.5	239	48.2	37.7
Charolais	Red Sindhi crossbred	244 ± 09.4	243	50.6	40.6
Red Sindhi	F_1 (HF × Laisind)	255.5 ± 7.9	240	49.8	39.8
Santa Gertrudis	F_1 (HF × Laisind)	236.3 ± 11.7	228	47.2	36.7
Charolais	F_1 (HF × Laisind)	213.7 ± 8.9	214	47.1	35.8

Before slaughtering, all the crossbred calves were fattened by being given 20–25 kg fresh grass and 1 kg concentrate/head/day. Productivity and slaughter information is in Table 8.

It was found that F_1 Charolais in particular and Santa Gertrudis calves were of promise when compared with the others. It was also found that Laisind calves can reach 300 kg at 27 months of age and their dressing percentage can be 46.8% if the weaners are given supplements and fattened from 24 to 27 months of age.

Conclusion

To meet the demand for beef and milk in both short- and long-term periods, besides rearing pure HF in some suitable areas, there should be created dairy crossbred cattle (50–75% HF blood) which are well adapted to a range of climatic conditions.

Crossbred calves (Charolais, Santa Gertrudis bulls × Laisind cows) with a body weight of 290–300 kg at 27 months of age and a dressing percentage of 53.4% seem to be better than other crossbred calves. Crossbred (F_1 HF cow × Red Sindhi) calves have higher body weight and dressing percentage than those of other crossbreds. Red Sindhi cross calves can have a body weight of 300 kg and dressing percentage of 46.8% if they are given a supplement and fattened for 3 months.

Rotational breeding (three breeds, two tropical and one temperate) is strongly recommended for improvement of body size and performance of native cattle.

The improvement of body size and performance of native cattle through using Red Sindhi or Sahiwal bulls is the first important step of the cross breeding program.

The results obtained showed that opportunity for improvement of native cattle for milk and meat purposes in the future is full of promise.

Table 7. Body weight of crossbred calves at different ages (kg ± SE).

Sire	Dam	At birth	6 months	12 months	24 months	ADG (g/head/day)
Red Sindhi	Laisind	20.5 ± 0.50	94.2 ± 3.60	143.3 ± 10.4	223.5 ± 10.1	284.94
Santa	Laisind	21.3 ± 0.53	90.0 ± 3.73	157.6 ± 12.9	241.0 ± 10.2	305.14
Charolais	Laisind	21.5 ± 0.58	96.0 ± 3.13	155.2 ± 08.4	263.2 ± 11.2	336.69
Brown Swiss	Laisind	21.7 ± 0.17	98.0 ± 2.83	155.3 ± 05.4	241.7 ± 12.0	305.59

ADG = average daily gain.

Table 8. Effect of three months fattening on the body weight and meat production of 24 month-old crosses.

Sire	Dam	Body weight (kg)		ADG g/head/day	FCR	Dressing percentage (%)	Muscle percentage (%)	Bone rate (%)
		Initial	Finishing					
Red Sindhi	Laisind	239	292	589	5.92	46.8	38.4	8.5
Santa	Laisind	246	293	522	7.10	53.4	44.6	8.8
Charolais	Laisind	243	300	633	5.90	53.4	44.7	8.7
Brown Swiss	Laisind	245	285	444	9.20	48.8	41.5	7.5

ADG = average daily gain.
FCR = food conversion rate.

Development of Poultry Production in Vietnam

Duong Thanh Liem*

Abstract

The conditions under which chickens and ducks are raised in Vietnam are described. Local breeds are disease resistant but have low performance. Ducks can harvest 70% of rice left in paddies. Cross-breeding can be exploited for semi-intensive production. Existing methods of developing poultry production in the differing agroecological zones are described.

There are needs for production models with varying breeds and management systems, an example of which is the integration of Super Meat ducks with fisheries and crops. Improved disease control, nutrition, processing facilities, farmer training courses and research cooperation are needed.

THE number of chickens and ducks in any region of Vietnam depends on the natural environment, economy and society. In the provinces of the Mekong Delta, an area where there is much paddy and many rivers, farmers raise annually 13–17 million ducks and 12–13 million chickens. In other regions of southern Vietnam where there are many areas of high altitude such as the central coast of Southland, central highlands and the south-east of Southland, chicken numbers in 1992 (17 million) were higher than duck numbers (5 million).

Traditional production, in which farmers raise local breeds, low in performance but strongly resistant to disease, relies mainly on agricultural crop usage. This production is still useful in areas where industrialisation is limited. The number of birds increases in the rainy season and where there are rice crops. After harvesting, ducks can pick 70% of the rice left in the paddy, resulting in low-cost duck meat; for instance, farmers can produce 1 kg of duck meat from free-range duck fed only 1 kg of rice. Poultry meat and eggs are plentiful from mid-autumn till the Vietnamese New Year. On such traditional holidays, consumption of poultry meat is high.

Intensive production of poultry can be set up in cities or suburbs where agricultural services are available.

With semi-intensive production, farmers can exploit good characteristics of local breeds by cross-breeding them and vaccinating appropriately (Hai 1995).

* University of Agriculture and Forestry, Thu Duc, Ho Chi Minh City, Vietnam.

Current methods of developing poultry production in the differing agroecological zones are:

- In the suburbs: intensive production with meat or egg lines of chicken and Super Meat duck. (e.g. Suburbs of Ho-Chi-Minh City (HCMC), Long An, Tien Giang, Can Tho, Dong Nai and Song Be provinces)
- On the coast: raising Chinese (Co Lun) ducks or Khaki Campbell ducks which are egg lines with good performance in poor conditions (e.g. mid-Vietnam, Kien Giang, An Giang and Minh Hai provinces).
- In the paddy: using small size Chinese ducks at a rate of 30–40 ducks per hectare. These have a good ability to forage for feed, and also help farmers control insects and yellow snail. Ducks are normally introduced two weeks after rice planting. It is found that Tau Ran, Co Lun and the imported Khaki Campbell ducks are the most suitable breeds.
- In the remote areas: extensive or semi-extensive production with crossbreeding of local breeds and imported breeds (Rhode-Ri crossbreeds, Tam Hoang breeds) providing that vaccination is practised.

In all zones, other needs are:

- Provision of services to supply breeders and especially the involvement of Extension Centres in provinces to do this. Establishment of different models which are suitable for different breeds, for instance intensive production of Super Meat ducks along with fish or with crops (e.g. Phuoc Long Farm, Vigova Farm and Fosaco Farm, HCMC.

- Availability of food and vaccines in all villages and establishment of product price to stabilise farmers' income. Such factors are very important for increasing poultry production in the rural areas.
- Short training courses for farmers to improve their technical expertise. This is effective in increasing poultry productivity (e.g. Man and Dong 1992).
- Cooperation between universities and research institutes in establishing research projects, and the issuing of a poultry journal to extend information.
- Attention to nutritional problems: Quality of poultry feed is another factor which depends on raw materials and environmental conditions. Concentrated energy sources are needed for higher productivity. Kinh (1995) has studied optimal energy and protein requirements for broiler feed and Thuan (1995) for layer hens. Liem in 1980 (Liem 1995) studied trace element requirements in poultry and from the studies developed Protoman, a mineral supplement used for chicken and duck feeding. He and colleagues of the Nutrition Department in 1978 studied the processing and use of carotene leafmeal for poultry feeding and in 1983 led efforts to produce cassava leafmeal in four provinces. About 10 000 t are produced annually and are very effective in producing rich yellow pigmented egg yolks and yellow carcase skins. It is fed at about 3–4% of the diet (Liem 1995).
- Studies to prevent aflatoxin intoxication in poultry have been commenced (Liem and Phung 1995) and continued attention to the potential problem is needed.
- Suitable poultry processing facilities: At present this is mainly done manually but in future will be mechanised in larger units.
- Good poultry disease control: Currently poultry disease is a major problem particularly with the importation of new breeding stock. There is a need for better diagnostic facilities, safer vaccines and locally produced chemicals, medicines and vitamins. Economics will determine whether this occurs or importations continue.

References

Hai, L.T. 1995. Results of cross breeding and selection and experiment of laying hens raised in the garden of Binh Thang (in Vietnamese). Annual Scientific Reports of the Institute of Agricultural Science of South Vietnam, Ho Chi Minh City.

Kinh, L.V. 1995. Determination of optimal levels of energy, protein, lysine and methionine for broilers (in Vietnamese). PhD thesis. Institute of Agricultural Science, Hanoi.

Liem, D.T. 1995. Leafmeal production from legume trees and green crop residues. Journal of Agricultural Science and Techniques (in Vietnamese). University of Agriculture and Forestry.

Liem, D.T. and Phung, L.A. 1995. Aflatoxin in animal feeds and its influences on poultry production in Vietnam. 17th Grain Post Harvest Technology Workshop. Lumut, Malaysia.

Man, N.V. and Dong, D.D. 1992. Potential for development of the native chicken raised on the grey soil of the south eastern part of the South Region of Vietnam (in Vietnamese). Report presented to the Conference on Farming Systems at Bac Thai province, Vietnam.

Thuan, L.T. 1995. Influence of energy and protein level in the yield and quality of laying hens (in Vietnamese). PhD thesis. University of Agriculture and Forestry, Ho Chi Minh City.

Research Work on Pig Production in the Mekong Delta

Tran The Thong*, Le Thanh Hai* and Vo Ai Quac†

Abstract

The Mekong Delta is one of the most important pork-producing areas of Vietnam. Local Ba Xuyen, Thuoc Nhieu and Yorkshire pigs are still low producers and need improvement to meet national policy and market demands.

Studies have been made in both breeding and feeding, which showed satisfactory performance of improved local pigs. Through selection and inbreeding carried out by researchers at the Institute of Agricultural Science of South Vietnam, the Thuoc Nhieu breed has stabilised and improved substantially. Its growth and reproductive performance have improved by more than 10% over those from traditional husbandry. Local Yorkshire pigs have also shown good results.

The crossing of local pigs with Yorkshire and Landrace gave good results in reproduction and showed the superior performance of three-way crosses over two-way crosses.

Studies at Cantho University showed deficient feeding existing in Ba Xuyen pigs which can be corrected by supplementary feeding with concentrates or by complete diet feeding. Growth, carcase quantity and litter performance were significantly increased in the better fed groups.

Further studies on the breeding of Ba Xuyen pigs and the nutritional requirements of local pigs are considered crucial for improvement of meat productivity of future commercial pig herds in the region. Veterinary and housing studies are also needed and should be coupled with conservation of the environment as nationally advocated. Local pork should always be nutritious and safe for human consumption.

LIKE other Asians, Vietnamese relish pork and give the pig the first priority in national animal production. The pig herd of Vietnam, numbering 14 million, is one of the biggest in Southeast Asia. Its product quality, however, is very low when compared to regular farming standards in western countries. The government has introduced numerous measures to develop pig production in its policy to push animal production to be comparable to crop production and to improve the people's nutritional level.

The Mekong Delta is the biggest of the two granaries of the country and its potential is not only in cereal, pulse, vegetable and fruit but also in livestock, poultry and aquaculture. Its swine population accounts for around 40% of that of southern Vietnam. Traditional farming systems practised by rural farmers still comprise the predominant part of pig production of the region. New production technology is applied only in a few commercial farms. In its aim to provide leaner pork for local consumers and a better standard of living, and for export, this section of the economy needs research to modify every area of the pork industry from husbandry to product processing and technology transfer.

* Institute of Agricultural Science of South Vietnam (I.A.S.), 121 Nguyen Binh Khiem, Dist. 1, Ho Chi Minh City, Vietnam.

† Agriculture and Fisheries Export-Import Company (AFIEX), 1234/63 Tran Hung Dao, Long Xuyen, An Giang, Vietnam.

Present Situation for Pig Production

Zootechnical productivity

Pigs in Vietnam can be classified (Thong and Hai 1995) into three general types:

- the meat type, including Yorkshire and various crossbreds of imported western pigs, for example from Europe and America);
- the bacon type, including improved local pigs such as Ba Xuyen and Thuoc Nhieu and crossbreds with more than 50% western blood; and
- the lard type, comprising native breeds and improved pigs that have not met improved selection standards.

The two latter groups comprise 70% of the total swine herd, thereby inhibiting national pork yield. Meat productivity of pigs varies with geographic

regions of the country (Table 1), which are influenced by management practice and breed types.

Weight of liveweight yield per one hundred thousand pigs reflects the breed quality of the pig herd of the provinces. In the central and northern parts of the country, pigs are mostly household animals of indigenous breeds, reared in a traditional scavenging system. They are lard-type animals of small size with slow growth. Pigs living in the vast fertile rice fields and orchards of the Mekong Delta have gradually improved along with the economic development history of the region which is characterised by successive contact with Chinese, French and American pig breeds (Quac et al. 1985). Towards Ho-Chi-Minh City (HCMC) and its surrounding provinces in the south-eastern region of the country, local pigs have improved more and more. Ba Xuyen and Thuoc Nhieu pig breeds were created in the areas of Soc Trang and Tien Giang, respectively, through stepwise crossing of the native Grazer to Chinese Hainan, French Craonnaise, then to American Berkshire, giving rise to Ba Xuyen, or Large White and/or Middle White, ultimately giving rise to Thuoc Nhieu (Directorat National d'Élevage 1960).

Ba Xuyen is moderately productive—between native pigs and the Yorkshire reared locally (Table 2).

Table 1. Pig meat productivity in typical provinces of Vietnam (Thong and Hai 1995).

Province	Pig population ('000 head)	Total liveweight yield ('000 t)	Liveweight yield per 100 000 pigs ('000 t)	Rank
Northern part				
Thanh Hoa	730	36.6	5.0	8
Ha Bac	663	41.7	6.3	6
Nghe An	623	29.6	4.8	9
Central part				
Quang Nam—Da Nang	510	26.2	5.0	8
Quang Ngai	376	16.8	4.6	10
Binh Dinh	318	17.6	5.5	7
Mekong Delta				
Minh Hai	392	27.0	6.7	5
Tien Giang	341	29.9	9.0	3
Ben Tre	249	20.9	8.2	4
South-eastern region				
Dong Nai	182	18.9	9.9	2
Ho-Chi-Minh City	171	18.9	11.0	1

Table 2. Growth, carcase and reproductive performance of native, improved local and local Yorkshire pigs.

Performance characteristic	Native I breed[a]	Improved local breeds		Local Yorkshire[d]
		Ba Xuyen[b]	Thuoc Nhieu[c]	
Liveweight at 8 month (kg)	40	65.8	72.2	78[e], 101.8[f]
Daily weight gain, weaning—8 month (g)	170	325.3	376.6	450
Carcase at 100 kg liveweight				
• Dressing percentage (%)	60.7	79.3	81.3	
• Wholesale cuts (%)		72.0	74.1	74.7
• Loin-eye area (cm^2)		21.0	21.6[b]	33.8[b]
• Backfat thickness (mm)	35	43.6	43.5[b]	26.1
Litter size at birth (piglets/sow)	9.4	8.5	8.8–10.0[g]	9.0–9.8[g]
Litter size at weaning (piglets per sow)	7.2	7.7	8.4–9.5[g]	8.5–9.6[g]
Piglet weight at weaning (kg/head)	4.5	7.5	8.7–10.2[g]	12.6–12.2[g]

[a] Mien (1977); [b] Quac (1989); [c] IAS. (1990a); [d] IAS. (1990b); [e] of gilts; [f] of boars; [g] from first to third parity.

Consumption trend

It is true that native pigs only suit a local self-sufficient economy in remote villages where farmers can afford small-size pigs for their family feasts. They are satisfied with slow growing and fat pigs. Fat is widely used in daily cooking by rural housewives. On the other hand, where the living conditions are improved such as in cities, towns and even now in the small population centres of rural villages, people prefer to eat more lean pork and will pay more for it. Table 3 gives an example of that tendency in 1994.

Recent data from 1994–5 (AFIEX 1995). indicate that buying price of market pigs offered by animal merchants is always higher by about 10% for animals kept on commercial farms than for those kept in rural areas.

The reasons why farmers continue to prefer local rather than western pigs are that capital input for initial animals, that is cost of housing and feed, is lower and they are easier to rear. From field studies, however, it is seen that commercial pigs are more economically efficient, as shown in Table 4 for example.

Table 3. Price range (VND/kg) of fat and lean cut at local markets.

Region	Fat	Lean cut
Mekong Delta	6000–8000	17 000–22 000
Ho-Chi-Minh City	6000–9000	20 000–25 000
Coastal central provinces	7000–9000	17 000–20 000

Source: Thong and Hai 1995.

Research to Improve Pig Production

Vietnam has developed a package of projects for the technical improvement of its swine production, including studies in breeding, feeding, management and animal health.

This paper aims to describe some important projects which have been undertaken toward that objective for Ba Xuyen and Thuoc Nhieu pigs and their close Yorkshire relatives.

Breeding

The first important discipline on which scientists and authorities have focussed is breeding. Research was carried out on management and renewal of breeding boars, to stabilise and improve the breeding stock, and subsequently on selective crosses with imported pigs such as Yorkshire, Landrace and Duroc to develop the commercial pig herd for local consumption and export.

Selection and inbreeding

THUOC NHIEU PIG

A project of selection, inbreeding and improving breed quality of Thuoc Nhieu pig was carried out by the Institute of Agricultural Science of South Vietnam during 1981–1989 (IAS 1990a).

Breeding pigs were selected from rural backyards in Tien Giang province based on preset criteria of conformation, growth rate, litter performance (for sows) or semen quality and sired litter performance (for boars). First-grade boars and sows of second grade and upwards were brought into the 'April-the-Thirtieth' state breeding farm of the province for inbreeding between lines for two more generations with continuing selection. Results showed significant increases in weaner weight of 18% and weaned litter size of 10%. Selected sows also showed good prolificacy, surpassing Yorkshire sows reared in Vietnam.

Table 4. Primary comparison of pig production in rural areas to that in urban areas.

Item	In rural areas (VND)	In urban areas (VND)
Initial pig cost	200 000	500 000
Housing mortgage	nil	(750 000 × 4.5/60) = 56 250
Feed cost	(1050 × 660 kg) = 693 000	(2050 × 280 kg) = 562 800
Labour cost	(1000 × 300 days) = 300 000	(1000 × 135 days) = 135 000
Total	1 193 000	1 254 050
Butcher pig sale	(12 500 × 100 kg) 1 250 000	(14000 × 100 kg) = 1 400 000
Profit per pig	57 000	145 950

Source: AFIEX 1995.

YORKSHIRE PIG

A similar project (IAS 1990b) with similar objectives involving the Yorkshire reared for a decade in HCMC and its surrounding provinces was carried out. Selection was made on 216 sows and 23 boars at different commercial breeding farms and 1050 sows and 40 boars at family farms.

It was found that the pigs studied had almost all the conformation characteristics of the typical Yorkshire with a few minor deviations such as small black spots on the skin in the orbital or trunk regions, arched or straight backs and it was also more meaty. The animals had good breeding quality, 80% of boars being of first grade and all sows second grade or better. Selected pigs showed improved performance over the population average, by 16% in newborn litter weight, 9% in litter size at weaning and 17% in litter weight at weaning.

Crossing

The first project (IAS 1990a) also carried some crossing programs between the Thuoc Nhieu and Yorkshire and Landrace, which were tested on 419 progeny litters. Results, as presented in Table 5, showed that Thuoc Nhieu sows crossed with Yorkshire or Landrace had higher performance compared with pure Thuoc Nhieu, even with pure Yorkshire or Landrace, and that three-way crosses were higher than two-way crosses.

Table 5. Reproductive performance of purebred and crossbred sows.

Crossing formula	Weaners/sow/year (n)	Weight of weaners/sow/year (kg)
T	14.39	157.17
Y	15.14	165.36
L	15.27	197.75
Y×Y×T	14.85	199.65
Y×T	16.43	218.64
Y×L×T	16.47	231.97
L×Y×T	17.43	243.38

Y: Yorkshire, L: Landrace, T: Thuoc Nhieu.

Feeding Research

Nutritional status

PHYSIOLOGICAL NUTRITION

One primary haematological study (Quac et al. 1985) carried out at Cantho on Ba Xuyen slaughter pigs found a possibly permanent anaemic and hypothyroidic condition, as reflected in low haemoglobin concentration and low blood sedimentation rate but a possibly good energy metabolism, as reflected in a high erythrocyte count in pigs reared in rural areas.

NUTRIENT DIGESTIBILITY

Digestion trials were carried out at Cantho University (Quac 1989) comparing Ba Xuyen and Yorkshire pigs. Ba Xuyen were shown to be better able to digest cereal crude fibre and plant crude protein.

Feeding experiments

FEEDING OF SUPPLEMENTS

Trials at Cantho University (Quac 1989) proved that supplementation of vitamin A-D or green silage restored thriftiness to underfed Ba Xuyen weanlings and the addition of supplemental calcium, phosphorus, micromineral-vitamin premix or protein, substantially improved weight gain in weanlings, litter weight in sows and semen quality in boars.

COMPLETE DIET FEEDING

A trial at Cantho University (Quac and Dung 1988) showed that complete formulated diets improved weight gain and carcase quality in Ba Xuyen growers.

USE OF FEED PREMIXES

Experimental protein/mineral/microelement premixes and vitamin supplements were tested (Quac et al. 1988) and found to maintain good performance in different types and breeds of pigs fed conventional complete diets.

Further research approaches

Past research work on local pigs revealed a need to establish a foundation herd of local sows for future upgrading of commercial pigs to meet market demands. Imported pigs used for crossing need to be acclimatised to allow their maximum use.

In accordance with the national program of improvement of living environment for the people (Ordinance No. 200 dated April 29, 1994 of the Prime Minister), pigs have to be reared in confinement with proper housing to stop the contamination of local waters with animal excreta and to provide a sanitary environment for pigs. Housing techniques applied to the conditions of the region need to be studied. Feeding techniques also need to be appropriate for the region. Extension work also needs to be strengthened encouraging knowledge to be diffused into smallhold farms and effect changes in husbandry practice. Animal health must also be improved in such new management systems.

References

AFIEX. 1995. Result of field survey on pig price (in Vietnamese). Fast Report. AFIEX Agriculture and Fisheries Import-Export Company Feed Mill, An Giang.

Directorat National d'Élevage. 1960. La production porcine au Vietnam (in French). Directorat National d'Élevage, Ministère d'Agriculture, Saigon.

IAS 1990a. Selection, inbreeding and raising the breed quality of Thuoc Nhieu pig, project 02.03: 1981–1985, project 02B:1986–1990, (in Vietnamese). Department of Small Livestock, Institute of Agricultural Science of South Vietnam. Ho Chi Minh City, IAS.

——1990b. Selection, inbreeding and raising breed quality of Yorkshire pig to establish the Vietnamese York Pig, (in Vietnamese). Summary. Institute of Agricultural Science of South Vietnam. Ho Chi Minh City, IAS.

Mien, Tran Dinh. 1977. Selection and breeding of domestic animals (in Vietnamese). Hanoi. Nong Nghiep Publ.

Quac, Vo Ai, Trinh Huu Phuoc, Nguyen Minh Thong, Tran Phu Loc and Ta Vu Ky. 1985. Preliminary results of the study programme on the spotted Ba Xuyen Pig at Hau Giang Province, 1982-83, (in Vietnamese). Paper presented at the Appraisal Meeting of the Committee of Science and Technology, Ministry of Agriculture, November 1985, Ho-Chi-Minh City.

Quac, Vo Ai and Dung, Nguyen Nhut Xuan. 1988. Effects of supplementation of protein on growth and carcase value of Ba Xuyen barrows, (in Vietnamese). Paper presented at the Appraisal Meeting of the Committee of Science and Technology, Ministry of Agriculture, November 1985, Ho-Chi-Minh City.

Quac, Vo Ai, Manh, Luu Huu and Dung, Nguyen Nhut Xuan. 1988.Experiments on feed concentrates in pig feeding, (in Vietnamese). Paper presented at the Scientific Meeting of the Department of Agriculture, Hau Giang.

Quac, Vo Ai. 1989. Study on breed characteristics and improvement of the Ba Xuyen Local Pig in the Mekong Delta of Vietnam. Ph D Thesis. Academy of Agriculture and Technology in Olsztyn. Olsztyn, Poland.

Thong, Tran The and Hai, Le Thanh. 1995. Raising the quality of the Mekong Delta Swine Herd (in Vietnamese). Bulletin of Science, Technology and Environment, 1/1995, An Giang.

Animal Health Improvement: a High Priority for Livestock Development

Nguyen Tien Dzung*

Abstract

Although animal production has received attention from the Vietnamese government, husbandry is still considered as supplementary and productivity of livestock is very low. One of the main causes impeding animal production development is the lack of adequate veterinary services. Animal diseases that occur in Vietnam are not well studied. There is a lack of knowledge of whether many animal diseases actually occur. Furthermore, epidemiological data are not available making it difficult to take correct decisions for animal production. An analysis of infectious diseases in different animal species and also a brief description of the results of the implementation of ACIAR's project on hog cholera show the need to strengthen veterinary services.

Additionally it is considered that the capability of veterinary laboratories must be greatly increased to sustain animal production and its necessary development.

For thousands of years, agricultural production has needed animals for labour and for manure. Other objectives of animal raising are for extra income from agricultural by-products and for kitchen waste. However, animal raising always was and still is considered supplementary work in a household.

The Vietnamese government has made great efforts to encourage animal production, aiming to convert this occupation into a main branch of production. Through the generous aid of various international organisations and donor countries, high performance animals and poultry stock as well as new grass seed have been introduced into the country. In animal science, much progress has been seen in genetics, animal nutrition and management and some of these studies are at a very high scientific level.

Even so, in the veterinary sciences, the situation is not the same. In our view, the poor veterinary services today, as well as in the past, comprise one of the main causes that render animal raising unprofitable and thus impede husbandry development. This paper presents discussion of animal health in Vietnam and argues for the need for an improvement in this field.

* National Institute of Veterinary Research. (NIVR), 61B Truong Chinh, Dong Da, Hanoi, Vietnam.

Animal Diseases Present in Livestock

For a better understanding of animal diseases in livestock I will discuss infectious diseases, which have a great economic and often social impact. However, this does not imply that we underestimate the importance of certain other diseases. Table 1 names those diseases that are diagnosed, studied or at least confirmed as being present or absent in Vietnam and also diseases whose occurrence is unknown.

It should be emphasised here that:

- no information is available about the occurrence of more than half of the diseases known to affect animals;
- the incidence and/or the actual prevalence of the diseases present in Vietnam is unknown, or at least no reliable data exist on them; and
- consequently, the economic importance of each or all of them remains imprecise.

Furthermore, it seems that the diseases known to have occurred are mostly acute diseases which attract more attention than other diseases. However, unproductive animal raising is caused not only by these but also by insidious diseases. The ignorance on their occurrence constitutes a real danger for domestic and international markets. Therefore it is considered imperative that animal disease laboratories, which aim to study in more detail the situation in Vietnam, should be improved and the status of unknown diseases clarified.

Table 1. Major animal infectious diseases in Vietnam and their incidence.

Occurred	Unknown	Confirmed absent
a. In cattle and buffaloes		
Foot-and-mouth	Bovine papular stomatitis	**Brucellosis**
Rinderpest	Malignant catarrhal fever	
Anthrax	IBR	
Black leg	BVDV	
Hemorrhagic septicemia parainfluenza	Other arthropod-borne virus diseases	
Salmonellosis paratuberculosis		
Tuberculosis		
Leptospirosis		
b. In pigs		
Hog cholera	Erosive diseases	Brucellosis
Aujeszky's	TGE	
Erysipelas	Rotavirus	
Parvovirosis	Influenza	
Pasteurellosis	Encephalomyelitis	
Salmonellosis	Listeriosis	
Colibacillosis	Diseases common to other animal species	
Enzootic pneumonia		
Leptospirosis		
c. In poultry		
Newcastle disease	Infectious Bronchitis	
Chicken pox	Laryngotracheitis	
Gumboro	Reovirus	
Marek's disease	Adenovirus (EDS)	
Pasteurellosis	Encephalomyelitis	
Colibacillosis	Influenza	
Salmonellosis	Haemophilus	
(Pullorum disease)	Diseases common to other animal species	
CRD (chronic respiratory disease)		

Current Situation

In cattle, according to the official reports, foot-and-mouth disease is still occurring in sporadic pockets in regions bordering Cambodia and Laos. Hemorrhagic septicemia is another problem in cattle and buffaloes. Parasites are certain to be the cause of decreased productivity in these animals.

In pigs, since 1990 three problem areas have emerged in this industry:

- The first is reproductive trouble in breeders (heat return, abortion, stillbirth and small litters). A single study carried out at the National Institute of Veterinary Research (NIVR) pointed to parvovirus as the main cause. However, recently during the implementation of the ACIAR's Hog Cholera (HC) project, Westbury and Morrissy from the Australian Animal Health Laboratory (Geelong) in cooperation with our laboratory have detected the HC virus (HCV) in the spleen of two one-day-old piglets which died with lesions that are not symptomatic for HC. It is important to remember that the first incidence occurred long after field veterinarians had advised the ubiquitous presence of the 'dry form' of HC by which they meant a clinical form characterised only by constipation and stunting. This suggested the presence of a chronic and congenital form of HC in Vietnam.
- The second area consists of digestive troubles in all pig categories. This condition is present in the whole country and it is said that more than 90% of pigs are affected.
- The third is respiratory trouble that sometimes is fatal to sows and usually causes stunting in fattening pigs. In fact, pig raising in Vietnam is not now considered profitable because of these problems.

In poultry, Newcastle disease and fowl cholera impede village chicken production which itself comprises more than 95% of the chicken production in Vietnam. Introduction of intensive poultry raising which is very promising, is hindered by Gumboro disease, collibacillosis, chronic respiratory disease (CRD) and coccidiosis. Everyone who has ever owned, for example 100 industrial chickens, knows that intensive poultry production faces big losses if respiratory signs appear in the flock. Moreover, according to poultry veterinarians, nearly every flock is affected by Gumboro disease, even those birds that are vaccinated with imported vaccine.

In short, animal production is very low because of animal diseases and it is obvious that again, veterinary activities deserve to become a high priority if any attempt to develop animal production is to be taken seriously.

Epidemiology

It is common knowledge that in veterinary medicine, prevention is primordial as disease occurrence means the loss of invested money and because recovered animals lag behind in productivity. Epidemiology, the study of 'disease pattern in a country or even in a region', helps:

- to prevent diseases from occurring;
- to take measures more rationally before and after disease occurrence, and more importantly; to
- make the right decisions in investing money in animal production.

This area of study is still very inadequate in Vietnam. Many farming enterprises have failed because they could not decide on the amount or on the right moment to spend money. Some examples show clearly the importance of this epidemiological work. In nutrition, the number of cattle to be kept on a pasture depends on the land surface and the availability of grass and these facts are well researched. But, how large should a pig farm be if it is set up in a region where enzootic pneumonia and/or Aujeszky's disease exist? How high is the risk if money is invested in poultry production in the Hanoi vicinity? How often does a cow become diseased in Hue? To answer these questions, epidemiological studies and knowledge are necessary.

Another prevailing belief is that every infectious disease problem can be resolved by vaccination alone. That is a simplistic way of thinking. What is significant is that even with vaccination, diseases still persist and thus discourage farmers even more from keeping animals.

To continue the argument, epidemiology has to rely on laboratory results. It could be said that laboratory competence is the basis for all reliable epidemiological study. Thus it is stressed again how important it is to strengthen the capabilities of veterinary laboratories in Vietnam.

ACIAR Projects in the NIVR

Early in 1995, for the first time, two ACIAR projects were implemented at the NIVR. The first one dealt with fowl cholera and the second one with hog cholera. Preliminary results showed that the *Pasteurella* isolates in Vietnam are much more virulent for chickens than any other isolates studied (Frost, A. and Nguyen Ngoc Nhien, pers. comm.). In hog cholera the same results as reported by Westbury and Morrissy are found. We noticed that the Weybridge HCV strain was less virulent for local pigs than the Vietnamese isolates. In the HC project we have determined that only 20% of the local pigs that were officially stated as being vaccinated had antibodies against HCV. Moreover, we have discovered for the first time, the presence of the congenital HC in Vietnam and confirmed the role of HCV in reproductive failure. Thus, with assistance from ACIAR, the NIVR is now capable of evaluating the immunity induced after vaccination against HC, and of isolating the HCV in apparently healthy pigs by using different techniques. These improved conditions will render the control of HCV spread possible.

With these first results from the implementation of the ACIAR projects, it has been clearly demonstrated that the diseases in Vietnamese animals 'have their own pattern or their own look' and that more useful information can be obtained locally for better control of animal diseases.

Conclusion

There is no doubt that improving veterinary services in Vietnam is an imperative. This is not only a deduction from theories. The actual situation shows clearly that animal diseases are the main cause of the low productivity and sometimes of the loss of invested money in husbandry. Ignorance about the animal health situation disables correct decisions from being taken in animal production and management and at the same time constitutes a danger for the international market. ACIAR's project implementations (on HCV and FC) are examples, showing clearly how the situation could be controlled through the upgrading of veterinary laboratories.

Acknowledgment

Thanks are due to Dr Niels Wuyts for reading and for initial English correction of this paper.

Research and Development of the Goat in Vietnam

Dinh Van Binh, Nguyen Quang Suc and Le Viet Ly*

Abstract

Studies have been carried out in Vietnam on a number of aspects of goat production. These have included: biological characteristics and productivity of Bach Thao, grass goats and crossbreds; methods and technologies for selecting and improving productivity of dairy and dual purpose goat breeds; intensifying goat production by making better use of local feed resources; and prevention and control methods for goat diseases. In addition work has been carried out on establishing sustainable farms on a scale of 5–50 head per farm and developing feeding methods for dairy goats in the different ecological areas. Since 1994 the adaptation to Vietnamese conditions of goat breeds imported from India has been studied.

Bach Thao, a local breed, has high milk and meat production when reared under household farm conditions and the bucks can be used to improve the local meat goat (grass goat) and the imported Barbary, Jumnapari and Beetal breeds. By-products and residues of crop production such as rice straw and molasses urea blocks are fed to goats resulting in high efficiency in production for both growth and milk and output cost. A range of pasture species has been studied for use as green fodder and supplementation for goats. Goat production can improve the nutritional status of the human population and increase farmers' income and can be an integrated part of present farming systems and generate employment for farmers.

GOAT production has been established widely in Vietnam under extensive systems. The national goat population is 0.41 million, of which 72.4% are in the north and 27.5% in the south, most of them being concentrated in the hill-mountainous areas. Eighty-five per cent of these are meat types (grass goats) and the balance, the improved dual purpose breed, Bach Thao, which is having an increasing impact at farmer level on milk and meat production.

In the last few years a program for goat production development has been established by the Ministry of Agriculture and Food Industry. Three breeds of dairy goat were imported from India with this aim in mind, especially for dairy goat production in Vietnam. The present number of Indian dairy goats is 650 head of which 300 head are Barbary, 250 are Beetal and 100, Jumnapari. The annual production from goats is 600 t of meat (75% for city consumption) and 3600 t of milk, 85% of which is consumed by farmers themselves. Recent prices for goat products show a rise to equal or surpass that of other animals. For example, meat goats are valued at 14 000 VND/kg liveweight and breeding stock at 35 000 VND, compared with cattle (12 000 and 25 000 VND) and pigs (14000 and 35000 VND). The price of 1 litre of goat milk is 6500–7500 VND and for cows milk 3500–4000 VND. At present goat production is quietly suiting the policies of the Vietnamese government in creating employment and improving the well-being of poor farmers.

* Goat and Rabbit Research Centre, National Institute of Animal Husbandry, Chiem Tu Hiem, Hanoi, Vietnam.

Recent Activities and Results of Studies on Goat Production in Vietnam

Productivity of goat breeds

The aim of the breeding goat chosen and improved, was to increase the productivity of the dual purpose goat breeds in meat and milk products. During the period of the selection of the Bach Thao goat breed and the use of Bach Thao bucks for crossing with the grass breed, data were obtained on some productive characteristics as shown in Table 1.

Table 1. Performance of goat breeds in Vietnam.

	Bach Thao		Grass goats		Crossed goats	
First kidding age of does (days)	346		330		300	
Kidding intervals (days)	217		257		213	
Av. litter size (n)	2.09		1.35		1.75	
— Single birth (%)	21.5		70.5		64.6	
— Multiple birth (%)	78.5		29.5		35.4	
Growth traits (Female = F, Male = M)						
Body weight	F	M	F	M	F	M
— At birth (kg)	2.49	2.84	1.76	1.92	2.08	2.21
— At 6 month (kg)	17.30	20.6	10.20	11.25	12.00	13.0
— At 12 month (kg)	29.20	40.0	17.10	20.10	20.20	24.3
Productive traits						
Meat production						
— Carcase (%)	42.8		45.8		44.6	
— Lean meat (%)	30.0		33.4		32.8	
Milk production						
— Yield (L/day)	1.181		0.325		0.815	
— Lactation length (days)	148		105		115	
Feed conversion (kg DM/kg LWG)	4.43		5.34		4.34	

DM = dry matter
LWG = liveweight gain

The Bach Thao goat is a dual purpose breed (meat and milk) that was developed in Vietnam a long time ago. The study results show that the productivity of the Bach Thao goat is potentially as high as some imported Indian breeds though direct comparisons were not made. The data also show that the Bach Thao bucks are better producers and should be suitable to improve reproduction and also meat and milk productivity of grass goats

Feeds for goat production

Forages and multipurpose trees

The essential demand of animal husbandry development is to optimise feed resources, especially green fodder for monogastric and herbivorous animals. The selection of varieties with maximum biomass yield and protein-rich foliage to supply goat fodder, needs to be the subject of extensive research. Already there are twelve plants grown at the Centre and adjacent areas under study for both quantity and quality criteria. In the period of three years, the studies were focussed on measuring yields to ascertain which would have highest efficiency when used as green fodder or supplementation. Initial data are shown in Table 2.

It was found that the above imported grasses and leguminous trees were well adapted and developed well for the purpose of animal production. Most of these varieties gave high yields of biomass and dry matter and could be used for goats and rabbits. Possible rates of utilisation are 60–86% when fed in the fresh form. Some multi-purpose trees such as sugarcane, banana, cassava and even *Acacia mangium* have been planted widely in intensive and household farms in order to both increase farmer income and reduce the cost of animal feed in sustainable farming systems.

Processing and use of locally available feed resources for animals

Sheep and goats have advantages because of their small body size and an inherent capacity to select the more nutritious parts of the available plant biomass. Residues such as cereal straw, sugarcane top or bagasse can be fed to goats. Feeding strategies must be based on a clear understanding of the relative roles and nutritional needs of animals fed unbalanced fibre-rich forages. The trials were carried out and now the following have been applied on a wide scale in many farms:

- use of the molasses urea block as a feed supplement for energy, mineral and protein for animals after study had shown it to be utilised efficiently by goats;
- the suspended part of sugar cane juice, boiled soya-bean and minerals were processed and used for kids to replace part of their mothers' milk—in experiments the body liveweight gain of kids so fed was 7.9% higher than suckling kids and the cost of feed for these kids was also lower by 21.5%; and

Table 2. The yield of biomass and dry matter of some plants (t/ha/yr).

Variety of plant	Yield of biomass	Yield of dry matter
Panicum maximum cv Liconi	67.5	13.5
Panicum maximum cv Riversdale	67.9	11.3
Pennisetum purpureum cv King Grass	107.0	14.2
Andropogon	54.3	10.3
Setaria hybrid	65.3	8.5
Pangola	41.3	9.6
Leucaena leucocephala cv Cunningham	15.0	3.4
Morus alba	29.0	4.7
Trichantera gigantea	58.7	7.6
Flemingia congesta	54.2	8.2
Sugarcane	140.0	42.0
Bananas (leaves, stems)	115.0	11.5

- the use of rice straw treated with urea and sugar cane tops for feeding lactating goats as a basal diet with leaves of one of the following, Jack fruit, banana, *Acacia mangium* and elephant grass—it has been shown that by the use of this basal diet with Jack fruit or banana leaves, lactating goats gave more milk than under conventional feeding systems using concentrates with grasses.

Integration of goat production into sustainable farming systems at the household level.

Farmers in the hilly land areas have been accustomed for many years to planting cassava in their farming system as the main crop in the agricultural system. Its major use is for food and by-products given to animals, but there is a lack of technology to process it for maximum benefit. Each family has only one or two local pigs fed nutritionally poor diets. Some farmers can afford to buy one cow but land areas which consist of small wood trees and shrubs are mainly used for fuel purposes. The soil is becoming eroded leading to lower yields of crops and less food for home consumption and for feeding animals. If farmers cannot get capital for their integrated farms to buy one cow, which costs 2–3 million VND, they may be able to get one dairy goat for 1 million , then in one year the number of kids will be 3–5 head (2–3 kids × 1.8 litter size). If these can then be sold at a price of 30–35 000 VND/kg of breeding animal and 14000 VND of meat animal and additionally if sugarcane is grown instead of cassava or lower economic value crops, farmers can get a higher rate of net income per unit of expenditure and the standard of living will be increased. The modern farming system which has been implemented in the hilly areas is based upon the above hypothesis.

Demonstrations were set up with smallholders who have participated in this technology transfer. Overall it was found that :

- integrated systems of production including animal husbandry, forage planting, biodigester and fish pond increased the economic efficiency (i.e. receipts, profits, especially the rate of return on capital) of biological production and provided more employment opportunities for farmers;
- for all farming systems, dairy goat, sugarcane and fish production had the highest priority and should be promoted as the main production system integrated with raising cows or a pond for fish;
- use of biodigesters is important not only for avoiding expenditure on fuel but also for conserving forests; and
- the rate of return on capital for the integrated system of production was much higher than the traditional systems of production based on cassava, pigs, cows and fish ponds.

Orientation of development of goat production in Vietnam

The direction of development is towards:

- increasing at lowest cost, selection to create pure and cross goats having high productivity in milk and meat-milk and adapted to different ecological conditions, especially the hilly-mountainous areas;
- establishing systems of forage production and pasture use, integrated with agroforestry for goat production; and
- establishing systems of milk production, collection and processing from goats, cows and other animals, based on locally available feed resources with the overall objective of improving the wellbeing of poor farmers.

To further develop goat production in Vietnam research should be aimed at producing varieties of plants that can be used as feed resources and can grow well in the hilly land and dry seasons. The transfer of technology already introduced to farmers in establishing various farming systems such as integrating animal crops or aquaculture/animal crop in the hilly-mountainous or delta areas should be pursued. The training of scientific staff and supply of more good quality equipment than available at present for research should be provided by the government and co-operation with international organisations, especially Australian organisations, should be expanded.

Short Papers—Species and Disciplines

Improved Tropical Dairy Production

G.I. Alexander* and M.L. Tierney†

Abstract

Dairying has been emphasised by governments in Southeast Asia because of its nutritional, financial and agricultural benefits. There is interest in expanding the small dairy industry in Vietnam located in the southern part of the country. Local cattle are very well adapted and resistant to tropical conditions and parasites, but have low milk production and poor reproduction.

Three approaches are needed. The initial area is nutrition. Improved tropical pastures as produced with advantage in northern Australia can be used, either in special dairy pasture land or in road-side and wasteland sowing, which is of particular benefit to small landless farmers.

The second approach is the genetic improvement of cattle, usually through mating the local cattle with exotic dairy breeds. Crossing European breeds such as Holstein Friesian with the local animals has been found to produce immediate results but the next step in the mating program is the problem. The question is how to maintain this improvement and continue to improve individual performance. Recent breeds developed in Australia and subjected to progeny testing programs can be used as a source of proven semen for mating to crossbred cattle and for grading up.

Progeny testing in smallholder situations is difficult since each farmer usually has only two or three cows and there are no recording systems. Research projects are needed for these. Semen from bulls selected in Australia could be used in such programs, either for breed improvement or for comparison with locally produced sires.

DAIRYING in tropical Asia offers farmers an important source of regular income, better nutrition for their families, it utilises crop residues, pasture and other crops, and also helps reduce population drift into urban areas. Dairy programs have been developed by governments, or supported, in India, Malaysia, Thailand, Indonesia and the Philippines. In most Southeast Asian countries, local cattle are well adapted to tropical conditions and resistant to tropical diseases and parasites, but the cows have low milk production and often relatively poor reproductive performance.

In many instances farmers in Southeast Asia can make a reasonable income from one or two cows. Even in situations where farmers are landless, it is still possible for them to derive an income from either cutting feed from roadside areas and wastelands or allowing the cow(s) to graze such areas. Farmers can then either sell milk locally to consumers, or to cooperatives/processors and receive their income on a daily or weekly basis. Some Southeast Asian governments have introduced schemes whereby farmers obtain low interest loans to purchase dairy cattle.

In Vietnam, there is considerable interest in the expansion of the small dairy industry which is currently predominantly located in the south. At present there are about 17 000 dairy cattle. It is planned that the dairy cattle population could increase to approximately 300 000 head, to meet the needs of an expanding population and to reduce dependency on imported dairy products.

Impediments to Increased Dairy Production

The initial approach to improved dairy production in the tropics is to introduce new genetic material by crossing the local cattle with exotic (usually European) breeds that have been selected for high levels of milk production. Numerous studies have shown that, under tropical conditions with high temperatures and humidity, cattle having about 50% local genes and 50% exotic genes will generally have the best potential for milk production. Under less

* Palamere Pty Ltd, GPO Box 870, Brisbane Queensland 4001, Australia.

† Department of Primary Industries, GPO Box 46, Brisbane Queensland 4001, Australia.

stressful conditions, cattle having more than 50% exotic genes can often outperform the half-cross cattle, provided the nutritional conditions are adequate.

The crossbred cow is usually larger than the local cow and this larger size, allied with the higher potential milk production of the crossbred cow, means that the nutritional requirements of the crossbred cow are higher than those for local cattle. In addition, the crossbred cow has a reduced capacity to tolerate tropical conditions and has less resistance to endemic diseases. Very often the emphasis on genetic improvement is not matched by efforts to improve the nutrition of the stock used for dairying and so the benefits of the improved genetics are not utilised to their full potential.

These factors highlight the three areas of nutrition, disease control and genetics which provide the main hurdles to be overcome if the Vietnamese dairy industry is to be developed and become a significant feature of the rural economy.

Nutrition— Tropical Australian Experience

It is useful to review the changes that occurred in tropical Australia over the last 30+ years as it is one of the few major dairying regions in the tropics and subtropics. The experience gained in the Australian tropics provides some pointers as to what can be achieved in other tropical regions including Vietnam.

Before the 1960s, the tropical Australian dairy industry was quite substantial with over 28 000 farmers having herds of more than 40 head. The industry was based on the supply of butterfat produced, mainly from native pastures augmented by limited amounts of improved tropical pastures, mainly forage sorghums, lucerne, oats and concentrate feeding. Native pastures provided a flush of growth of, at best, mediocre quality (55–65% digestibility) for between two and four months after the commencement of the spring rains. For the rest of the year the quality of standing pasture was very poor (< 55% digestibility) supporting low milk production and lactations as short as 5–6 months. In the late 1950s it was well recognised that the survival of the dairy industry in the tropics beyond the 1960s would largely depend on improving the reliability, quality and quantity of feed.

During the 1970s and 1980s rapid progress was made in the technology of efficiently producing milk year-round using systems based on paddock feed. Research was initially directed at improvement of milk production using tropical pastures. Milk production levels between 9 and 12 L/cow/day appear to be the maximum achievable from tropical grasses without supplementation and 13 and 16 L/cow/day from tropical grass/nitrogen and grass/legume pastures without supplementation. The twining tropical legumes have higher quality than tropical grasses but they have not persisted under stocking pressures used by modern dairying so that grass-based pastures heavily fertilised with nitrogen have become an important source of dairy grazing.

Because of the ceiling on milk production caused by the low digestibility of the tropical pastures, research emphasis was shifted to temperate species used during the cooler months of the year. Temperate pasture species (ryegrass/clovers/medics) under irrigation have proved ideal for increasing the quantity, quality and seasonal distribution of paddock feed in the tropics and subtropics providing forage from autumn to spring. Cultivars both perennial and annual are sown annually in high density swards.

Annual temperate irrigated pastures are responsible for about 15% of tropical Australian total milk production. Adding to their importance is the fact that much of this milk is produced in the late autumn/spring period when production from tropical pastures is at its lowest.

Fodder crops are also quite significant for milk production in the Australian tropics and subtropics, 46% of the total improved pasture/crop area of dairy farms being used for fodder crops. As dairying systems continue to become more intensive, crops can make a contribution by providing an ad libitum source of good quality conserved forage, which can be fed at any time, at reasonable cost, and with low wastage using feed pads.

Research over the last 20 years has seen milk production in the Australian tropics increase and become more competitive with the temperate areas of Australia. Recorded production per cow of the Queensland herd has increased from 78% of that recorded in Victoria in 1971 (2328 L/cow as compared with 2997 L/cow) to a level equivalent to production in Victoria in 1994 (5023 L/cow as compared with 4962 L/cow). See Figure 1 which shows the progress of tropical dairy production compared with that from a temperate region, Victoria, over the last 40 years.

The tropical Australian experience shows that the provision of high quality fodder is vital for successful large scale dairying in the tropics. Improved tropical pastures need to be supplemented by concentrates and conserved fodder. If it is possible to produce temperate species under irrigation to supplement the improved tropical species, these should be considered but they would only be of value in tableland areas where the climate is milder.

The improved tropical pastures which have been developed in Australia and other countries can be planted in many countries, on wasteland areas and

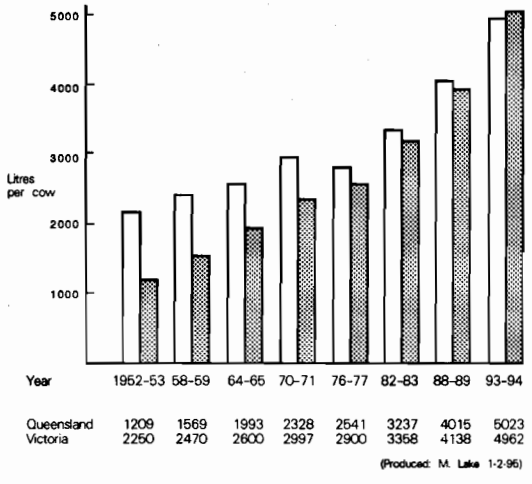


Figure 1. Average milk production per herd from recorded herds of Queensland and Victoria, 1952–1994.

roadsides to provide feed. There have been examples of successful roadside and wasteland sowing programs in countries such as Thailand and Indonesia but in some other tropical countries these programs have either not been put into place or are only just commencing. To adequately utilise these areas it is essential that perennial pastures be sown, and where fodder crops have to compete with cash crops, there is often a necessity for shade-tolerant species also. There may well be a role for the use of leguminous fodder trees in many situations.

In terms of the quantity of high quality feed provided to cattle, the quantity of feed provided in cut-and-carry situations is determined by what can be conveniently cut and carried in a day by the farmer along with his or her other chores. Farmers are usually familiar with the requirements for maintaining local cattle at relatively low levels of production but need to be informed of the requirements of improved cattle at significantly higher levels of production.

Disease Control

Local cattle have developed resistance to ticks and other endemic diseases. In addition, as farmers come to rely more heavily on introduced cattle for an increased income it is essential that other diseases to which the introduced cattle are not resistant are avoided or contained. This makes the development of disease diagnostic facilities and epidemiological units vital to improved production systems.

Many diseases, particularly those diseases affecting reproduction, also become important when the emphasis on individual dairy cow productivity increases. It will be important to develop methods of integrating disease control systems into dairy production recording systems so that farmers can maintain the desired level of fertility and overall health performance along with good herd husbandry.

It is not proposed to deal with disease to any extent in this paper, but merely to indicate that it is an aspect which is of importance in any consideration of dairy improvement.

Genetic Improvement

Provided adequate nutrition and disease control programs are in place, the improvement of local cattle by crossing with exotic European dairy breeds offers the potential to significantly improve dairy production in tropical countries. The major improvement occurs in the initial cross to produce the half local breed and half exotic breed. Where the conditions are suitable, a further cross back to the exotic breed may offer further improvement in production. However, the time then arises when a decision needs to be made as to the next steps to be taken to effect continued improvement in productive performance of the dairy herd.

One method is to alternate the use of bulls of the two parent breeds for breeding successive generations of cows. This tends to maintain the level of milk production but does not provide much opportunity for further improvement in milk production. Sometimes bulls of the exotic breed are used to breed further generations of cattle but this usually leads to a lowered performance because of their lack of adaptability, heat tolerance and resistance to parasites and disease. The approach which has been used in Australia and some other countries has been through the development of tropical breeds of dairy cattle based on inter se breeding and selection. Australia has been a leader in the development of tropical breeds of dairy cattle. Two tropical breeds have been developed in Australia, namely the Australian Milking Zebu (AMZ) and the Australian Friesian Sahiwal (AFS). The AMZ breed was developed from crossing the Sindhi breed with the Jersey breed while the AFS was developed by crossing the Sahiwal breed with the Friesian breed.

Both breeds have been developed over a period of more than thirty years in Australia and provide a model for the development of tropical dairy breeds in other countries. The early development of the AMZ breed has been described by Hayman (1974) and the early development of the AFS breed by Alexander et al. (1984).

A more detailed description of the development of the selection techniques used in the development of the AFS has been given by Alexander and Tierney (1990). This paper describes the three distinct phases of selection: culling of first cross females to eliminate problems due to failure to let down milk; progeny testing young bulls to ensure genetically superior bulls for use through artificial insemination; and more rapid development of the breed using a multiple ovulation and embryo transfer (MOET) program.

The most recent results from this MOET program show that during the period from 1991 to 1993 the average Australian Breeding Values (ABV) for AFS cows had increased from +28 L of milk and +2 kg of fat plus protein to +101 L of milk and +5 kg of fat plus protein. During the same period the ABVs for the first lactation AFS donor cows involved in the MOET program increased from +389 L of milk and +23 kg of fat plus protein to +482 L of milk and +29 kg of fat plus protein.

These figures indicate the genetic superiority of the young cows being used in the MOET program to breed young bulls for use both to breed heifers for export and for the production of proven semen for export.

The development of both these breeds has taken place in Australia where selection has occurred in subtropical environments. The efficiency of the selection process could be improved if selection was carried out in tropical countries under the smallholder conditions in which the cows will generally be expected to perform.

However, there are problems with conducting progeny testing programs under smallholder conditions. In conventional progeny testing under temperate dairying countries, herds are normally in the range of 50–100 or more cows and it is easy to have daughters of a number of sires, which are all of the same age, calving at the same time of the year so that their production can be compared. In a typical smallholder situation, each farmer will usually have fewer than five cows, with the number often being as low as one or two. This means that it is very difficult, if not impossible, for any one farmer to have daughters of the same age of more than one bull at any one time. Some progeny testing programs are now in place, particularly on the Indian sub-continent, which are based on comparing daughters on a village, or artificial insemination (AI) sub-centre basis rather than on an individual farm basis. These programs represent a major step forward in addressing the problem of effective progeny testing but, unfortunately, they tend to be relatively low in efficiency when compared to the systems in use in more developed dairy industries.

The development of successful progeny testing programs in emerging tropical dairy industries will be dependent on the development of efficient production recording systems under smallholder conditions. Probably the most efficient system could involve the use of a government dairy herd acting as the nucleus herd for the progeny test program with small holder herds being used as supplements to the central station. If these progeny testing programs can be developed, they will allow more efficient selection of genetically superior local bulls or bulls bred in Australia to be used in overseas countries, depending on the particular process favoured by the individual country. Semen from selected local-cross bulls, Australian bred bulls or sons of Australian bulls produced in the recipient country could be used in these progeny testing programs.

Australia has one of the most efficient dairy genetic evaluation programs in the world through the operation of the Australian Dairy Herd Improvement Scheme (ADHIS) which has been in place since 1982 and the state-based production recording schemes which have been in operation for more than 40 years and constantly being upgraded and improved. These programs could well form the basis of the recording and progeny testing programs needed in other tropical countries but some research would be needed to adapt the Australian programs to suit the conditions in these tropical countries.

References

Alexander, G.I., Reason, G.K. and Clark, C.H. 1984. World Animal Review, 51, 27–34.

Alexander, G.I. and Tierney, M.L. 1990. Proceedings of the 4th World Congress on Genetics Applied to Livestock Production, Edinburgh, Scotland pp. 263–266.

Hayman, R.H. 1974. World Animal Review, 11, 31–35.

Dairy Cattle Production on Small Farms in Cu Chi District, HCMC

Huynh Ngoc Dien*

Abstract

Aided by the poor economics of pig production, a more stable system of dairy cattle production on small farms has developed near HCMC, in Cu Chi District by making use of by-product feeding. There are 17 000 ha of seasonal rice, over 4000 ha of peanut and 1000 ha of sugarcane in the district. Dairy cattle are fed natural grass, rice straw, by-products of peanut and sugarcane, cassava waste and brewery waste.

At present, one small-scale holder with three dairy cattle can produce 30 kg fresh milk daily. With the milk price of 2600 VND/kg, the farmer receives 78 200 VND/day. Feeding costs for this level of production are 60 000 VND, therefore the farmer's income is 18 200 VND/day. Total annual income is 5 460 000 VND from milk plus about 10 million VND from three calves born annually.

Along with dairy cattle development, biodigesters made from plastic film are being widely used, which is the result of the extension project carried out by the University of Agriculture and Forestry, HCMC. They bring more profit to farmers and improve efficiency in production as well as providing fertilizer for pastures and biogas for the home. Since 1994 we have organised and trained local technicians to install biodigesters. They have already fitted 41 biodigesters in small-scale farms and the demand for them has increased.

The major constraint to dairy production on small-scale farms is the low price of fresh milk sold to the cooperative Vinamilk, a State company which processes fresh milk and other dairy products. It is only 25%–31.25% of the price of other dairy products though its quality is relatively high. I believe it should be 60% of the price of other dairy products in the market. Though at such a price, Vinamilk will have a lower income per litre of milk processed, total production will increase and Vinamilk's total income will be large.

There should be established a system of long-term credit with low interest/month rather than the shorter two-year credit at 1.7% per month interest which is current.

Experience so far suggests solutions to two problems are needed, improved performance of the dairy herds and determining a sound livestock-cropping system for dairy production in this district.

* Vietnamese Association of Farmers, 236 A/6 Le Van Si Str, Ho Chi Minh City, Vietnam.

Dairy Cattle Production in Southern Vietnam

Le Viet Anh*

Abstract

Southern Vietnam, with a wet-hot climate of average temperature 25–26°C and a humidity of 80–90%, is not suitable for purebred dairy cattle. It is necessary to cross local breeds so that F_1, F_2 and F_3 dairy cattle can adapt to conditions in Vietnam and produce an acceptable milk yield.

Eighty percent of the nation's dairy herd is in the south and eighty percent of these are on smallholder farms.

Milk yields in highland areas are highest in Holstein/Friesian (HF) cows, but are lower in regions of lower altitude, where 7/8 HF × 1/8 local breed gives the highest production.

Projected development of the herd by the year 2000 seeks to more than double numbers to 30 000 dairy cattle and production to 55 000 t of milk annually.

We have already determined nutritional requirements and management procedures for highest efficiency. Small-scale dairy production can be efficient. Herd sizes ranging from 10–40 per farm head give the best profit under the current management.

Priority areas for further research covering aspects of breeding, pasture development, farm integration and processing and marketing are given.

SOUTHERN Vietnam lies between 8–16N and 104–106E in the Southeast Asian region. It has a population of 33 624 398 and major cities with trading and tourist interests such as HCMC, Ba Ria, Vung Tau, Can Tho, Da Lat, Nha Trang, Da Nang.

In this wet-hot climate, the average temperature is 25–26°C ranging from 10–40°C, humidity 80–90% and the annual rainfall 1500 mm. North-east winds come during October–April, south-east winds during March–August and very hot-dry south-west winds during June–September.

Generally the climate is not suitable for purebred dairy cattle produced in temperate areas. Therefore, it is necessary to crossbreed the Holstein Friesian with local breeds (the local breed is usually a crossbreed between Vietnamese Yellow Breed and Red Sindhi) and to have good nutrition and management, to improve efficiency in production. Data on the distribution of the dairy herd between the regions of Southern Vietnam are shown in Table 1.

The national dairy herd has quickly developed. In HCMC there were 5000 dairy cattle, including 2000 cows, in 1990 and twice this by 1994. The herd size in other provinces was very small in 1990 but is increasing at the present time. In Lam Dong province and Nha Trang city, the number of dairy cattle have decreased a little due to lack of milk collection and processing facilities and consumption.

The number of dairy cattle in the south is 80% of the total national herd. Eighty percent of the herd is on small-scale farms and 20% on state farms. Data on milk yield may be summarised as follows (Table 2).

The data show that purebred HF cattle in Lam Dong, a highland area which is 1000 m above sea level and cool, have produced 4270 kg of milk per period. In HCMC, Dong Nai, Song Be and Nha Trang, F_1 dairy cattle have an average milk yield of 2692 kg/period, F_2 cows 2737 kg and F_3 cows 3043 kg.

The Vietnamese government plans to increase the national herd both quantitatively and qualitatively. National targets are shown in Table 3.

To reach these goals will require a strong research and extension effort.

Present and Future Research in Dairy Cattle Production of Southern Vietnam

In the 1960s there were studies on dairy cattle in the areas of crossbreeding between HF and crossbred Red Sindhi, agroecology, physiology and milk productivity. Then, in the 1970s, dairy cattle were imported from Cuba and the research focused on HF breed, sperm physiology and bulls. In recent years, the need for more milk has forced Vietnam to

* Buffalo, Cattle, Dairy Breeds, Milk Production Corporation, 42/18 Nguyen Binh Khiem Go Vap, Ho-Chi- Minh City, Vietnam.

establish a state project entitled 'Determination of crossbreeding, establishment of industrial feeding system for current crossbreeds and establishment of models for dairy cattle production in HCMC and the provinces of southern Vietnam', which has been carried out by the Institute of Agricultural Science, University of Agriculture and Forestry (HCMC) and other bodies.

This study has so far determined the nutritional requirement and feed intake to produce 1 kg of milk and especially established the direct effect on milk yield and milk cost of increased protein level in rations, thus allowing determination of a feeding system for milking cows. Other studies cover the effects of some factors on milk yield such as shed micro-environment, hosing and brushing, exercise, feeding and even relationship between workers and animals.

It was found that small-scale holders in dairy cattle production were economically efficient. The cost and price of fresh milk during the period 1990–1994 brought profit to holders. Herd size per farm in the ranges of 10–20 or 21–40 gave the highest profit in the current market and management system.

In breeding programs, it has been shown that purebred HF could adapt well to the conditions of Lam Dong Highlands. Crossbreeds were developed from HF breed and Sindhi crossbreeds (F_1 and F_2) and had acceptable milk yield and good adaptation to the environment in southern Vietnam.

After confirmation that the dairy crossbreed F_2 could be raised in south Vietnam, the dairy crossbreed F_3 carrying 7/8 HF were introduced to the plains provinces and suburbs of HCMC.

Priority in the study of dairy cattle production has been assigned to:

- determining the best blood ratio between HF and local breed for optimal production (crossbred animals with blood ratio of 3/4 or 5/8 or 7/8 HF);
- exploring whether to use another purebred such as Jersey or Brown Swiss to produce crossbreeds from the three breeds;
- studying the adaptation of HF to the conditions of the southern Vietnam plains;
- learning how to use efficiently legumes such as stylo and alfalfa in order to substitute these for expensive sources of concentrate feeds taking due account of digestive physiology; and
- establishing an applicable model of a dairy cattle co-operative which incorporates the integration of farms, processing plants and markets, and results in further development of dairy production.

Conclusion

In conclusion, dairy cattle production is relatively new but an efficient system has been developed for Vietnamese farmers. Dairying supplies an important source of food, is a source of revenue for farmers and should be given more attention in research. Australia has made good progress in industrialised animal production and therefore could cooperate with Vietnam to help develop dairy cattle production.

Table 1. Dairy cattle herd and distribution (in June 1995).

Regions	Southern Vietnam	HCMC	Dong Nai	Song Be	Long An	Lam Dong	Nha Trang	Da Nang
Total herd	13650	10600	1000	200	150	1500	100	100
Cows	5580	4000	500	100	80	800	50	50

Table 2. Milk yield from genetic groups of dairy cows.

Genetic groups	Head	Milking period (days)	Milk yield/ period (kg)
Holstein Friesian (HF)	208	305	4270
1/2HF × 1/2 local breed	584	291	2692
3/4 HF × 1/4 local breed	117	300	2737
7/8 HF × 1/8 local breed	43	300	3043

Table 3. Projected development of the national dairy herd in 1996 and 2000.

	1995	1996	2000
Total herd (n)	13650	16000	30000
Dairy cows (n)	5580	7000	15000
Daily milk yield (kg)	10	10	12
Total milk production/year (t)	18250	23725	54750

Achievable Production Targets for Intensive Pig Production

P.E. Hughes*

Abstract

Agriculture no longer serves only home markets, and international trade places pressure on local producers to raise efficiency and be competitive. The target figures presented in this paper can serve as guidelines to pig producers and policymakers, indicating the approximate performance levels that are required if the average piggery is to remain viable and competitive in the longterm. Some account has been taken of the likely impact of local conditions (climate, feed supply etc.) in the formulation of these target figures, but they generally relate to production in temperate climates.

SUGGESTED targets are given for performance of both the growing/fattening herd and the breeding herd. These relate, specifically, to the use of the dominant world breeds (Large White, Landrace and, to a lesser extent, Duroc, Hampshire and Pietrain). An attempt is also made to identify which production parameters will be responsive to genotype change and which will require major alteration in management strategies.

Where altered management is the suggested strategy, detailed breakdowns of the constituent target areas are given in order to facilitate the use of problem-solving techniques.

The internationalisation of trade in agricultural products exerts considerable pressure on local producers/farmers to enhance their efficiency to be competitive with the imported product. In most cases this increased productivity has been achieved by expanding the size of the production unit, importing better genotypes and raising management standards.

Changes in the Australian Pig Industry—an Historical Perspective

The Australian pig industry provides a good example of the degree of change that is likely to occur in any market that opens itself to competition. Figures 1 and 2 demonstrate that, while the size of the Australian national pig herd remained virtually constant, the number of pig producers fell by nearly 90% over a twenty-five-year period while mean herd size rose from 8.0 sows in 1969 to 68.3 sows in 1994. A structural change also occurred within the industry with the appearance of the 'mega-piggeries'—piggeries that are extremely large (see Table 1). These achieve considerable economies through their size and apply those management principles that are more normally associated with manufacturing industry.

Similar, though less dramatic, changes were also seen in herd productivity over the same period of time (see Table 2). These changes, particularly in the performance of growing pigs, reflect the importation of new genotypes and local improvement of both existing and imported genotypes. Equally, much of the improvement seen in the performance of the breeding herd over this period is attributable to better knowledge of reproductive processes and adoption of new management strategies.

Table 1. The current structure of the Australian pig industry.

Herd size (no. of sows)	No. of herds	No. of sows ('000)	% of national herd
<25	2468	18.9	5.3
25–100	1552	76.6	21.4
100–200	419	91.4	25.5
200–1000	212	72.8	20.4
>1000	32	98.0	27.4

* Faculty of Agriculture, Forestry and Horticulture, University of Melbourne, Parkville, Victoria 3052, Australia.

Since these changes in piggery performance occurred in response to an increase in the competitiveness of the market it is not surprising that the end result of these changes in both the structure and efficiency of the Australian pig industry has been a stagnation in the real income from pig production and a considerable reduction in the cost of pigmeat (Fig. 3).

This historical review of how the Australian pig industry has changed over the past 20–25 years is of value in that it (a) suggests the pathway that will be followed as intensification of the pig industry proceeds, and (b) it indicates those areas of piggery efficiency that are likely to be either easy or difficult to improve at the practical level.

Production targets

What, then, are achievable targets for intensive pig production in the 1990s? The answer to this may depend, at least to some extent, on the country in which the production is occurring. In essence, three factors need to be considered:

Genotype

The use of a Large White × Landrace female and Terminal Sire Line male (usually consisting of genes from the Large White, Landrace, Duroc, Hampshire and Pietrain breeds) is now considered standard for intensive pig production anywhere in the world. The targets discussed below are therefore based on the assumption that these genotypes constitute the majority of the breeding stock. It should be noted that no account has been taken of either the possible impact of prolific Chinese breeds (e.g. Meishan) or the introduction of transgenic pigs.

Nutrition

The nutrient requirements of the pig are, largely, preset by its genotype. However, the way in which these requirements are met in practice will depend on the type, availability and cost of raw ingredients. These may vary widely from country to country. Hence, while the target growth rate will remain unchanged (since it reflects genotype), the figure for feed conversion efficiency (FCE) can only be of limited value since it relates to the quality of diet offered.

Environment

The genotypes outlined were primarily developed for temperate Northern Hemisphere production systems

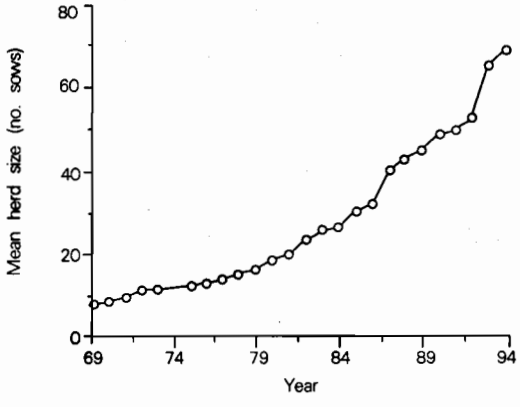


Figure 2. Mean size of Australian pig herds 1969–94.

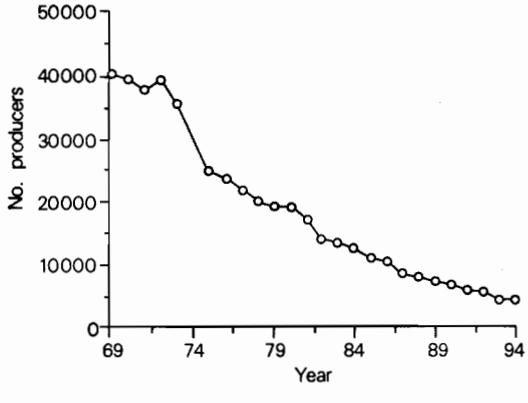


Figure 1. Number of pig producers in Australia 1969–94.

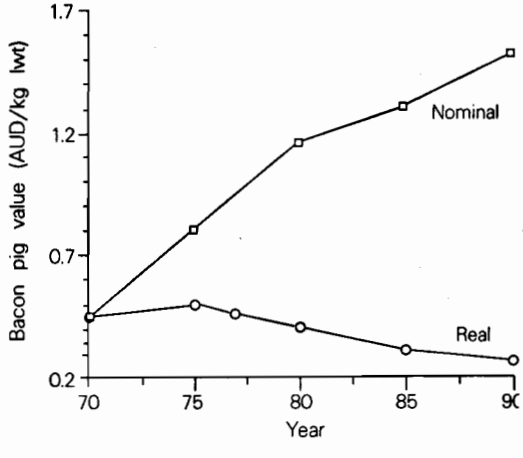


Figure 3. Value of Australian pigs at slaughter 1970–90.

Table 2. Changes in pig herd performance figures 1970–1990[a].

	1970	1980	1990
Mean no. pigs sold/litter	7.4	7.6	9.4
Mean no. litters/sow/year	2.12	2.24	2.15
Mean no. pigs sold/sow/year	15.7	17.0	20.2
Mean growth rate to 95 kg (g/day)	458.0	500.0	591.0
Mean P2 backfat depth (mm)	23.0	15.0	13.0
Mean herd liveweight FCE[b]	3.9	3.6	3.0

[a] These data relate to a single large Australian piggery which has reliable records for the time period given.
[b] Feed conversion efficiency.

and are, therefore, less well adapted to more tropical climates. Nevertheless, many of these genotypes are 'partly adapted' (e.g. those developed in Australia) and should perform close to their potential under semi-tropical conditions. It must, however, be accepted that some loss of performance can be expected.

In the following estimates little account has been taken of the above limitations as they are currently impossible to quantify. Even so, their possible impact on piggery performance should be assessed in each country in order to provide more refined and achievable production targets.

Targets for the fattening herd

These are normally considered to be primarily determined by the pig's genotype. However, growth rate may be depressed if high ambient temperatures reduce food intake, while both high temperatures and poor quality diets may adversely affect FCE. Equally, it is not possible to predict optimum sale weight since this will vary from country to country—therefore, all the targets set below are based on an average sale weight of 95 kg. The estimates provided in Table 3 may be too high if the above factors prove to be significant.

Table 3. Production targets for the fattening herd.

	Australian[a] commercial	Pigstats[b] mean	Pigstats[b] best	Hughes[c] estimate
Growth rate (g/d):				
—preweaning	–	–	–	200
—weaners	500	–	–	450
—growers	730	–	–	750
—finishers	850	–	–	750
—overall	610	565	647	605
Liveweight FCE:				
—preweaning	–	–	–	1.0
—weaners	–	–	–	1.6
—growers	–	–	–	2.3
—finishers	–	–	–	2.8
—overall	–	2.6	2.0	2.3
Herd liveweight FCE	2.8	3.2	2.7	2.8
P2 backfat depth (mm)	12.5	–	–	12

[a] Target figures of a large commercial piggery (>25 000 sows) in Australia.
[b] Currently achieved figures for average and best recorded herds in Australia as published in Pigstats '94—Australian Pig Industry Handbook.
[c] Personal estimates.
FCE: feed conversion efficiency.

Targets for the breeding herd

The genotype of a pig is not normally considered to be a primary determinant of reproductive output. However, this only applies once the major breed components of the female line have been fixed as Large White and Landrace, and advantage is being taken of heterosis. Beyond this point reproductive efficiency is usually determined by the quality of management decisions. Indeed, in the figures presented in Table 2 there is a strong suggestion that either (a) this input may have been at a plateau level 25 years ago in Australia, or, more likely, (b) the adoption of new management techniques has been slow or unsuccessful.

Under tropical or semi-tropical conditions several aspects of reproductive efficiency are likely to be compromised. In particular, food intake during lactation is likely to be depressed by high ambient temperatures, this leading to reductions in both subsequent fertility and fecundity. Other effects of high temperatures, such as depression in boar fertility, are more difficult to assess since research data are limited and the degree of acclimatisation cannot be estimated. Hence, the estimates provided in Tables 4–6 may, again, prove to be too high if the above factors are significant.

Finally, these reproductive data can be placed together into a single figure—number of pigs sold/sow/year—if we combine litter size data with that for farrowing frequency. This summary data is presented in Table 7.

Conclusions

There is little doubt that the pig industry is particularly well-suited to intensification, and that this tends to result in the development of large-scale production units (mega-piggeries). Large intensive piggeries benefit from economies of scale and access to good information supply at both the scientific and business management levels. Hence, over time there is usually a trend towards larger piggeries and fewer pig production units. The target figures presented in this paper can serve as guidelines to pig producers indicating the approximate performance levels that are required if the average piggery is to remain viable in the longterm.

Table 4. Litter size targets for the breeding herd.

	Australian[a] Commercial	Pigstats[b] mean	Pigstats[b] best	Hughes[c] estimate
Litter size:				
—total born	12.0	11.3	12.5	12.0
—born alive	11.0	10.4	11.6	11.3
—weaned	9.7	9.2	10.4	10.1
—sold	9.4	8.3	10.3	9.9
Stillbirths (%)	8.3	8.0	5.0	5.8
Preweaning mortality (%)	12.0	12.7	5.8	10.6
Postweaning mortality (%)	2.5	9.8	1.0	2.0

[a] Target figures of a large commercial piggery (>25 000 sows) in Australia.
[b] Currently achieved figures for average and best recorded herds in Australia as published in Pigstats '94—Australian Pig Industry Handbook.
[c] Personal estimates.

Table 5. Farrowing frequency targets for the breeding herd.

	Pigstats mean[a]	Pigstats best[a]	Hughes estimate[b]
Weaning age (days)	25.8	–	24.5
Empty days/cycle[c]	–	–	20.2
Litters/sow/year	2.23[d]	2.53[d]	2.28

[a] Currently achieved figures for average and best recorded herds in Australia as published in Pigstats '94—Australian Pig Industry Handbook.
[b] Personal estimates.
[c] see Table 6 for calculations
[d] these estimates are based on gilts being included only from first mating.

Table 6. Targets for the individual components of empty days.

	Australian[a] commercial	Pigstats[b] mean	Pigstats[b] best	Hughes[c] estimate
Ann. replacement rate(%)	–	65.8	–	50.0
Gilts: intro-mating (days)	–	–	–	45.0
Weaning-mating interval (days)	–	8.2	5.0	6.0
Anoestrus (%)	–	–	–	3.0
Conception rate (%)	–	–	–	91.0
Farrowing rate (%)	85.0	81.9	95.3	87.5
Abortions/NPT[a] (%)	–	–	–	2.0
Sow deaths (%)	–	–	–	2.0

[a] Target figures of a large commercial piggery (>25 000 sows) in Australia.
[b] Currently achieved figures for average and best recorded herds in Australia as published in Pigstats '94—Australian Pig Industry Handbook.
[c] Personal estimates.
[a] non-pregnant at term.

Table 7. Target figures for pigs sold/sow/year.

	Pigstats mean[a]	Pigstats best[a]	Hughes estimate[b]
Pigs sold/sow/year	18.6	22.8	22.6

[a] Currently achieved figures for average and best recorded herds in Australia as published in Pigstats '94—Australian Pig Industry Handbook.
[b] Personal estimates.

Factors Effecting Farrowing Rate and Birth Litter Size in Piggeries in Southern Vietnam and Queensland

T.T. Dan* and P.M. Summers†

Abstract

A retrospective study was undertaken in six piggeries in South Vietnam and Queensland to define the reproductive performance of sows in the tropics. Reproductive performance was analysed according to breed, age of first mating, mating frequency and time of the year. The number of matings per oestrus and interval between matings influenced both farrowing rate and number of piglets born. Increased litter size at birth was accompanied by an increase in stillbirths and mummified foetuses. There was a significant effect on farrowing rate, of the time of the year at mating. Highest farrowing rates were achieved when sows were mated during the cool time of the year in the Australian piggeries and during the dry-hot period as opposed to the wet-hot period in Vietnamese piggeries.

REPRODUCTIVE performance of sows depends on a complex interplay of environmental factors and physiological processes particularly in tropical areas, where pigs may be exposed to temperatures above their thermoneutral zone. As there are few published reports on sow performance in tropical areas, we undertook a retrospective study at six piggeries in Queensland and southern Vietnam to examine the influence of factors such as breed, number of matings per oestrus and time of the year on the reproductive performance of sows. A full analysis of this study is published elsewhere (Dan and Summers 1996).

Materials and Methods

Location of piggeries

The retrospective study was carried out at six piggeries designated as A, B and C containing 140, 210, 440 sows, respectively, in North and Central Queensland, Australia; and D, E and F currently containing 600, 890 and 400 sows, respectively, in Ho-Chi-Minh City, South Vietnam (Table 1).

Climatically, the year consists of 2 periods, the hot period (January–June in Vietnam and October–March in Australia) and the cool period (July–December in Vietnam and April–September in Australia). Meteorological data were obtained from weather stations near the piggeries. The mean maximum ambient temperature during the cool period was higher in Vietnam than in Australia (32.1°C versus 23.7°C), whereas the mean maximum ambient temperature during the hot period in Vietnam was in the range of highest temperatures in the survey regions of Australia (38.4°C versus 32.3–40.7°C).

Management in the piggeries

In Australia, the piggeries were constructed with galvanised and chemically-insulated iron roofs, whereas most of sheds in Vietnam had uninsulated fibrocement roofs with a central air vent.

Special pens for mating were located in sheds containing weaned and non-pregnant sows and gilts where the females were kept adjacent to the boar or exposed to the boar daily. Gilts were checked daily with a boar for oestrus and served at the second observed oestrus. In Vietnam, sows were served twice on the second day of oestrus (0700–0800 and 1600–1700 hours). In piggeries A and B, most of the females were mated in the morning (0800–0900 hours) by one boar or sometimes by two boars; the number of matings were one, two or three on consecutive days depending on sows' receptive behaviour to the boar. In piggery C, sows were mated both in the morning (0800–0900 hours) and in the afternoon

* Department of Animal Physiology and Biochemistry, University of Agriculture and Forestry, Ho-Chi-Minh City, Vietnam.
† Department of Biomedical and Tropical Veterinary Sciences, James Cook University of North Queensland, Townsville, 4811, Australia.

Table 1. The location, type of operation, number of sows and distribution of genetic groups in the piggeries studied.

Piggery	Location	Operation	Genetic group	Num. of sows
A	19.03S, 146.24E	Commercial	LW × LR[a]	434
B	17.16S, 145.29E (upland)	Commercial	LW × LR[a]	715
C	24.24S, 150.31E	Breeding	Hamp[b]	142
			LW	311
			LR	288
			½ LW + ½ LR	230
			¾ LW + ¼ LR	254
			¾ LR + ¼ LW	176
			⅞ LW + ⅛ LR	63
			⅞ LR + ⅛ LW	52
D	10.40N, 106.37E	Breeding & commercial	LW	98
			LR	39
			LW × LR[a]	192
E	10.40N, 106.37E	Breeding & commercial	LW	89
			LR	34
			½ LW + ½ LR	112
			¾ LW + ¼ LR	155
			¾ LR + ¼ LW	70
F	10.40N, 106.37E	Breeding	Belgian LW[c]	69
			Japanese LW[c]	72
			Japanese LR[c]	52

[a] LW × LR = Large White (LW) and Landrace (LR) crossbreed with undetermined blood ratio.
[b] Hamp = Hampshire.
[c] These breeds were imported from Belgium and Japan to Vietnam in 1984.

(1600–1700 hours) with the number of matings being determined by the technician and sows' oestrus manifestation (Table 2).

The main difference in the feeding regime of sows was that the weaned sows were deprived of feed on the day of weaning in Vietnam but not in Australia.

Pigs were vaccinated against hog cholera, Aujeszky's disease and salmonellosis in Vietnam and against leptospirosis, erysipelas and parvovirus in Australia

Data collection and statistical analysis

Records for the period January 1987–June 1993 for piggeries A, B and C; January 1990—June 1993 for piggery D and January 1988—June 1993 in piggeries E and F were used. Reproductive performance data from 13 708 parities (from the 1st to 11th parity) of 3647 crossbred and purebred sows were analysed using Statistix 4.0 package (Analytical Software 1992) and Statgraphics plus 6.0 (Manugistics 1994). Count data were analysed using multifactor ANOVA with a post-hoc LSD test. Analysis of data in proportion was performed using log-linear test. Interactions among some factors were tested and those that were not significant ($P > 0.05$) were excluded from further analyses. If there was a significant difference in the effect of analysed factors ($P<0.05$), the P value was shown with the pairwise comparison of means.

Gilts were divided into three groups according to the first mating age (group 1: ≤210 days of age, group 2: 211–240 days and group 3: ≥241 days) for the analysis of effect of mating age on reproductive performance of first parity sows.

Results and Discussion

Difference between breeds

The overall farrowing rate was similar in both countries (A, 85%; B, 84%; C, 80%; D, 87%; E, 90% and F, 79%). Breeding herds had a lower farrowing rate than commercial farms even though breeding piggery C was located in a cooler region. Landrace sows tended to have the highest farrowing rate in 3 out of 4 piggeries which had pure breeds (Table 3).

Table 2. Mating procedures in piggery C.

Mating procedure	Number of matings	Time of mating[a]
m	1	Morning
m + a	2	Morning and afternoon of the same day
m + m	2	Two consecutive mornings
m + a + m	3	Morning and afternoon of one day, and next morning
m + m + a	3	Morning of one day, plus morning & afternoon of next day
m + m + m	3	Three consecutive mornings
m + a + m + a	4	Morning and afternoon of two consecutive days

[a] The first mating depended on the sow's receptive behaviour after daily check with a boar. Normally, the first mating occurred on the day following the detection of oestrus.

Table 3. Farrowing rate and litter size at birth of breeds at the six piggeries.

Piggeries & breeds	Farrowing rate (%)	Number of piglets born/litter	Number of piglets born alive/litter
A			
LW × LR	85.0	11.4 ± 0.08	10.1 ± 0.07
B			
LW × LR	84.0	10.6 ± 0.06	9.6 ± 0.05
C			
Hamp	75.4[a]	10.4 ± 0.2[f]	9.2 ± 0.2
LW	84.8[b]	11.6 ± 0.1[g]	10.4 ± 0.1
LR	86.4[b]	11.1 ± 0.1[f,g]	10.1 ± 0.1
½LW + ½LR	82.8b	11.4 ± 0.1[f,g]	10.1 ± 0.1
¾LW + ¼LR	82.3b	10.8 ± 0.1[f]	9.7 ± 0.1
¾LR + ¼LW	83.3b	10.9 ± 0.2[f]	9.8 ± 0.1
⅞LW + ⅛LR	82.6[b]	11.9 ± 0.3[g]	10.5 ± 0.3
⅞LR + ⅛LW	81.0[a,b]	11.1 ± 0.3[f,g]	9.9 ± 0.3
D			
LW	90.3[a]	9.6 ± 0.2[a]	9.1 ± 0.2[a]
LR	95.2[a]	10.4 ± 0.2[b]	9.7 ± 0.2[b]
LW × LR	84.9[b]	9.1 ± 0.1[c]	8.7 ± 0.1[c]
E			
LW	91.0	9.7 ± 0.1	9.1 ± 0.2
LR	89.8	9.6 ± 0.2	8.9 ± 0.3
½LW + ½LR	88.8	9.4 ± 0.1	8.8 ± 0.1
¾LW + ¼LR	90.2	9.6 ± 0.1	8.6 ± 0.1
¾LR + ¼LW	86.7	9.7 ± 0.2	9.1 ± 0.2
F			
Bel LW	74.8[d]	9.2 ± 0.2	8.8 ± 0.2
Jap LW	77.7[d]	9.5 ± 0.2	8.9 ± 0.2
Jap LR	87.9[e]	9.3 ± 0.2	8.7 ± 0.2

[a,b,c] difference at P<0.001.
[d,e] difference at P=0.004
[f,g] difference at P=0.02.

In addition, the farrowing rate was age-related in all genetic groups. The rate increased gradually from parity one (79.7–87.6%) and was highest at parity 4 and 5 (86.1–95%). There was no effect of breed of boar on farrowing rate.

The average litter size in Vietnam was smaller than in Australia (9.4–9.5 versus 10.6–11.4). On the other hand, the number of piglets born alive was 93.6–94.7% of the total piglets born in Vietnamese piggeries and 88.6–90.1% in Australian herds. In addition, the percentage of stillborn piglets per litter in Vietnam was lower than in Australia (2.1–4.2% versus 7.5–9.6%).

Effect of first mating age

The mean first mating age in the piggeries is shown in Table 4.

The genetic composition of gilts did not influence the age at first mating. The farrowing rates for gilts in groups 1 and 2 were similar in all piggeries although significant differences were observed between group 3 and groups 1 and 2 in piggeries B and C (Table 5).

There was not an associated effect of first mating age and the number of matings per oestrus on farrowing rate.

In piggeries A, B, D, E and F, older gilts had more piglets. However, except for piggery D, the number of piglets born alive was not significantly different between the groups. Group 3 in piggery C had both a low farrowing rate and a smaller number of piglets born per litter compared to other groups. This small litter size was not influenced by breed, number of matings per oestrus, interval of boar use or period of the year. The small number of gilts in this group (n=34) in relation to the total number of gilts (n=709) probably indicated the effects of other factors such as growth rate or disease on gilt performance.

We did not find differences between genetic groups in first mating age although Johnson et al. (1978) indicated that breed of gilts had a significant influence on pubertal age. The exposure of gilts to boars could eliminate the difference in first mating age between genetic groups in the herds studied. Farrowing rate was not different between young and older gilts in herds A, D, E, and F. However, older gilts had a larger litter size than younger gilts. Clark et al. (1988) reported an increased litter size as the age at first conception increased from 180 to245 days, but the day of conception did not influence litter size if conception occurred after 245 days of age. This was different to our result due probably to differences in breed, growth rate and feeding regime.

Influence of mating frequency and interval between matings

The number of matings per oestrus and interval between matings strongly affected the farrowing rate. One mating per oestrus gave the lowest rate (Table 6).

Most single matings occurred in sows that had a weak acceptance of the boar. It is likely that these were sows with a high susceptibility to stress after weaning, low body condition, or weak response to boar stimuli, resulting in an insufficient luteinising hormone surge to ensure a normal ovulation rate and thus a small litter size.

In piggery C, the mating procedure of m+a+m gave a significantly lower farrowing rate than m+m+a. The result was not in accord with the finding of Tilton and Cole (1982) due probably to the differences in environment, sow response to the boar, or boar fertility. The effect of the mating procedure on farrowing rate was not constant in all genetic groups of herd C, which may be due to sample size rather than the associated effect of mating procedure on breed .

Although one mating per oestrus resulted in significantly fewer piglets born, the impact of mating frequency on the number of piglets born alive was not strong due to the increased number of stillbirths . There was not a significant difference between genetic groups for litter size resulting from different mating procedures.

Influence of season at mating on farrowing rate

There was a significant effect of season at mating on farrowing rate. The highest rate occurred during the coolest time of the year (July–September), whereas the farrowing rate in Vietnam was highest during the dry-hot time of year (January–March) and was lowest during the wet-hot period (April–June) (Table 7).

Table 4. Mean ± SE and range of first mating age in the six piggeries studied.

Farm	A	B	C	D	E	F
Mean (days)	234.3	204.4	205.2	245.2	260.5	289.9
SE	± 1.2	± 0.9	± 0.6	± 1.1	± 2.4	± 2.9
Range	182–297	151–272	159–306	215–318	182–383	228–474

Table 5. Mean ± SE of farrowing rate and litter size at birth in gilts related to age of first mating.

Piggery & piglets	Group 1	Group 2	Group 3
A			
Farrowing rate (%)	96.0 (27)	90.0 (181)	92.3 (104)
Total born	9.8 ± 0.6[a]	10.7 ± 0.2[a]	11.4 ± 0.3[b]
Born alive	9.1 ± 0.6	9.7 ± 0.2	10.2 ± 0.3
B			
Farrowing rate	85.8[a] (286)	91[a,b] (143)	100[b] (16)
Total born	9.5 ± 0.2	9.8 ± 0.2	10.0 ± 0.6
Born alive	8.7 ± 0.2	9.2 ± 0.2	9.3 ± 0.7
C			
Farrowing rate (%)	85.5[a] (470)	83[a] (205)	67.6[b] (34)
Total born	10.8 ± 0.1[a]	11.3 ± 0.2[a]	9.6 ± 0.7[b]
Born alive	9.9 ± 0.1[a]	10.1 ± 0.2[a]	8.8 ± 0.6[b]
D			
Farrowing rate (%)	NA	84.9 (146)	83.9 (137)
Total born		7.5 0.2[a]	8.7 0.2[b]
Born alive		6.8 0.2[a]	8.3 0.2[b]
E			
Farrowing rate (%)	90.5 (21)	95.0 (81)	87.4 (167)
Total born	8.4 ± 0.6	7.8 ± 0.3	8.7 ± 0.2
Born alive	7.2 ± 0.7	6.9 ± 0.3	7.6 ± 0.3
F			
Farrowing rate (%)	NA	75 (8)	79.1 (135)
Total born		7.5 ± 0.8	8.4 ± 0.2
Born alive		7.3 ± 0.9	8.0 ± 0.3

[a,b] significant difference at P=0.007, and c,d at P<0.001.
NA. = Not available.
Numbers in parentheses are sample sizes.

Table 6. Mean ± SE of farrowing rate and litter size at birth related to mating frequency in piggeries A, B and C.

Piggeries & mating frequency	Farrowing rate (%)	Piglets born	Piglets born alive
A			
1	79.0[a]	11.8 ± 0.3	10.3 ± 0.3
2	88.0[b]	11.5 ± 0.1	10.1 ± 0.1
B			
1	79.8[c]	10.3 ± 0.2	19.3 ± 0.2
2	89.1[d]	10.7 ± 0.	9.6 ± 0.1
C			
1 (m)	70.2[c]	10.7 ± 0.2[a]	9.7 ± 0.1
2 (m + a)	80.9[d]	11.4 ± 0.2[ab]	10.3 ± 0.2
2 (m + m)	84.8[d]	11.2 ± 0.1[ab]	10.0 ± 0.1
3 (m + a + m)	83.7[d]	11.3 ± 0.1[ab]	10.1 ± 0.1
3 (m + m + a)	90.3[e]	11.7 ± 0.1[b]	10.4 ± 0.1
3 (m + m + m)	88.6[d,e]	11.1 ± 0.2[ab]	10.0 ± 0.2
4 (m + a + m + a)	87.9[d,e]	11.8 ± 0.2[b]	10.3 ± 0.2

[a,b] indicates significant difference at P=0.003, and [c,d,e] at P<0.001.

Table 7. Analysis of farrowing percentage based on the time at mating (trimester) in the six piggeries.

Trimester	Farrowing rate (%)					
	A	B	C	D	E	F
Jan–Mar	85.1[b]	82.9[b]	82.0	94.5[c]	92.5	85.7[e]
Apr–June	85.3[b]	82.8[b]	82.5	82.0[a]	87.2	73.9[d]
Jul–Sept	92.0[a]	91.4[a]	84.9	84.9[ab]	90.2	77.5[de]
Oct–Dec	86.0[b]	87.1[ab]	83.0	89.7[b]	92.6	80.7[d]

[a,b,c] shows significant difference at $P<0.01$, and [d,e] at $P = 0.02$.

This profile of variation was similar in all genetic groups .

A seasonal effect on the number of piglets born and born alive was not found in herds A, B and D. For the other piggeries, litter size varied inconsistently over the periods of year although there was a trend towards a small litter size during the summer months in herds E and F. The seasonal effect may have been confounded by the influence of breed and mating procedures.

During summer, ambient temperatures in both countries were higher than the sow's thermal comfort zone. Lemin et al. (1991) observed that the average internal temperature of sheds with insulated-roofs in Central Queensland was 2.5°C lower and 7.6°C warmer than the ambient temperature during summer and winter, respectively. The reports by Hang (1989) and Giang (1993, unpublished data) on the uninsulated-shed environment of piggery E indicated that the shed temperature was similar to the ambient temperature. Cooling of sows with automatic water sprays in Australian piggeries or extensive hosing of sows with water in Vietnam may partly reduce the adverse effect of high temperature. However, humidity effects should be addressed in Vietnamese piggeries during wet-hot periods.

Conclusion

The major finding in this study was that the seasonal time of mating influenced farrowing rates. Highest farrowing rates were achieved when sows were mated during the cool months in Australia and during the dry-hot months in Vietnam. This suggests a direct effect of hot-humid conditions on the decline in pregnancy rates possibly through fertilisation failure or embryonic death although it was noted that litter size was not significantly influenced by time of the year.

The acclimatisation of sows to a hot environment and adoption of management practices including boar stimuli, daily cooling and close observation by stockmen may have reduced the severe effect of high temperature on sow fertility. Despite these practices, there was an adverse impact of both high temperature and high humidity on fertility during the early period of the rainy season in Vietnam.

To make such comparative studies of even greater value, there is a need for a standardised system of pig production recording in Vietnam.

Acknowledgments

We acknowledge the help of the farmers, directors and technicians of the six piggeries in Australia and Vietnam, who allowed their records to be used in this study, and thank Mr. Glen De'ath for statistical advice. The study was funded by Winrock International Institute For Agricultural Development.

References

Analytical Software. 1992. Statistix (V.4.0), St Paul, USA.

Clark, L.K., Leman, A.D. and Morris, R. 1988. Factors influencing litter size in swine: parity-one females. Journal of the American Veterinary Medical Association, 192, 187–194.

Dan, T.T. and Summers, P.M. 1996. Reproductive performance of sows in the tropics. Tropical Animal Health and Production (in press).

Hang Thi Bich Nguyen. 1989. Surveying some factors of the microenvironment in the farrowing shed at the state piggery 19/5 (in Vietnamese) Bachelor Thesis, University of Agriculture and Forestry, HCMC, Vietnam.

Johnson, R.K., Omtvedt, I.T. and Walters, L.E. 1978. Comparison of productivity and performance for two-breed and three-breed crosses in swine. Journal of Animal Science, 46, 69–82.

Lemin, C.D., Casey, K.D. and Foster, M.P. 1991. The economics of suboptimal environments in Australia piggeries. Queensland Department of Primary Industries, Brisbane, Australia. pp. 29.

Manugistics. 1994. Statgraphics Plus (V.6.0), Rockville, USA.

Tilton, J.E. and Cole, D.J.A. 1982. Effect of triple versus double mating on sow productivity. Animal Production, 34, 279–282.

Local Feed Resources in Smallholder Pig Development in Central Vietnam

Le Duc Ngoan, Nguyen Kim Duong, Nguyen Thi Loc and Du Thanh Hang*

Abstract

In Central Vietnam, where there is strong competition between humans and livestock for the same food resources, the pig population is about 3.8 million of which 2.8 million are kept by small farmer families. The increasing pig production is leading to serious shortages of feed. This paper reports on studies that have been conducted on the properties of some alternative local feed resources for pigs.

One major local feed resource is cassava and also its by-products from starch processing. Feeding trials were conducted both at the university research station and on farms on the substitution of cereals and cereal by-products with ensiled cassava and cassava by-products The conclusion reached was that ensiled cassava and cassava by-products could replace up to 50% of the cereal by-product (rice bran) in pig diets and ensiling was shown to greatly reduce HCN content.

Sugarcane is one of the most successful crops in the region. The study showed that sugarcane juice (SCJ) could be used as an energy source for fattening pigs. The growth rate of pigs fed a diet of SCJ and 220 g of crude protein supplement, derived from groundnut cake, was 57% better than pigs fed the traditional village diet. Molasses, one of the most important by-products of sugar processing, was also studied as a feed source. Feeding at a level of 50% of energy requirement in the diet of pigs resulted in good performance and economic returns.

CENTRAL Vietnam consists of 13 provinces with a population of about 17 million inhabitants, 24% of the national population, and is about 1000 km in length from Thanh Hoa to Ninh Thuan provinces. A common feature of these provinces is that they are adjacent to the Truong Son mountain range and to the sea. The whole region can be described as being a very long narrow strip of flat land between much larger sloping mountainous areas. Compared with other regions of the country, Central Vietnam is the poorest and the least developed agriculturally, mainly due to a hostile climate and the predominant steep sloping areas. Floods, droughts, storms and hot winds are some of the problems commonly encountered

The productivity of rice and maize is very low, and amounts to approximately 15.6% and 13.5% respectively of the total production in Vietnam. However, the cassava is higher amounting to 33.5% of the total in Vietnam (Nguyen Sinh Cuc 1995). In 1993, 4 million (26.5%) of the national herd of 15 million pigs were in this region. Liveweight total was about 23% of the total national production and slaughter weights were considered to be low. The main reasons are believed to be the use of low-producing local breeds and a lack of feed and necessary nutrients.

The vast majority of livestock are owned and raised by farmer families averaging 2–10 pigs per family. The main pig feeds are rice bran, cassava, sweet potato, peanut cake and fish meal. Most of the farming families are small producers, so they cannot produce sufficient feed for the year because they lack processing and preserving facilities. Feed used depends on the harvesting season but the yield of agricultural products is still low. Climate affects animals as well as vegetation growth from which their feed supply is derived and new technology has not been applied to reduce the harmful effects of climate.

* Hue University of Agriculture and Forestry, 24 Phung Hung St, Hue, Vietnam.

In Central Vietnam, the productivity of rice and maize is not even enough for human consumption. Thus pig production cannot develop if solely based on conventional feed. The main need for the farmer is to increase yields of pig production using non-conventional feed products.

The Use of Local Resources in Pig Feeds

Cassava and its by-products

Cassava (*Manihot esculenta* cv Crantz) is the main crop of the high areas in Central Vietnam. Its average yield is eight t/ha. Cassava root and cassava by-products are potentially important feeds for monogastric animals, replacing cereals and their by-products which can be used for human consumption. The price of both cassava root and cassava by-products is cheaper than that of rice bran and maize.

Use of cassava roots

The greatest limitation to the use of cassava as animal feed is its content of cyanogenic glucosides. It is possible to reduce this toxicity by some conventional means, such as sun drying, artificial dehydration and ensiling (Limon 1992). The silage made from either fresh or steamed cassava is of good quality. Ensiled cassava root chips could be a relatively inexpensive solution to the postharvest deterioration of the roots, particularly in Central Vietnam where drying of root chips is not feasible since cassava is harvested during the rainy season.

Ensiled chipped/ground cassava root (ECR) is produced by washing, grinding or chipping and adding salt (0.5% of the weight of the root), and mixing followed by pressing and layering (20–30 cm thick) in a tank.

The ECR are fed after 50–60 days and can be used for up to eight months after ensiling. The technique is simple, cheap and suitable for current Vietnamese conditions.

Some data on chemical analysis of ECR, both ground and chipped, are shown in Table 1.

Ensiled cassava root in pig feed

In one experiment, eight pigs (Mong Cai × Large White) of 16.3 kg initial LW were fed diets containing 80% ensiled cassava whole root and 20% 'A' molasses (based on DM) supplemented with protein supplements containing groundnut cake and fish meal. The growth rate increased by from 9–11 kg/month in the first month and to 11–13 kg/month in the second month. It was concluded that cassava whole root silage (CWRS) may be kept in a silo for at least 6–7 months and that, given daily with 200 g of protein supplements to grower-finisher pigs, produces satisfactory performance results.

Cassava by-products in pig feed

Experiments were carried out on the Farm Station of the University and aimed to study chemical composition changes with time, and performance of pigs fed cassava by-products. Results of the former are shown in Table 2 and the latter in Table 3.

The data in Table 2 show that with increasing duration of ensiling, HCN content falls dramatically and pH to a limited degree.

The data in Table 3 indicate that liveweight gain and feed conversion ratio were not significantly affected by dietary treatment ($P < 0.01$). This means that replacing some of the rice bran with cassava by-products (either fresh or ensiled) has not affected pig performance in these experiments.

Table 1. Some chemical components of two forms of ensiled cassava root.

Days of ensilage	0	30	60	90	120
Ground cassava					
DM %	36.3	41.3	41.6	42.5	42.8
HCN, mg/kg	110.4	78.3	67.3	63.6	62.8
pH	6.2	3.8	3.7	3.7	3.7
Lactic acid, %	0	1.94	2.33	2.47	–
Chipped cassava					
DM, %	34.9	36.6	38.1	41.1	42.8
HCN, mg/kg	118.0	87.7	70.8	67.9	65.5
pH	–	4.0	3.8	3.7	3.7
Lactic acid %	–	1.77	2.18	2.32	–

DM: dry matter.

Table 2. Dry matter (DM), crude protein (CP), cyanide (HCN) and pH levels in cassava fines and ensiled dregs.

Duration of ensilage (days)	DM (%)	CP (%)	HCN (%)	pH
Fines	52.2	2.54	–	–
Dregs				
0	19.5	19.10	18.9	19.5
5	19.4	1.95	12.5	3.4
10	19.1	1.98	7.8	3.0
15	17.9	1.97	5.1	2.9
20	17.1	1.98	1.8	3.0

Sugarcane and by-products of sugar processing

In Central Vietnam, sugarcane is an important crop with an average yield of cane stalks of 40–60 t/ha. In some areas it has become a traditional source of most of the family income. Normally, sugarcane is sold to sugar factories or to artisan mills. The price of sugar usually fluctuates and consequently this leads to instability in its production and in the farmer's income. Molasses, one of the important by-products of sugar making, has not been used effectively. With a view to developing alternative outlets for sugarcane and its by-products through animal production, two experiments were carried out in the villages of Thuy Xuan and Binh Dien in Thua Thien-Hue province to evaluate the use of sugarcane juice and molasses as sources of energy in pig feeds. The results are shown in Tables 4 and 5.

Although no direct comparisons were made, it can be noted that the gain of young pigs on traditional diets was a low 302 g/day but in a second phase when sugarcane juice was fed to older pigs, a higher growth rate resulted.

Some data on growth of pigs fed a diet containing 48% molasses plus other ingredients are shown in Table 5.

Weight gain of these pigs was broadly comparable to those on traditional diets but again direct comparisons were not made.

Table 3. Mean value of weight gain and feed conversion for pigs fed cassava by-products.

Treatments[a] (T)	T 1	T 2	T 3	T 4
Initial LW	19.5	19.1	18.9	19.5
Final LW	84.7	85.9	78.8	84.9
Daily gain (g)	543	556	499	545
Feed intake, (kg/day/pig)	2.54	2.58	2.37	2.50
Feed conversion (kg/kg)	4.7	4.64	4.74	4.58

[a] T 1 Rice bran: 40 kg, brewery grains: 10 kg, ensiled cassava dregs: 20 kg; cassava fines: 20 kg and protein supplement (50% fish meal and 50% peanut cake): 10%, supplying 200 g CP/pig/day.

T 2 As T 1 but protein supplement, 150 g CP/pig/day for pigs of up to 50 kg and 350 g CP/pig/day for heavier pigs.

T 3 As T 1, but ensiled dregs replaced by fresh material.

T 4 As T 3, but with protein supplement as T 2.

LW: liveweight

Source: Nguyen Kim Duong and Nguyen Van Phong (1995).

Table 4. Growth of pigs fed a traditional diet followed by an experimental diet of sugarcane juice and protein supplement.

	Traditional diet	Experimental diet
Duration (days)	108	90
Initial LW (kg)	6.8	39.5
Final LW (kg)	39.5	82.6
Daily gain (g)	302	479

LW: liveweight

Source: Nguyen Thi Loc et al. (1994).

Table 5. Daily gain of pigs fed molasses-cassava meal-based diets[a].

No. of family	No. of pigs	Initial LW (kg)	Final LW (kg)	Daily gain (g)
10	20	14.2	74.4	403.8

[a] Molasses: 48%, Cassava meal: 37%, peanut cake: 7% and green vegetable: 8% as total dry matter of the diet.

LW: liveweight.

Source: Du Thanh Hang et al. (1995).

Conclusions and Recommendations

It is concluded that to develop pig production on smallholder farms, cassava and its by-products from starch processing and sugarcane juice and/or molasses, could be used as cereal replacements in the diets of growing pigs. It is recommended that further research, including direct dietary comparisons, be conducted to refine practical recommendations for the use of by-products of cassava and sugarcane production.

References

Du Thanh Hang, Le Duc Ngoan and Nguyen Thi Thuy. 1995. The use of molasses as pig feeds (in Vietnamese). Faculty Seminar on Animal Sciences, Hue, March, 1995.

Limon, R.L. 1992. Ensilage of cassava products and their use as animal feed. In: Machin D. and Nyvold S. eds. Roots, tubers, plantains and bananas in animal feeding. FAO Rome, N. 95, pp. 99–110.

Nguyen Kim Duong and Nguyen Van Phong, 1995. Cassava by-products and using them as pig feeds (in Vietnamese). Faculty Seminar on Animal Sciences, Hue, March, 1995.

Nguyen Sinh Cuc 1995. Agriculture of Vietnam, 1945–95. (in Vietnamese). State Publishing House, Hanoi, 386 pp.

Nguyen Thi Loc, Ngo Thi Bich Loc, Nguyen Kim Duong and T. Preston, 1994. Feeding sugar cane juice to growing pigs (in Vietnamese). Proceedings of a National Seminar-Workshop on Sustainable Livestock Production on Local Feed Resources. Hanoi/HCMC, Nov 1993. SIDA/MAFI/MET/SAREC, pp. 115–117.

Improvement of Productivity and Meat Quality of Pigs in the Red River Delta Region by Crossbreeding

Nguyen Thien, Phung Thi Van, Pham Nhat Le, Pham Huu Doanh, Nguyen Nghi, Nguyen Khanh Quac and Vo Trong Hot*

Abstract

The Red River Delta (RRD) region of Vietnam is a major pig-producing region containing 22.5% of the nation's pigs. Nearly three quarters of the region's sow population is still predominantly made up of local breeds which are hardy and have reasonable litter size but have low productivity and grow slowly. Exotic breeds have been introduced to lift productivity and, both in the experiment station and under practical conditions, have been observed to do so in both reproduction and production. The interaction of nutrition and breed type is in need of further study. The three-way cross of Landrace by Large White and Mong Cai is being encouraged and targets for the year 2000–2010 in the RRD have been set involving breeding programs of this type.

THE Red River Delta (RRD) is located in the North of Vietnam and comprises seven provinces. The total area is 16 644 km^2 with a human population of 17 050 000. The traditional occupation here is paddy rice cultivation and pig raising. Food production in 1992 in the area was 2 651 820 t, 12.6% of total national production (Anon 1993).

Pig numbers in RRD in 1994

Data on production in 1994 in the RRD and nationally are shown in Table 1 (Extension Department 1995):

- total number of sows in 1994 was 557 600 of which local sows, mainly Mong Cai and I breeds, comprised 72.05%, crossbred F_1 (local sow with exotic boar) 27% and 1% (VIE 1995) were exotic sows; and
- commercial crossbred pigs comprised 80% of the total, of which crossbred pigs with 3/4 exotic blood breeds were 25% (VIE 1995).

Feed for pigs is derived mainly from agricultural by-products supplemented with cereals such as maize or rice.

* Pig Research Centre, National Institute of Animal Husbandry, Chem Tu Liem, Hanoi, Vietnam.

Animal production systems

In this region two forms of animal production farming systems are maintained:

- intensive systems: mainly in the state farms and to a small degree in private households in the suburbs of major cities such as Hanoi and Hai Phong; and
- semi-intensive and extensive systems which comprise 85–90% and which are mainly located on small farms.

Production performance of local Mong Cai breed and exotic pig breeds

The local Mong Cai (MC) pig breed is the most popular in the RRD and is concentrated in the coastal provinces such as Hai Phong and Thai Binh. Some of its characteristics are shown in Table 2 (Dinh H Luan 1979, Pham H Doanh 1985, Nguyen Thien et al. 1992).

The advantages of the Mong Cai are that they are prolific with a large litter size, have good resistance to poor conditions (lack of quantity and quality of feed, unfavourable climate) and good disease resistance. The disadvantages are low productivity for meat production including a slaughter weight at 10 months of 60–68 kg, high feed consumption (4.52–4.95, of concentrate feed/1 kg liveweight gain) and a low lean-meat rate of 32–34%.

Exotic pig breeds have high productivity but they are difficult to develop in the unfavourable

Table 1. Pig numbers and production in the Red River Delta region (RRD) in 1994.

	Vietnam	RRD	RRD / Vietnam (%)
Total herd (n)	15 569 384	3 514 401	22.5
Sows (n)	2 180 006	557 600	22.6
Sow/total herd (%)	14.00	15.89	
Fattener (n)	13 304 858	2 936 701	22.0
Market pigs (n)	13 908 827	3 673 592	26.4
Pig meat production (t)	937 370	246 153	26.0
Slaughter: weight/head (kg)	67.4	67.0	
Slaughter: pigs/sow/year (n)	6.38	6.58	

Source: Extension Department 1995.

Table 2. Production performance of the local Mong Cai breed and exotic pig breeds in the Red River Delta region.

	Local MC	Exotic breeds
Production purpose	fat	lean meat
Body size	small	large
Adult sow weight (kg)	100–115	180–200
Age of maturity (day	120–150	190–200
Litter size (piglets)	11–13	9.0–10.0
Birth weight (kg)	0.45–0.6	1.25–1.45
Number of litters/year	>2	1.6–1.8
Number of weaned piglets/sow/year	15–17	14–15
60 day weaning weight (kg)	5.9–7.6	12–13

Source: Pham H Doanh 1985; Dinh H Luan 1979; Nguyen Thien et al. 1992.

conditions in Vietnam such as lack of high nutrient feed, high temperatures and humidity and primitive pig sheds in extensive systems. With such conditions exotic pig breeds can achieve only 60–70% of their potential, leading to low economic efficiency.

To improve meat quality and animal production efficiency, local pig herds must be crossed with exotic breeds, using crossing programs that will give high productivity suited to the Vietnamese ecological conditions.

Some results of pig commercial crossing (1970–1990) in the RRD.

Table 3 records some data collected from commercial pig crossbreds in the RRD over an extensive period (Nguyen Thien et al. 1985).

Recent research results (1990–1994)

During the period 1990–94 at the National Institute of Animal Husbandry (NIAH), the experimental farm in Bac Thai, part of the Agricultural University, and at some other farms, data on reproduction and other productivity was gathered for two types of crossbred pigs as in Tables 4 and 5.

Observations have been made on the effect of certain dietary items on productivity. Table 6 records data derived from studies of the effect on growth of two energy levels as effected by two declining protein levels in crossbred (3/4 exotic) pigs.

With regard to ADG, FCR and lean meat percentage, there was no significant difference between different protein levels of the higher energy groups. However in the lower energy group, the higher protein group had higher average daily gain (ADG) and lean meat percentage and lower food conversion ratio (FCR). The mean of the lower energy levels gave better ADG and FCR and clearly further study is indicated.

The reproductive performance of F_1 sows was studied under practical conditions at four differing locations and, together with the productivity of their progeny is reported in Tables 7 and 8.

Table 3. Some results of commercial pig crossing (1970–90) in the Red River Delta region.

Breed Type	Local (MC, I, Lang Hong) × exotic boar	F_1 sow (local I × Large White) × exotic boar
New born piglets/litter (n)	9.0–11.0	9.3–10.7
Weaned pigs/litter (n)	7.5–8.5	7.4–8.7
Weight at 60 days weaning (kg)	7.0–8.8	9.0–10.3
Daily LW gain (g)	366–500	432–554
FCR (kg/kg)	3.61–4.29	3.43–4.24
Lean meat (%)	39.06–44.54	45.2–46.1
Fat (%)	39.3–45.38	32.67–37.50

LW: liveweight
FCR: food conversion ratio
Source: Nguyen Thien et al. 1985.

Table 4. Reproductive performance of F_1 (Large White [LW] × Mon Cai [MC]) × Landrace (LR) boar.

Location	NIAH Mean ± SD	Bac Thai X ± m	Dong Anh X ± m
No. of litter (n)	56	20	21
Born alive/litter	10.75±2.21	9.37±1.65	10.39±1.94
Birth weight (kg)	0.97	0.93	0.96
Litter weight (kg)	8.00±1.38	8.63±1.83	8.78 ± 1.27
Average LW at weaning (kg)	11.22	9.82	11.83
Litter size (n)	1.98	–	1.97

LW: liveweight

Table 5. Growth and carcase characteristics of F_1 (LW × MC) pigs at three locations.

	NIAH	Bac Thai	Dong Anh
Number	22	21	13
Initial weight (kg)	22.24	12.51	22.0
Finishing weight (kg)	97.6	97.5	93.23
ADG (g/day)	601	566.6	569.8
FCR (kg/kg)	3.39	3.76	3.81
Slaughter weight (kg)	96.8	99.6	93.0
Carcase rate (%)	71.9	72.77	72.53
Lean meat rate/ carcase (%)	47.1	46.11	48.68
Fat rate/carcase (%)	36.3	37.5	33.50

ADG: average daily gain
FCR: food conversion ratio

Results from Tables 7 and 8 show that the formula used for crossing Landrace [LR] boars with F_1 sows (Large White [LW] × Mon Cai [LC]) obtained good results. The number of pigs per litter weaned at 60 days was higher whilst other criteria resulted in values similar to pigs reared in experimental conditions.

In 1993 the three-way cross with ¾ of exotic breeding comprised 25% of the total herd of commercial pigs in the RRD (VIE 1995).

It is expected that in 1996 some small farms will have 30–50 pigs of exotic breeding instead of 3–5 pigs as now happens.

Together with any exotic breed production by farmers, the crossbred pig, LR × (LW × MC) will play an important role in meeting the demand of pork for the region and export.

Conclusion

Crossbreeding between local and exotic pig breeds is a very efficient way to increase total productivity as it is adapted to economic and ecological conditions in the RRD.

The direction in which pig production for the years 2000–2010 should be pointed is as follows (VIE 1995):

- further development of lean meat program by use of improving crossing formulas between three breeds and the pure exotic breeds in the region;
- expansion of the intensive system of pig production;
- establishment of medium-scale intensive pig farms with 5–10 sows and 100–200 fatteners;

Table 6. Protein and energy effects on growth and slaughter characteristics of crossbreds (¾ exotic).

Energy Level (Kcal)	3215		3050		3215	3050
Experimental group	I	II	III	IV	Mean	
Protein %	17-15-13	16-14-12	17-15-13	16-14-12	I + II	III + IV
n	11	11	11	11	22	22
Initial weight (kg)	24.16	24.16	24.32	24.44	24.16	24.37
Finishing weight (kg)	97.0	100.4	98.2	96.7	98.7	97.4
ADG (g/day)	603	620	610	587	607	599
FCR (kg/kg)	3.44	3.41	3.34	3.40	3.43	3.37
Slaughter weight (kg)	97.4	97.7	97.6	98.4	97.0	98.0
Lean meat rate/carcase (%)	46.7	46.2	47.0	46.5	46.3	46.9
Fat rate/carcase (%)	36.6	37.5	36.6	36.3	37.2	35.5

ADG: average daily gain.
FCR: food conversion ratio.

Table 7. The productive performance of F_1 sows (LW × MC) × LR under practical conditions.

Localities	Quang Ninh	Thanh Tri	Thanh Hoa	Hai Hung
Litters (n)	156	38	30	41
Born alive/litter (n)	10.7	10.9	10.2	10.7
Birth weight (kg)	0.97	0.97	0.81	0.96
No of weaned pig/litter	8.6	9.5	9.71	9.50
Weaning weight (kg)/litter	93.74	111.6	92.9	112.4
Weaning weight/piglet (kg)	10.9	11.74	9.56	11.83

Table 8. Growth and carcase characteristics of crossbred progeny (LW × MC) × LR.

Localities	Quang Ninh	Thanh Hoa	Hai Hung
n	72	7	30
Initial weight (kg)	10.99	13.1	14.1
Finishing weight (kg)	92.42	92.7	94.6
ADG (g/day)	452.6	501.4	575.0
FCR (kg/kg)	3.70	3.80	3.22
Slaughter weight (kg)	98.6	90.5	93.5
Carcase rate (%)	71.5	74.2	–
Lean meat/carcase	47.07	46.8	48.0

ADG: average daily gain
FCR: food conversion ratio

- change in the ratio of the sows to achieve exotic breed sows: 5%, F_1 crossbred: 30% and local sows: 60%; and
- improvement of the average slaughter weight to achieve a figure of 80 kg in the year 2000 and 95 kg in 2010.

References

Anon 1993. National Statistics of Vietnam (in Vietnamese). Hanoi.

Dinh H. Luan 1979. Initial results on commercial crossing between LR and LW (in Vietnamese). Results of Scientific Research 1969–79. Agricultural Publishing House, Hanoi pp. 27–29.

Extension Department, Ministry of Agriculture and Food Industries 1995. Statistical Data (in Vietnamese) Vol 7.

Nguyen Thien, Pham H. Doanh and Dinh H. Luan 1985. Results on the crossing formula of commercial pigs (in Vietnamese). Scientific Work in Animal Production: 1969–84. Agricultural Publishing House, Hanoi pp 42–43.

Nguyen Thien, Phung Thi Van and Pham H Doanh 1992. Reproductive performance of some pure pig breeds and crossbreeds for lean meat (in Vietnamese). Results of Scientific Work 1985–90. Agricultural Publishing House. Hanoi pp. 23–24.

Pham H. Doanh 1985. Some characteristics and production performance of local pig breeds (in Vietnamese). Selection of Work in Animal Husbandry 1969–84. Agricultural Publishing House. Hanoi, pp. 15–17.

VIE 1995. Plan for animal husbandry development. General planning for the Red River Delta (in Vietnamese). VIE Project 89.034. Hanoi 1995.

Management and Performance of Village Cattle and Buffalo: a Case Study from Phuoc Thanh Village, Saigon River Delta

Le Dang Danh*, Chau Chau Hoang*, Nguyen Kim Cuong*, Pham Trong Nghia*, Tran Van Chinh*, Nguyen Van Phat* and John Perkins†

Abstract

A study of the management of cattle and buffalo was conducted in Phuoc Thanh village, 40 km northwest of Ho-Chi-Minh City. A sample of 176 farmers who reared a total of 262 cattle and 94 buffalo were studied. Cattle were mainly Red Sindhi crosses and included 58 oxen. The buffalo were all of the swamp buffalo type. General health and condition of animals were good. Male and female cattle averaged 400 kg and 280 kg at maturity respectively; both buffalo sexes reached mature weights approaching 400 kg. Growth rates for both species averaged >600 g/day for the first few months but soon fell away to c. 200 g/day in the second year and <100 g/day thereafter. Female cattle first calved at c. 22 months with a calving interval after that of 12–14 months; the respective figures for buffalo were 44 and 21–22 months. Future research should concentrate on beef production and, particularly, more profitable production strategies.

A series of studies was recently conducted at selected sites in Vietnam, including Phuoc Thanh. The main objective was to describe the current production and productivity of cattle and buffalo managed by village farmers within a range of farming systems; secondly, to determine which future research might make the biggest impact on the welfare of village farmers rearing large ruminants. This case study presents a first summary of data from the Phuoc Tranh site with particular attention paid to measures of growth in relation to resources typically available to the farming community of the Saigon River Delta in southern Vietnam.

Data Collection

The site was selected to be reasonably representative of the Saigon River Delta, which shares many characteristics with the Mekong River Delta further south. It was important that the site have cattle and buffalo management systems typical of those in the area and, in particular, not be a current location for official livestock development programs which might bias the data.

The study was conducted by staff and students of the University of Agriculture and Forestry, Ho-Chi-Minh City in October–November 1994. A short questionnaire was administered to the sample of 176 farmers, who reared a total of 262 cattle and 94 buffalo. The animals were weighed on portable electronic livestock scales and a recording form completed for each. Secondary data on the village and environs were collected from government offices and other sources, supplemented by informal discussions and observation.

Results

Phuoc Thanh village

Phuoc Thanh has a population of 13 100 people in 2900 households, of which 1800 are classified as agricultural. Land used for agriculture totals 1108 ha—of this, 1078 ha are used for annual cropping, which gives an average cropping area of 0.38 ha per farm. Little land is available for uses other than agriculture.

* University of Agriculture and Forestry, Ho Chi Minh City, Vietnam.
† Faculty of Agriculture, Forestry and Horticulture, University of Melbourne, Parkville, Victoria 3052 Australia.

Phuoc Thanh is very close to Thai My village, about which the general cropping systems and farming environment are reported elsewhere in these proceedings (Chau and Perkins, these proceedings). Farmers' responses indicated that most land is cropped twice per annum. Rice is the dominant crop followed by peanuts and much smaller areas of vegetables and other minor annual and perennial crops.

Cattle and buffalo

Statistics

Official data indicated totals of 928 cattle and 1019 buffalo in 1994. Most of the cattle are cross-breeds of Red Sindhi and local cattle. The crosses have become fairly stable and most animals display the body conformation and deep red-brown hair colour typical of the Red Sindhi. Buffalo are all of the swamp buffalo type.

The sample comprised 176 households of which 72% reared cattle, 19% buffalo and 9% reared both species. Average agricultural area operated by these households (0.68 ha) was almost double that of the overall village figure; 16% were classified as landless. All buffalo farmers reared two animals while most cattle farmers reared either one or two head and a few reared more than two. The single cattle tended to be females kept for calf production and sale whereas double cattle or buffalo teams were mainly maintained for draught power. A few farmers also specialise in raising bulls to provide reproductive services.

Almost equal proportions of male and female cattle were kept by the sample households. Fifty-eight of the males (22%) were oxen (castrates) kept in matched pairs for draught work, in either land preparation or carting. Farmers maintain these older specialist animals for many years and do not use any other cattle for draught work. One- and two-year-old animals were the next most dominant classes for both sexes.

Among the 94 buffalo sampled, almost two-thirds were male with about 40% in the 13–36 months age category whereas older classes dominated for females. In total, 43% of the buffalo (male and female) were used for draught power compared with 22% of cattle. Farmers said that male buffalo were raised for both draught and mating but, after about three years of age, became more aggressive and difficult to handle and were sold for meat and income.

Growth

Estimates of total body weight and average daily gain (ADG) are presented in Figures 1 and 2 for cattle and buffalo respectively. Weight was measured on portable electronic cattle scales but ages had to be estimated by the farmer and others, as many of the animals had not been born on those farms. A more sophisticated analysis of the data is in progress and will be presented later in a separate publication, together with information from other sites. The present analysis provides some indications of the general patterns of growth under village management.

CATTLE

Male and female cattle grew at similar rates for their first twelve months, averaging some 32 kg during the first month and increasing to c. 160 kg eleven months later. After this the weights of males and females diverged markedly. Weights of males increased to about 250, 330 and 380 kg by Years 2, 3 and 4 respectively and mature weights were close to 400 kg. Female cattle averaged about 210, 240 and 260 kg in Years 2, 3 and 4, with a mature bodyweight around 280 kg. It should be noted that male weights include those for castrates which dominate the older age classes. These receive special care and, possibly, feeding in view of their draught work. This might mean they achieve generally higher levels of weight than other animals of similar ages.

ADG for both sexes was about 700 g/day after birth but declined fairly rapidly to about 400 g/day at six months. Females were estimated to average 150–200 g/day for their second year and <100 g/day thereafter; males appeared to maintain rates above 200–300 g/day for the second year and 200 g/day for the third, thence declining to 100 g/day or less. The general pattern is one that might be expected: reasonably high initial rates as the calves are suckled but fairly rapid drops as they increasingly shift to forages of relatively low quality.

BUFFALO

As displayed in Figure 2, body weights and growth patterns were virtually identical for both male and female buffalo, although there was a progressive slight divergence and females appear to mature at some 20 kg lighter than males. Body weights averaged 42, 160 and 290 kg at 1, 12 and 24 months; around 400 kg at five years. Growth rates commenced at c. 650 g/day after birth, dropping to about 300 g/day by the end of the first year. Thereafter the decline in growth was slow but pronounced: about 200 g/day by the end of the second year and <100 g/day after the third.

For both cattle and buffalo there was high variability of individual weights around the mean which was as expected, particularly for older animals when historical and genetic factors have had time for expression. University staff said that a similar study had been conducted in the area in 1974 (unpublished) and had recorded similar patterns of growth and development. It would appear that little has changed but, on a positive note, it might be said that there is no evidence for a decline in general herd performance.

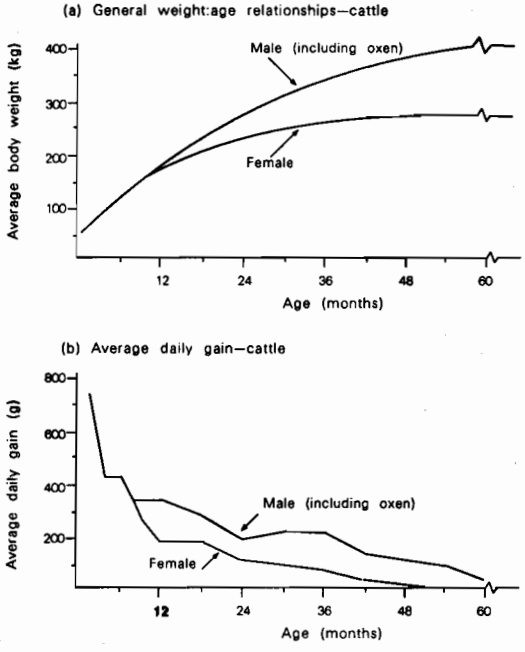


Figure 1. Estimated average growth curves for cattle, Phuoc Thanh village

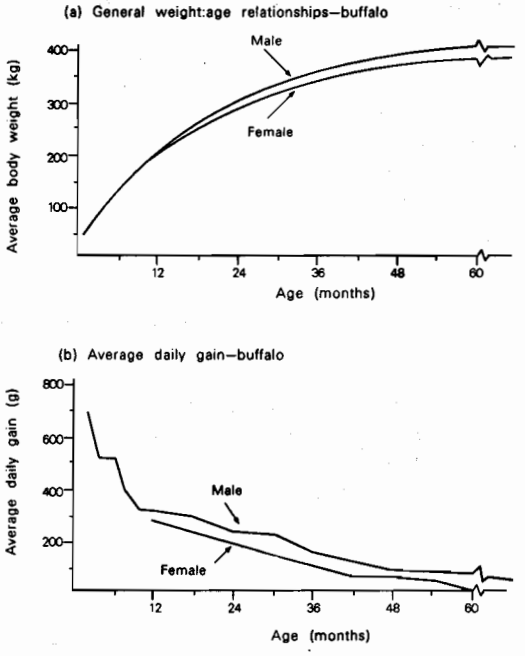


Figure 2. Estimated average growth curves for buffalo, Phuoc Thanh village.

Nutrition

Combinations of cut-and-carry and tethered grazing were the most common methods of feeding cattle and buffalo in both the wet and dry seasons. Cut-and-carry was used more in the dry season than the wet (40% versus 25%) because of the limited areas of fresh grass for grazing. Farmers said that cut-and-carry had become more widely used in the past ten years as a result of more intensive farming and cropping practices.

Fresh grasses and weeds, rice straw and peanut vines were the most common feeds, with working and nursing animals given priority for fresh grass forages in the dry season. There was some supplementation with rice bran, swine compound feeds or peanut meal and salt for draught animals on working days and bulls when used for mating. Almost 80% of farmers practised feed conservation, mainly of rice straw. Peanut vines were said to be difficult to conserve because of leaf-shedding and mould.

Breeding and reproduction

The ratio of male:female cattle was 1:16. There are some professional bull rearers who manage one or two animals for mating and charge VND30 000–50 000 per service. A second service is provided free if the first fails. Ten bulls were sampled, from 2–4 years of age, and had an average liveweight of 376 kg. Cows were said to average about 30 months at first calving and would be used for reproduction up to the seventh or eighth calf. Calving intervals were estimated at around 13 months.

None of the male buffalo are castrated and the ratio was 35 male to 29 females. Animals are frequently run together as a group yet, despite the apparently favourable conditions, fertility indexes were not high. Age at first calving was estimated at c. 45 months, with an average calving interval of 22 months.

Health

All animals were ranked according to condition, with scores from 1 (emaciated) to 5 (fat). Most cattle were placed between 3 and 5 with the highest proportion being 4; most buffalo were judged as 4 or 5. Few animals were regarded as below average or thin.

A comprehensive checklist was provided to externally assess each animal's health status: few were noted with obvious symptoms of disease or other veterinary problems. Some farmers said that diarrhoea,

bloat and coughing did occur and there were cases of inflamed reproductive tracts after delivery. Death of animals under six months was said to be very rare.

Health and condition were generally good. It is acknowledged that sub-clinical conditions could not be assessed, particularly internal parasites. However, health was not frequently mentioned as a current management concern by the farmers.

Labour

Rearing cattle or buffalo was considered a secondary enterprise, given the small numbers of animals raised on each farm. This must be tempered with the observation that farmers with specialist draught oxen would devote substantial time to the maintenance and working of their animals. The husband was said to have primary responsibility (45% of the sample) followed by the family (23%), the wife (21%) and children (11%). Hired labour was not used in rearing the animals.

Value

Rental for ploughing and sale represented the two main sources of cash income from large ruminants. Hire rates for ploughing were said to be VND40 000 per half-day and VND30 000 for levelling; similar rates were quoted for using the paired teams for cartage and transport. Draught animals were estimated to work 30–60 days per year and it was likely that total draught capacity was in excess of need. Despite this, the use of mechanical cultivators is said to be increasing rapidly in Phuoc Thanh, which will place pressure on draft animal retention within the system for the purposes of land preparation and hauling.

Mature bulls (c. 380 kg) are worth VND4–5 million; pairs of specialist draught oxen or buffalo were valued at VND10–12 million. Weaned calves were valued at around VND1.4 million. The slaughter price of cattle was said to be about VND7000 per kg and that of buffalo VND5000 kg.

Conclusions

Cattle and buffalo in Phuoc Thanh appeared to be in general good health and to be serving important roles within local farming systems. As in many similar environments, their growth and development were relatively slow, but this was achieved through the use of available resources at fairly low levels of intensity. Farmers were asked about the major constraints on production. As in the adjoining Thai My village, they said that the animals were fairly easy to raise and did not highlight recurrent problems of production though these farmers were very concerned about its profitability.

It is this latter aspect that offers the greatest opportunity for future research. Cattle and buffalo are currently the major providers of draught power in Phuoc Thanh but are facing a strong challenge from mechanical cultivators. In terms of income-earning potential they must achieve profitability levels similar to those available for intensively-managed animals (e.g. pigs and poultry) and crops (e.g. rice, peanuts and vegetables) to remain viable. This could mean concentrating on more profitable production of beef. Appropriate research would include farm-level studies on:

- earlier weaning of calves;
- nutritional strategies to boost early growth and development, including sources and composition of feeds;
- improving information on reproductive indexes, particularly fertility and reproduction of buffalo; and
- economic assessment of recommended changes.

Cattle Production in Central Vietnam

Nguyen Kim Duong, Nguyen Xuan Ba and Hoang Manh Quan*

Abstract

Central Vietnam contains 1.5 million cattle with a higher growth rate and better performance than other regions. It is a key area of the country for cattle genetic improvement through artificial insemination (AI) use with exotic breeds.

The number of cattle kept by farmers has recently increased and they are fed mainly on green pasture and crop residues. Though kept for draught power purposes in the past, the emphasis has changed to meat production. Supplementary feeding programs have been very effective and economic in improving this production.

The disease status of the cattle herd is severe, with more than half the cattle being infected with blood parasites, internal parasites and fasciolosis. These are important limitations in raising economic efficiency.

Studies in the future will focus on three main aspects including better organisation of the program of genetic improvement by the use of AI with exotic breeds; promotion of pasture production; advanced technology in cattle feed processing and prevention and treatment of disease.

CENTRAL Vietnam comprises 13 of the 53 provinces of the country, stretching from Thanh Hoa province in the north to Thuan Hai province in the south. Compared with other regions in the country, central Vietnam is the poorest and least developed of all.

The region possesses a cattle herd of 1 597 700 head, a high proportion (49.9%) of the total cattle population of the country. The cattle population here is increasing at a rate of 4.72% annually, while the figure for the whole country is 2.1%. Cattle production is the most advantageous compared with that of other livestock raised in the region.

The work reported in this paper arose from a study aimed at:

- identifying the constraints and opportunities for development of cattle production in the region;
- making better use of local feed resources to feed cattle; and
- working out appropriate technical solutions to increase the efficiency of cattle production.

* Animal Sciences Faculty, University of Agriculture and Forestry, 24 Phung Hung, Hue, Vietnam.

Results and Discussion

Some productive traits of local cattle

The result of some productive traits compared to those of cattle in Vietnam as a whole, is presented in Table 1.

It can be seen that all the productive traits recorded are better in this region than those of Vietnam as a whole. Because of the above-mentioned advantages central Vietnam was chosen to carry out this VIE project, which aims to promote beef cattle production in Vietnam. The government has also selected the region to start a program of native cattle (yellow cattle) improvement.

Table 1. Cattle production in Vietnam and in the region.

	Vietnam	Central Vietnam
liveweight (kg)	140–160	180–200
Age at first oestrus (month)	–	15–18
LW at first oestrus (kg)	–	150
Age at first mating (month)	32.6	15–19
Age at first calving (month)	41.7	25–30
LW at birth (kg)	13–15	13–15
Calving interval (month)	18–20	14–15

Relative LW gain, male to female cattle: +15–20%

After several years of project implementation, the project has brought about an increase in the number of crossbred cattle in the region in which Quang Ngai, Binh Dinh, and Phu Yen are the provinces with the highest numbers. Crossbreds now comprise 4–7% of cattle with percentages varying with location. The higher liveweights of crossbreds compared with local cattle can be seen in Table 2.

The feed supply situation

The region's area of green grassland is large, especially in the hilly and mountain areas, however grassland quality is poor. In the dry season, grasses are very scarce because of lack of water.

Cattle are often grazed for 4–8 hours per day along the edge of ricefields, irrigation canal banks and uncultivated areas. Some are fed rice straw in the pen at night but only about 39% of available rice straw is used as feed for cattle. About 13–15% of households that keep cattle supply them with drinking water at the house at night, and some 12–13% of the households provide salt in the diet of their cattle.

Some crop residues such as rice straw, sugarcane tops, maize stalks and so on have been used as cattle feed, but most of the residues are used in their original state without treatment. The calculation and supply of feed especially protein feed supply to meet the demands of growth of cattle are not adequately considered.

The disease situation

Blood examination of cattle in the region shows that:

- 2.4% of cattle carry *Trypanosoma evansi*; and
- 50% of cattle carry *Anaplasma* spp.

The result of internal parasitic examination indicates that:

- 70% of cattle in the lowland and 50% of cattle in the upland are infected with *Fasciola* ; whilst
- 60% of calves are infected with *Neoascaris* spp; and
- 60% of calves are infected with *Strongylus* spp.

It is found that crossbred cattle groups and native ones carry similar parasitic species. However the intensity of infection of crossbreds is higher than that of native cattle. The difference may be imputed to the different rearing practices for the improved cattle. These are kept mainly in pens or fenced pastures whereas the native cattle are allowed to range freely. Parasitic disease is one of the biggest problems of cattle development in the region.

Cattle production practice

In central Vietnam, cattle are mainly kept by farmers with herds of 1–5 head per household. The scale of production has increased in recent years, and some households can now raise 10–30 cattle.

In the past, cattle were mainly used for draught purposes, but they are now used for meat supply. The price of crossbred cattle with their higher liveweight and dressing percentage is noticeably higher than that of the native cattle. These facts provide great motivation for developing crossbred cattle production in the region.

Dairy cattle in the region are few in number there being only several hundred head which are mainly F_1 or F_2 crossbreds of Holstein and *Bos indicus* types (Sindhi, Sindhi cross, Yellow). The dairy crossbreeds are quite good producers, giving 2500–3000 L per lactation cycle while some can produce 4000–4500 L/cycle.

Feed supplementation of cattle

To clarify economic efficiency of feed supplements for crossbred cattle and to motivate movement into crossbred cattle production in the region, experiments were conducted with the following design: 15 crossbred cattle of 12–15 months and weighing about 120–125 kg were allocated into three groups (one control group and two treatment groups) with five head in each. See Table 3.

The results can be seen in Tables 4 and 5.

The results indicate that liveweight gain (LWG) decreased from the first to the third month of the experiment but, in general, crossbred cattle in treatment groups are heavier than cattle in the control

Table 2. Age effects on liveweight of cattle (kg).

	at birth	6 month	12 month	18 month	24 month
Native (Yellow)	15	52	94		160
Sindhi × Yellow	20	80	122	170	208
Charolais × Yellow	26	91	135	182	225
Hereford × Yellow	25	89	131	178	220
Limousine × Yellow	25	84	135	182	223

Table 3. Design of cattle supplementation experiment.

	Control Group	Treatment Group 1	Treatment Group 2
n	5	5	5
Duration of experiment	90 days	90 days	90 days
Green grass access	grazing 8hours/day	grazing 8 hours/day	grazing 8 hours/day
Feed supplied every night:			
— Treated rice straw, 4% urea	no	ad libitum	no
— Rice straw, + 4% urea	no	no	ad libitum
— Cotton seed cake[a]	no	1–2 kg/head	1–2 kg/head
— Molasses A[a]	no	1–1.5 kg/head	1–1.5 kg/head

[a]Quantity gradually increased as experiment proceeds.

Table 4. Daily liveweight gain of experimental cattle (g/day).

	Control group	Treatment group 1	Treatment group 2
First month	330.0	806.7	746.7
Second month	166.6	713.3	566.7
Third month	–10.0	643.3	390.0
Mean	162.2	721.2	567.8

Table 5. Rice straw consumption of experimental cattle (kg/head/day).

	Treatment group 1	Treatment group 2
First month	0.81	0.49
Second month	1.01	0.56
Third month	1.43	0.65
Mean	1.08	0.57

group. The treated groups consumed additional supplement at night when it was available ad libitum. A possible explanation for this could be related to supply of pasture. The experiment was started late in the rainy season when green grass was plentiful but most of the experiment was in the dry season when it was very scarce. The cattle appeared to like eating rice straw treated with urea because their appetite was stimulated. These results suggest that it may be beneficial to supply cattle with feed supplements in the pen at night time.

Conclusions and Recommendations

From results of the study the following conclusions can be drawn:

- cattle in central Vietnam have shown on average a better productive performance compared with the national average;
- the management and administration of cattle production in the region are still poor;
- the incidence of parasitic disease is high; and
- supplementation of cattle fed at the house increased their liveweight gain (LWG) and brought about noticeable economic efficiency.

Recommendations for Further Studies.

Further short-term studies between now and the year 2000, will be focussed on some of the following aspects:

- genetic improvement of native cattle through practice of AI with frozen semen of exotic breeds, at the same time carrying out research to determine the most suitable cross combinations for the region by examining adaptation of cross-breeds;
- developing education and training programs to better equip extension workers and producers;
- improving the natural grazing areas as well as testing the benefits of grasses and fodders and, on the other hand, carrying out research that aims at processing and using available feed resources in the region to feed cattle;
- studying the prevention and treatment methods to limit the losses caused by disease; and
- providing information and data banks on all aspects of the region's cattle herd.

Results of these studies may support a scientific basis for the formulation of specific policies, solutions and management methods aimed toward development of an efficient cattle production system in the region.

Adequacy of Pig Diets in the Red River Delta

Vu Duy Giang and Nguyen Trong Tien*

Abstract

The rations commonly used by pig rearers in the Red River Delta were studied with a view to determining their adequacy, and the specific need to modify them as required to achieve higher productivity in these enterprises.

In pig enterprises where local pigs are crossed with foreign crossbreds, rations often consisted of maize, rice bran, groundnut cake and fish meal. Protein levels were not low (14–19%) but it was found that there was a lack of dietary lysine, methionine and thiamine. The feed processing was simple, being mainly limited to grinding. Feed conversion ratios (FCR) in this region were high (4.0–4.2 kg feed per kg gain) and the carcase lean percentage was 45–49%.

Where foreign pig breeds were reared, the proportions of ingredients fed in the rations were similar to those in the rations for crossbreds. Crude protein levels were 14–17%, energy was 2900–3000 cal per MJ per kg feed and rations again lacked lysine and methionine. At six months of age these pigs reached 78–82 kg liveweight and FCR varied from 3.5–3.7 kg feed per kg gain. The carcase lean percentage was 51–55%.

It was concluded that to raise the productivity of pigs in the region, there must be studies leading to an adjustment of the crude protein levels, the metabolisable energy (ME) concentration of the rations, the balance of the amino acid levels including the possible need for supplemental lysine and methionine and the level of minerals. In addition, processing of concentrates and other feedstuffs should be implemented where appropriate whilst studies in these areas should be further pursued.

* Faculty of Animal and Veterinary Sciences, Hanoi Agricultural University, Hanoi, Vietnam.

Proportion of Ingredients and Nutrient levels in the Rations of Dairy Cows in the Red River Delta

Vu Duy Giang and Nguyen Trong Tien*

Abstract

A cattle husbandry survey was conducted between 1991–94 to determine the feeding status and nutrient levels in dairy cow rations in the Red River Delta. One hundred and thirty-five rations were collected from government and household dairy cattle farms in Thanh Tri, and Gia Lam districts in the Hanoi area. They were analysed by the Weende system of proximate analysis and their feed nutrient values calculated from this.

Fodder crops and concentrate mixtures supplemented by wet brewers grains were commonly fed. Cows on government farms that produced low daily milk yield were found to be receiving lower levels of metabolisable energy (ME), crude protein (CP), Ca and P than those on household dairy cattle farms which had higher daily milk yields. These latter had high energy/protein (E/P) ratios and energy density but lower CP levels than recommended feeding standards. This suggests further ration improvement is possible at the various physiological stages of lactating cows.

Joint research projects are sought to establish dairy feeding standards for Vietnamese cattle and conditions and methods to improve dairy feedstuffs and feed supplements.

Cattle Husbandry in Vietnam

CATTLE husbandry is economically important to Vietnam. Since reunification, the industry has developed quickly. Cattle numbers of 1 462 000 in 1975 became 3 265 000 in 1993, a 2.23 times increase. Distribution of cattle in each area, reported in 1992, is shown in Table 1.

As can be seen in the table, 62.63% of cattle are concentrated in the central area.

Dairy cattle husbandry

Dairy cattle husbandry has been carried out in Vietnam since 1959 (Ly 1992) mainly on government farms. In recent years it has expanded rapidly in the small farms in the Hanoi countryside and Ho-Chi-Minh City (HCMC). The total number of dairy cows in Vietnam is about 15 000 head, about 80% of them on smallholder farms. 1995 statistics indicate that there are 9000 in HCMC and 1560 head in the Hanoi rural area.

* Faculty of Animal Sciences and Veterinary Science, Hanoi Agricultural University, Trau Qui-Gia Lam, Hanoi, Vietnam.

The major breed group of dairy cattle is the Holstein Friesian (HF) which number 2900 head, the remainder being mainly crosses between HF and local breeds called yellow cattle (YC).

The performance of some hybrid groups of dairy cows is presented in Tables 2 and 3.

Collected data showed that there are different average milk yields of hybrid cows depending on the different ecological zones and management systems and on available supply of nutrient sources. On government farms a shortage of feed supplies resulted in low milk production. For example on Ba Vi government dairy farm, the cows yielded on average 1303–1627 kg milk per lactation in 1983 and 1629–1959 kg in 1992, quantities which are far short of the genetic potential of the hybrid HF cows. Cows of the households in HCMC yielded 2692–2739 kg and Gia Lam district 2329.8–2724 kg per lactation.

Feeds and feeding of dairy cows in the households in Hanoi countryside

A survey was carried out on 135 dairy cow rations to ascertain the type and quality of feed and feeding of dairy cows in the Gia Lam district in 1993–1994. The fodder components in the rations included natural grass (in 73.77% of the rations collected), green maize (in 52.46%), paddy straw (in 27.88%) and hay (in 8.20%). The concentrate mixture also fed

Table 1. Distribution of cattle in Vietnam (1992).

Ecological Zones	Population of cattle (1000 head)		%	
Northern Mountain Area	348.7	827.4	10.95	25.95
Northern Midland	224.3		7.02	
Red River Delta	254.4		7.98	
Old 4th zone	701.3	1997.0	21.96	62.63
Coast of central part	889.3		27.97	
Western high plateau	406.4		12.70	
Southern west zone	200.9	369.6	6.25	11.42
Southern east zone	168.7		5.22	
	Total	**3194.0**		**100.00**

Table 2. Milk yield (kg) of crossbred groups of dairy cows in Vietnam (300 days per lactation).

Location	Crossbred group of dairy cows				Source
	F_1 (½HF)	F_2 (¾HF)	F_2 (⅞–¾HF)	Hybrid of Red Sindhi	
Phu Dong Farm	1601 + 87.7	1627 + 177.4	1303 + 72.3	1500–1993	Them (1985)
Ba Vi Farm	1509	1052	1070	–	Lap (1983)
Moc Chau Farm	–	2336–2350	–	–	Trach (1993)
Ba Vi Farm	1823–1559	1629–1693	1678–1778	–	Ninh (1992)
Vietnam	1653.4 + 215.12	1671.7 + 240.4	1664.7 + (196.9	–	Thuong(1992)
HCMC	2692	2730	–	1730	Hieu (1994)
Gia Lam Dist.	2329.8	2724.2	–	1267.5	Tien (1993)
Thanh Thi Dist.	2830	–	–	1340	Hong (1993)

consisted of maize flour 61.59–67.95%, rice bran 22.27–33.13%, and soybean meal 4.83–5.28% in varying proportions. This was fed at rates of 4.92–5.62 kg/day depending on the milk yield. Wet brewers grains were supplied to the cows in most of the households at 10–20 kg per cow.

The samples of feed supplied to hybrid cows were analysed by the Weende system of proximate analysis. The nutrient values of feed were then calculated by the regression equations of Wardeh (1981).

The average intake of various nutrients of dairy cows is shown in Table 4. Table 5 sets out the nutrient requirements of lactating cows as published by the National Research Council (NRC 1989).

From these tables it can be seen that at low daily milk yield (4.32 kg/day), the cows received 14.68 Mcal ME per day. It is enough for the production of 2.15 kg of fresh milk plus maintenance of mature lactating cows. In the survey daily milk yield ranged from 8–16 kg, though the cows were fed with higher ME levels than the recommended NRC levels.

Table 3. Percentage of milk fat (%).

Breed of cows		Lactation 1	2	3
F_1 (½HF)	n	60	59	142
	mean	3.96	4.09	3.99
	± SE	0.48	0.42	0.54
	CV (%)	11.71	10.36	13.53
F_2 (¾HF)	n	29	29	80
	mean	3.97	3.94	4.04
	± SE	0.10	0.34	0.51
	CV (%)	4.98	8.81	12.87
F_2 (⅞–¾HF)	n	51	50	93
	mean	3.88	3.94	4.12
	± SE	0.44	0.52	0.55
	CV%	11.37	13.03	13.35

Table 4. Estimated nutrient intake of dairy cows in RRD (1992–94).

Group of cows	Average milk yield (kg/day)	Nutrient intake					
		n (135)	DM (kg)	ME (Kcal)	CP (g)	Ca (g)	P (g)
I[a]	4.32± 0.44	6	5.24	14686	468	29	12
II[b]	8.03± 1.29	59	12.81	30954	1324	49.7	41.1
III[b]	11.27± 0.95	36	13.90	32370	1442	65.8	42.8
IV[b]	16.01± 1.35	34	14.84	35749	1673	66.1	42.7

[a] From Phu Dong government dairy cattle farm.
[b] From household dairy cattle farms in Gia Lam and Thanh Tri districts 1993–94.
DM: dry matter.
ME: metabolisable energy.
CP: crude protein.

Table 5. Requirement of lactating cows (NRC 1989).

Liveweight (kg)	Energy (Mcal)		Crude protein (g)	Mineral	
	NE	ME		Ca (g)	P (g)
		Maintenance of mature cows			
400	7.16	12.01	318	16	11
500	8.46	14.20	364	20	14
600	9.70	16.28	406	24	17
		Nutrient per kg of milk at different fat percentage			
Fat (%)					
3.5	0.69	1.15	84	2.97	1.83
4.0	0.74	1.24	90	3.21	1.98
4.5	0.78	1.32	96	3.45	2.13
		Daily requirement of lactating cows (BW = 400 kg)			
Daily milk yield (kg)					
5	10.86	18.30	768	32.05	20.9
10	14.56	24.41	1218	48.10	30.8
15	18.26	30.70	1668	64.15	40.7
20	21.96	36.81	2118	80.20	53.6

NE: nett energy
ME: metabolisable energy.
BW: body weight

Actually the cows require 30.7 Mcal ME, 1668 g CP, 64.15 g Ca and 40.7 g P for maintenance and production of 15 kg of milk per day, but they consumed up to 35.7 Mcal ME; 1673 g CP; 66 g Ca and 43 g P. At this level of feeding, the cow cannot increase her milk production beyond her inherited capacity. What they can do is to store the excess nutrient in the form of body fat instead of turning it into milk (Morrison 1950) and this may be a factor in development of fat cow syndrome (Miller 1979). Therefore some adjustment of nutrient consumption should be considered.

Nutrient content of rations of dairy cows in households

In the survey, the nutrient content of the rations was calculated to find out their adequacy or otherwise for various physiological functions of the dairy cow. Results are set out in Table 6.

Data collected in Table 6 show that the concentrate component of the ration provided, on average, 52.45% of the total ME. This may be too high a level resulting in superfluous ME intake as mentioned above.

Table 6. Nutrient content of the ration for dairy cattle in households of the RRD (1993–94).

Cow groups	n	Nutrient content of the ration					
		Concentrate (% ME)	Energy density (Kcal ME/kg DM)	CP%	CF%	Ca/P	E/P (Kcal ME/g DP)
Group I (8.03 kg milk/day)	59	55.92	2449	10.31	21.09	1.2	36.8
Group II (11.27 kg milk/day)	36	50.22	2415	11.30	19.73	1.54	35.5
Group III (16.01 kg milk/day)	34	51.22	2412	11.19	20.26	1.55	34.3
Mean ± SE		52.45 ± 3.01	2125 ± 16.87	10.93 ± 0.44	20.36 ± 0.56	1.43	35.5 ± 1.0

ME: metabolisable energy; DM: dry matter; CP: crude protein; CF: crude fibre; E/P: energy/protein.

The average ME density in the ration was 2425 Kcal/kg DM, a little higher than the 2357 Kcal ME/kg recommended by the NRC in 1978.

The percentage of CP in the ration was 10.93% (ranging from 10.3–11.30%) which is lower than the CP requirement for lactating cows recommended by the NRC data in 1978 (13–16%) and by Church (1991) who proposed a level of 16–18% in the first 3 months of lactation.

The E/P ratio ranged from 34.3–36.8 (average 35.5) a higher value than c. 27–28 which was recommended by Kearl (1982).

The NRC in 1978 recommended a CF level of 17% in the ration of dairy cows and Emelianop (1977) suggested that the percentage of CF (on DM basis) in the rations of dairy cattle should range from 20–30%. Our survey into the rations of dairy cows showed them to average 20.36%.

From the above observations it appears that the CF% and Ca/P ratio as well as the energy density in the rations given are suitable for lactating cows, but the CP% and E/P ratio should be adjusted to improve the efficiency of milk production.

Effect of nutrient levels on the performance of crossbred dairy cows

A survey was carried out on Ba Vi dairy cattle farm in two periods using different nutrient levels and measuring production.

In the first period (1977–78), lactating cows were fed daily 31 kg fodder; 2.3 kg concentrate mixture and 16 kg wet brewers grain (26 296 Kcal ME and 844 g CP).

During the second period (1981–83) cows received 20 kg fodder, 2.5 kg concentrate mixture and 10 kg wet brewers grains (19.735 Kcal ME and 640 g CP).

The milk yield of various crossbred lactating cows in the two periods is presented in Table 7.

The results in Table 7 clearly show that the lower feeding level in period II was accompanied by a considerable reduction in milk yield, although between-year effects may have contributed to some of the variation. The whole question of nutrient suitability therefore, needs to very critically appraised and investigated to ensure that nutrients are utilised with maximum efficiency for dairy cows without any deleterious effects. This type of study is a step in that direction.

Conclusion

From the above observations, it can be concluded that the performance of crossbred dairy cows in the Red River Delta is not consistent. The hybrid cows may or may not be reaching their genetic potential as there are many factors affecting their performance.

Thus, feeds and feeding emerge as the main factor. In the government dairy cattle farms a shortage of feeds occurred. The lactating cows were underfed resulting in a decrease in the milk yield. The farmers, on the other hand, overcame the situation by providing high energy levels for their lactating cows which lifted production. It emerged, however, that the calculated energy levels fed, were 12.6–30% higher in ME than the levels recommended by the NRC in 1989.

Table 7. A 300-day milk yield of crossbred dairy cows in Ba Vi farm.

Period		Hybrid Red Sindhi	½ HF	¾ HF	⅞ HF	15/16 HF	Mean ± SE
I	Milk yield in 300 days	1193	2343	2428	2002	2235	2252± 181.1
	Ratio to hybrid Red Sindhi (%)	100	196.4	203.5	167.8	187.0	188.8
II	Milk yield in 300 days (kg)	1050	1601	1627	1303	1431	1491± 152.2
	Ratio to hybrid Red Sindhi (%)	100	152.5	155	124.1	136.3	141.9
I–II	Variation between two periods (kg) (%)	143 12.0	742 31.7	801 33.0	699 35.0	804 36.0	

The intakes of crude protein, calcium and phosphorous were comparable with the published standards of the NRC in 1989.

Nutrient content of the dairy cow rations in the households were low in CP (10.93%) and too high in the E/P ratio (35.5) and the ME of the concentrate (52.45%), while the CF (20.36%), Ca/P (1.43) and energy density (2.4 Mcal kg DM) were comparable to recommended data. It could be concluded that present rations in household cows were not fully suitable for lactation.

Our research group would welcome research cooperation in three particular areas:

- establishment of a Vietnamese set of standards of nutrient requirements, and balanced rations for dairy cows at various stages of production and/or reproduction appropriate for Vietnamese conditions;
- application of biotechnology for processing selected feeds to improve feed efficiency and to increase available nutrient resources to cows in Vietnam; and
- conduct of further research on feed supplements for ruminants including protein supplements, mineral supplements and additives.

References

Church, D.C. 1991. Livestock feeds and feeding. Prentice Hall, Englewood Cliff, New Jersey.

Emelianop, A.C. 1977. Feeding dairy cows on complex with utilisation amino acid (in Russian). Russian Journal of Agricultural Science 1.

Hieu, V.D. 1994. Studies on the economic efficiency of dairy cattle husbandry on the smallholder farm models in HCM City (in Vietnamese). Proceedings of the National Veterinary and Animal Science Conference 1994, 136–183.

Hong, N.T.L. 1993. Investigation on dairy cattle husbandry status at smallholder farms in Thanh Tri District (in Vietnamese). Results of Scientific Research in Veterinary and Animal Science, 1991–1993, Agricultural Publishing House, pp. 72–74.

Kearl, L.C. 1982. Nutrient requirement of ruminants in developing countries. International Feedstuffs Institute, Utah State University, Utah, pp. 71–87.

Lap, L.T. 1983. Milk productivity of dairy crossbred cows kept on Ba Vi farm (in Vietnamese). Agricultural Science and Technology Journal 3, 83–86.

Ly, L.V. 1992. Notes on cattle research in Vietnam (in Vietnamese). Results of Scientific Research 1985–1990. Agricultural Publishing House, pp. 81–83.

Miller, W.J. 1979. Dairy cattle feeding and nutrition. Academic Press, FNC (London) 373–383.

Morrison, F.B. 1950. Feeds and Feeding. 21st edition unabridged.

National Research Council (NRC) 1989. Nutrient requirements of dairy cattle. National Academy of Sciences, Washington DC.

Ninh, N.K. 1992. Investigations of models of dairy cattle husbandry on Ba Vi farm (in Vietnamese). Results of Scientific Research 1985–1990. Agricultural Publishing House, pp. 72–79.

Them, T.T. 1985. Milk productivity of cross dairy cows (HF x local breeds) in north Vietnam (in Vietnamese). Agricultural Science and Technology Journal, 8 169–172.

Thuong, N.V. 1992. Genetic characteristics of hybrid dairy cows in Vietnam (in Vietnamese). Results of Science and Technological Research 1985–1990. Agricultural Publishing House, pp. 88–93.

Tien, N.T. 1993. Milk productivity of dairy crossbred cows kept in the Hanoi countryside (in Vietnamese). Results of Science Research in Veterinary and Animal Science 1991–1993, 69–71

Trach, N.X. 1993. Milk productivity of cross dairy cows (3/4 HF) in Moc Chau farm (in Vietnamese). Results of Science Research in Veterinary and Animal Science 1991–1993, 66–67.

Wardeh, M.F. 1981. Models for estimating energy and protein utilisation for feeds. PhD dissertation. Utah State University, Logan.

Research on the Nutrition of Large Ruminants in Indonesia: a Case Study

E Teleni*

Abstract

To increase the chances of success of a nutritional research program aimed at achieving a useful farm outcome, it is necessary that the resultant technology package is not only underpinned by sound nutritional science but also must be user-friendly.

In the years of carrying out research on the nutrition of cattle and buffalo in Indonesia, one has become constantly aware of the need for appropriate technology and sustainability and of the fact that the farmer is central to any assessment of these terms.

Appropriate technology in the context of nutrition is basic to the longer-term sustainability of a nutritional package and it might be characterised by its high degree of user-friendliness, the strength of the nutritional science that underpins it, the clarity of the farm system that it targets and the ready availability of relevant feed resources.

In this case-study an approach to nutritional research, taking into account the above points, is described for the smallholder farmer of Indonesia.

* Department of Tropical Veterinary Science, James Cook University, Townsville, Queensland 4810, Australia.

Control of Fasciolosis in Cattle and Buffalo

Bruce Copeman*

Abstract

FASCIOLOSIS, caused by infection with the liver fluke *Fasciola gigantica,* causes major production loss in cattle and buffalo in most humid tropical regions of the world. However, because the disease is common and unspectacular, the clinical signs of reduced weight gain, fertility and draught power output caused by infection with *F. gigantica* are often regarded as the norm or attributed to poor nutrition. As a consequence, there has been little research on the epidemiology of fasciolosis in tropical regions and no routine control is practised. Studies conducted in Indonesia have shown that the highest prevalence of fasciolosis occurs in regions where wet rice is grown. Infection occurs after harvest when animals are allowed to graze the stubble or are fed fresh cut rice stalks contaminated with metacercariae. In Indonesia the greatest sources of infection are rice fields into which cattle faeces drain from a nearby cattle pen, or fields close to a village where cattle faeces are regularly dumped as fertilizer.

Recommendations for control of fasciolosis must be low cost and readily integrated into current farming practices. Possibilities include fodder management, biological control of the infection of *F. gigantea* in snails, and chemotherapy. Control through fodder management can be achieved by denying animals access to recently harvested rice fields (especially high-risk fields near cattle pens or fields where faeces are used as fertilizer) and the lower third of cut rice stalks from such fields, for about one month after harvest.

The aquatic snail host of *F. gigantica, Lymnaea auricularia* and its subspecies, are also hosts for a number of other trematodes. Infection with one of these, *Echinostoma revolutum* (a common parasite of ducks in tropical regions), sterilises the snails and prevents dual infection with *F. gigantica.* Further-more, any existing infection with *F. gigantica* has been prevented in rice fields next to cattle pens by housing 5–10 ducks infected with *E. revolutum* over the effluent drain from the pen so that duck and cattle faeces entered the rice field together. In areas where rice is grown seasonally and where no rice is grown for a few months over the dry season, strategic treatment one month after harvest of all animals in a village with a single dose of Fasinex™ (triclabendazole, Ciba Geigy) is an effective means of control.

* Department of Biomedicine and Tropical Veterinary Science, James Cook University, Townsville, Queensland 4811, Australia.

Studies on Buffalo in the Mekong Delta of Vietnam

N.V. Thu*, N.T.K. Dong*, T.R. Preston† and R.A. Pearson#

Abstract

The swamp buffalo is used to cultivate rice fields and provide meat in the Mekong Delta (MD) because of its suitability to the environment. Although some provinces of the MD have more buffalo than cattle, the number of buffalo has decreased recently. Reasons for this include increased use of tractors and a reduction in grazing land. However many farmers in the MD still raise buffalo. An economic analysis of the use of draught buffalo compared with tractors showed that buffalo were 2.6 times more profitable. Buffalo in the Mekong Delta are larger than elsewhere in Vietnam. They can plough 5.3 hours a day with a working rate of 0.3 ha/pair/day. Most females produce 2 calves in 3 years. Urea-treated rice straw (URTS) and urea molasses cakes (UMC) are useful supplementary feeds. Research on buffalo kept as multipurpose animals is continuing, and appropriate feeding strategies for these animals are being identified. Other future areas of research include crossbreeding with the Murrah, and product processing (meat and milk) to widen the market opportunities for the smallholder farmer.

THE swamp buffalo (*Bubalus bubalis*) is an important animal of the MD providing power for cultivation of rice and meat for local consumption and sale. It is well suited to the hot, muddy, wet conditions. The buffalo population in the Delta is 176 260 head compared with 308 910 head in the South of Vietnam. Some provinces (e.g. Minh Hai, Kien Giang, Soc Trang and Can Tho) have more buffalo than cattle. Recently, the number of buffalo has declined with the introduction of tractors and reduction of grazing land. However, many farmers still continue to raise buffalo to use in land preparation, to ensure timeliness of seeding and for the profit they can get from sale of calves and meat (Ogle et al. 1994). Farmers in the Mekong Delta have traditional experience in buffalo raising but inputs and productivity are often low and their full potential for supplying draught power, beef, milk and manure are often not realised (Thu et al. 1987). Some Murrah buffalo have been kept at the University of Cantho since 1978. However their integration into the local region has been limited because of the lack of facilities and research funds. In addition, results from studies of local buffalo have shown promise. The aim of the research at the University is to provide farmers with information which will help them realise the potential of their animals in a sustainable way.

* Faculty of Animal Husbandry and Veterinary Medicine, University of Cantho, Vietnam.
† University of Agriculture and Forestry, Ho Chi Minh City, Vietnam.
# Centre for Tropical Veterinary Medicine, University of Edinburgh, Easter Bush, Midlothian, EH25 9RG, Scotland.

Productivity and Constraints to Buffalo Production

The indigenous buffalo in the MD is the swamp buffalo, which occurs there in its greatest density in South Vietnam. A study undertaken from 1979–87 showed that body size varied according to the soil-water-vegetation conditions in each part of the Delta (Table 1) but that the local buffalo were generally larger in the Mekong Provinces (average liveweight of females 458 kg) than local buffalo in the South-eastern (females 435 kg), Central (females 417 kg) and Northern (females 358 kg) provinces of Vietnam. Animals were largest in Dong Thap; bulls could weigh more than 500 kg and castrates and females (Table 1) could weigh about 600 kg. Size seems to have changed little over the years, since these figures agree with observations made by Vittoz in 1937 (see Mason 1974).

More than 74% of female buffalo produced two calves per three years or one calf per year and the total yield per female buffalo reached 9–10 calves. The mature buffalo had an average carcase weight of 276 kg and an average dressing percentage of 46.7%.

Table 1. Comparison of the body measurements and liveweight of adult female buffalo in selected provinces in the Mekong Delta of Vietnam.

	Long An n = 65	Dong Thap n = 55	Cuu Long n = 103	Hau Giang n = 115	Minh Hai n = 36
Height at withers (cm)	125.7	134.7	125.7	126.8	125.4
Length of body (cm)	142.7	150.3	138.7	142.1	134.3
Heart girth (cm)	190.1	212.2	183.2	195.7	186.4
Liveweight (kg)	454	598	412	481	412

Although buffalo meat is popular in both rural and city areas, it is produced as a by-product of the small farm household, rather than from a specialist buffalo beef farmer. Measurement of work rates showed that Delta buffalo could plough from 0.2–0.4 ha/pair with the working time of 5.4 hours/day.

Although the study showed that the rural farmers in the MD had lengthy traditional experience in raising buffalo, there were several constraints to production (Thu et al. 1987). Feed for buffalo was limited in the brackish areas of the Delta and, in these areas in particular, draught buffalo were in poor condition at the end of the dry season and at the beginning of the rainy season—times when they were expected to work hard. This could result in poor health and performance leading to sale or slaughter. Pasteurellosis, foot-and-mouth disease, fasciolosis, trypanosomiasis and other parasitic diseases have been reported in buffalo in the MD (Hung 1993).

Nutritional Studies

Local feed resources

A survey in 1989 of six districts in the alluvial regions and six districts of the brackish regions of the MD found that in the alluvial areas buffalo were generally superior in growth, reproduction and draught capacity, possibly because of the better green feeds and fresh water in the alluvial regions.

Urea-treated rice straw (UTRS)

Urea treatment of fibrous crop residues to improve their digestibility for ruminant animals is well recognised and village technologies for the urea-ammoniation treatment of rice straw have been developed (Dolberg and Finlayson 1995). Much rice straw is produced after each harvest in the MD. This is mainly used for feeding buffalo and cattle, for litter, mushroom growing and for fuel for cooking. Some on-station and on-farm research of UTRS (4% urea) for dairy and working buffalo gave good results in increasing nitrogen content of straw (in the order of 70.1–142.4% compared to controls), food intake and milk yield. Techniques to simplify the technology, and make the practice easier have been developed and some on-farm demonstrations of UTRS were carried out in some provinces such as Angiang, Haugiang and Minh Hai. Despite this, farmer adoption of the technology is poor. This is attributed to resistance to change in farmers' feeding practices, low growth rates of local buffalo, the cost and labour required and low profit. Dolberg and Finlayson (1995) reported similarly poor farmer uptake of the technology in village beef production systems in China.

Feed supplementation

Supplementation of the low nutritive value staple feeds such as stubble, rice straw and other crop residues may be of value to buffalo, particularly before and during the working season. On stations and in the villages some supplements of energy, nitrogen and minerals were tested on buffalo as mashes, powder, hard urea-molasses block and soft urea-molasses cake (UMC). The UMC contained 37.9% 'B' molasses, 7.6% urea, coconut oil meal, 39.4% rice bran, 3.8% salt, 3.8% bone meal and 0.15% trace minerals. Feeding this has some attraction as it can be used for local buffalo in the fields in normal form or in the form of a thick solution with drinking water, as mash sprinkled on straw, or as a wet slop administered orally via a bamboo tube. The results from trials of the UMC given to working buffalo fed mainly with rice straw are shown in Table 2.

Liveweight, erythrocyte count and area ploughed by UMC-supplemented working buffalo were significantly higher than in control-fed animals which did not receive UMC. Demonstrations of the use of UMC for working buffalo and cattle have been successful in some provinces with encouragement of local governments and farmers.

Table 2. Liveweight, blood erythrocyte count, pulse and respiration rates and area and speed of ploughing of buffalo fed rice straw only (control) and rice straw supplemented with urea molasses cake (UMC) in the MD of Vietnam.

		Control	UMC supplement	Significance of difference
Liveweight	At start	346	372	
(kg)	After 1 month	334	370	
	Change	-12.0	-2	**
Blood erythrocyte	At start	5.71	6.31	
count (million/	After 1 month	5.59	6.49	
mm^3)	Change	-0.12	0.18	**
Pulse	At start	45	41	
(beats/min)	After 1 month	48	42	
	Change	3	1	ns
Respiration	At start	20	20	
(breaths/min)	After 1 month	21	21	
	Change	1	1	ns
Area ploughed	At start	1919	2243	
(m^2/pair/day)	After 1 month	1508	2141	
	Change	-411	-102	**
Speed of ploughing	At start	0.60	0.73	
(m/sec)	After 1 month	0.52	0.67	
	Change	-0.08	-0.05	**

** P<0.01; ns not significant.

In young buffalo fed with rice straw and sugarcane bagasse, after three months there was a significant difference in liveweight between the UMC group and the control group (P<0.001).

Sansoucy (1995) reported that the degree of adoption of the UMC technology at farm level varied much with local conditions: characteristics of the basal diet, availability and cost of different ingredients, production systems, end product prices and marketing capacity. Although more information is needed locally, it is reasonable to assume that these conditions of adoption may also apply in the MD.

Urea-treated rice straw (URTS) with UMC

Some on-station and on-farm trials were used to test the strategy of feeding urea-treated rice straw, together with UMC, to dairy buffalo. Buffalo given the cake supplement grew faster (0.60 kg/day versus 0.31 kg/day) and gave more milk (14.1%) than buffalo at the stage of lactation not given cake supplementation. When working buffalo were supplemented with 5.0 kg URTS and 0.46 kg cake per day, the improvement in body weight, physiological values and ploughing capacity were significant compared with those of buffalo supplemented with 8.0 kg urea-treated rice straw and the control animals.

Economic Analysis of Draught Buffaloes Versus Tractors

Over recent years, with the free market policy of the Vietnamese government, the number of buffalo has declined largely because of tractor use. This has increased the area under cultivation and farmers' expectations of more comfortable work and higher profit. Despite this, in the MD many farmers still continue to raise buffalo (Ogle et al. 1994). In fact, in many cases farmers had sold buffalo to buy tractors, and then sold tractors to buy buffalo for work again because of their limited understanding of machines and the cost of repairs.

A comparison of the efficiency of use of a pair of buffalo and one tractor based on profit produced over the investment showed that buffalo were 2.6 times more efficient. It suggested that smallholder farmers in the MD with low income can obtain profit from their investment in buffalo production.

Dual- and Multi-purpose Buffaloes

Swamp buffalo have been raised for draught power and meat in many countries of Asia. In some countries such as Thailand and the Philippines buffalo

beef contributes nearly half of total beef consumption. However, the size of buffalo population in many countries has been decreasing (Chantalakhana 1992). In the MD buffalo meat consumption is very popular. The young buffalo meat is usually used for 'Pho' as a priority because of its softness and good taste. A very popular dish of buffalo meat is 'Trau luoc com me' (Buffalo meat and offal cooked with the rice yeast) and it is usually enjoyed together with local water plants and rice wine anywhere. People also believe that eating buffalo is good for the health. However, raising buffalo beef is not yet widely considered as an enterprise by farmers (Thu et al. 1987), and farmers have made no attempt to select within the local population of buffalo for growth rate—other than selection of size for draught in some cases. At present (1995) the price of beef buffalo is profitable for farmers and the buffalo population in some districts has shown a small increase as a result.

Chantalakhana (1992) suggested that at this stage, especially in Southeast Asian countries, it is questionable whether a priority should be given to selection of swamp buffalo for milk production. However, if the development goal is to improve the nutrition and health of rural people, particularly children, through upgrading of swamp buffalo for household milk consumption, the breeding goal becomes dual purpose, breeding for both draught and milk production. Local animal protein sources in the MD (fishes, scavenging ducks, snails) have declined with the increased pesticide use in the rice fields, so milk deserves promotion in the area, offering an additional source of nutrition.

The use of multipurpose animals for milk, meat, draught and manure, has shown potential for increasing farm productivity and income in other areas of the world (Zerbini and Gemeda 1993). With the changes that are occurring in the MD, it is not unrealistic to suggest that the multi-purpose buffalo will increasingly feature on the smallholder farm in the MD. Future research at the University at Cantho will include investigations of the management and feeding strategies that will be required to insure that the maintenance of multipurpose animals can be carried out in a sustainable and economic way by the smallholder farmer.

Crossbreeding of Local Buffaloes

There have been programs to improve milk and draught outputs of the local Swamp buffalo by crossing it with the Murrah buffalo in many Asian countries, for example, China, Malaysia, the Philippines, Thailand and Vietnam (Chantalakhana 1992). Thac (1980) reported that the F_1 crossbreed of local and Murrah buffalo in the North of Vietnam had large size, good growth rate, higher milk yield than the local buffalo and good draught power. They were easily fed under village conditions. However, their impact in villages in Vietnam has been poor so far. Crossbreeding has not yet been undertaken in the MD, but may well offer a means of increasing the productivity of the local buffalo in the area. This may be an activity that the University of Cantho could undertake with the participation of farmers in the local community.

Conclusions and Recommendations

Studies to date confirm that buffalo in the Mekong Delta still have an important role in food production and can be profitable for smallholder farmers. However the main problems to be overcome include malnutrition of working buffalo, disease, low growth rate and reproduction, lack of feed in the dry season and a need to modify traditional feeding systems in some areas, where grazing land is reduced. Research that will result in recommendations to overcome these problems is needed and to promote further development of buffaloes as multi-purpose animals, to raise the income of smallholder farmers and improve the lifestyle in their villages.

Future studies proposed include nutrition and feeds for beef, draught and multi-purpose buffalo, disease control, crossbreeding to improve buffalo meat, milk and draught outputs and reproduction, and the technologies of product processing for meat and milk to increase market opportunities for the smallholder farmer in the MD.

References

Chantalakhana, C. 1992. Genetics and breeding of swamp buffalo. In: Tulloh, N.M and Holmes, J.H.J. ed., Buffalo production. World Animal Science, C6, pp. 95-109.

Dolberg, F. and Finlayson, P. 1995. Treated rice straw for beef production in China. World Animal Review. 82, 14–24.

Hung, N.H. 1993. A survey on parasite diseases of cattle and buffalo in Hau Giang Province. Selected works of scientific research. Animal Husbandry and Veterinary Medicine Department, University Cantho, 15–27.

Mason, I.L. 1974. Species, types and breeds. In: Cockrill, W.R. ed., The husbandry and health of the domestic buffalo. Rome, FAO, pp. 1–47.

Ogle, B., Christoplos, I. and Thu, N.V. 1994. RRA/PRA Training course 3–10 August and targeted extension for resource-poor farmers through local community organisation. A presentation at Phung Hiep district of Cantho Province (in press).

Sansoucy, R. 1995. New developments in the manufacture and utilisation of multinutritional blocks. World Animal Review, 82, 78–83.

Thac, N.D. 1980. The F_1 crossbreed buffalo of the Indian Murrah and the Vietnamese swamp buffalo. Animal Husbandry and Veterinary Medicine Department, Works

of Science and Technology in Agriculture. Ministry of Agriculture, 36–39.

Thu, N.V. et al. 1987. Breed characteristics and productivities of local buffalo in Mekong Delta of Vietnam. In the Conference of Animal Production in the South of Vietnam and poster section of the Second World Buffalo Congress in India Dec. 1988.

Zerbini, E. and Gemeda, T. 1993. Effect of work on dry matter intake, milk production and reproduction in multipurpose cows fed low quality roughage. In: Proceedings of the International Conference on Increasing Livestock Production through Utilisation of Local Resources. CECAT, Beijing, 18–22 October 1993, pp. 332–356.

Livestock Viruses and Germplasm Transfer

G.I. Alexander* and T.D. St George†

Abstract

Although the common virus diseases of livestock are well understood as a result of disease outbreaks there is another group, the arboviruses, spread by flying insects and whose presence is affected by climate rather than by animal movement across country borders. They vary in pathogenicity and include the bluetongue group, the EHD group and Akabane viruses. Indigenous livestock have adapted to these and are asymptomatic, but when livestock are imported from areas outside the range of these vectors and their viruses, disease outbreaks are not uncommon. Examples of such fatalities are given.

Studies, including serology, to determine arbovirus presence in Vietnam and their epidemiology in its different climatic zones will greatly improve understanding and minimise risk to imported animals. Vietnam represents an intermediate zone between the increasingly studied epidemiological situation in Thailand and Southern China.

Traditional disease control centred on prevention of importation has failed to recognise that some viruses do not remain in the viraemic stage nor does antibody presence indicate virus presence, though such presence could still be immunologically helpful.

Animals seropositive to one bluetongue serotype may be sufficiently immune to others to prevent mortalities and provide some immunity. Australian sheep research has shown effectiveness of a broad-spectrum recombinant vaccine against a highly pathogenic bluetongue serotype. It should also aid germplasm transfer.

SINCE this workshop is concerned with exploring approaches to research in the animal sciences in Vietnam, it seems appropriate to spend some time examining the impact of virus diseases on animal production and on the international movement of livestock and germplasm. This can be carried out by using objective surveys rather than by developing a history of disease outbreaks. There is a substantial range of antigens available for use in testing for most known viral diseases. Any survey should cover not only those diseases that cause mortalities and high morbidity but also those that are of importance in the international movement of livestock and germplasm for use in livestock improvement programs.

Viral diseases

There are three classes of viral disease that need to be considered. The first class comprises the major economic diseases such as rinderpest, foot-and-mouth disease, haemorrhagic septicaemia, swine fever and Newcastle disease. These diseases are of such importance that they attract quite a deal of attention and there are well established disease-reporting systems which produce data about their presence in or absence from a particular area. There are also vaccines available for control of the spread of these diseases and quarantine measures to contain animal movements which may promote their spread. At the present time foot and mouth disease outbreaks are occurring in Thailand and Vietnam and probably in China. Measures to contain the spread of this disease are in operation.

The second class of viral disease are those of worldwide distribution that closely parallel the distribution of their host animals. In countries where they are endemic, they do not attract much attention as they do not appear to cause lower production or mortalities. However, when new animal genotypes are introduced or husbandry methods are intensified, the ecological balance between the virus and the host animal is altered by a change in the animal's genotype or by intensification of husbandry practices. This can result in these diseases assuming increased importance especially in economic terms. The bovine viral diseases in this category are bovine viral

* Palamere Pty Ltd, GPO Box 870, Brisbane, Queensland 4001, Australia.
† 15 Tamarix Street, Chapel Hill, Queensland 4069, Australia.

diarrhoea, infectious bovine rhinotracheitis, parainfluenza 3 and bovine herpes virus 2. These infections become vitally important if feedlotting or intensive fattening systems are introduced. Chicken diseases of this type include Marek's disease, infectious laryngotracheitis, infectious bronchitis and infectious bursal disease.

Arboviruses

The third class of viral disease is that due to the group of arboviruses that are spread by insects and ticks. They are dependent on their vectors for their spread and these vectors are, in turn, dependent on the climate and the presence of a suitable vertebrate host for the female vector to obtain a meal of blood to provide the nutrient for the maturation of its eggs. These viruses can travel as far as their vector hosts can range and multiply. They can be blown across wide expanses of ocean and major uplifts of air can carry them over mountain ranges. Some of these viruses are very insidious and can be present without being detected for long periods especially in tolerant hosts.

The most important group of arboviruses is the bluetongue group. It was only in 1977 that their presence in Australia was first established. Since then, they have been found in Indonesia, Malaysia, Papua New Guinea and China using techniques developed in Australia. Bluetongue is viewed by the Office International des Epizooties (OIE) as a List A disease. There are 15 List A diseases which are defined as 'communicable diseases which have the potential for very serious and rapid spread, irrespective of national borders, which are of serious socioeconomic or public health consequence and which are of major importance to the international trade of livestock and livestock products'. Member countries of OIE have reporting obligations for these diseases and trading partner countries are usually particularly strict with regard to regional freedom and health certification. Other list A diseases include foot-and-mouth disease, rinderpest, hog cholera and Newcastle disease.

It now seems apparent that the bluetongue viruses are distributed across a broad band of the earth from the Americas, through Africa and southern Asia to southern Japan and northern Australia.

Being a List A disease, bluetongue has a major impact on international trade as no nation wishes to acquire diseases that it does not already have. Stringent bans or restrictions have been invoked to keep bluetongue from spreading. To a large extent, such restrictions are pointless as there is no evidence that they serve any useful purpose in controlling the spread of bluetongue. Recent research in Indonesia has found that most of the serotypes of bluetongue that occur in Australia also occur in Indonesia and were probably blown on the northwest monsoon in a south-easterly direction across the Timor Sea within their *Culicoides* vector hosts.

The *Culicoides* spp., which act as vectors for bluetongue virus and are most widely spread in Australia, depend on cattle or buffalo for their propagation as they breed in cattle or buffalo faeces. Since cattle and buffalo were introduced to northern Australia only last century, these *Culicoides*, if blown across the Timor Sea before that time, would not have been able to establish themselves until the advent of cattle and buffalo.

There are a number of other arboviruses that affect cattle and buffaloes. Bovine ephemeral fever which is very disabling to draught animals is well known and is spread by a range of mosquito species. Akabane, Aino, EHD and a range of other viruses are spread by *Culicoides* or mosquitoes and occasionally may be spread by both classes of arthropods.

With arboviruses it is equally important to understand which insects are competent vectors of the virus as their distribution and seasonal incidence will determine the distribution of the virus. The implication of any insect species as a vector of an arbovirus involves a number of steps. Firstly the insect must be known to feed on the mammalian host and the virus can be isolated from the insect under natural conditions. The capacity of the insect to transmit biologically the virus from one mammalian host to another must also be established. This implies that the insect acts as part of the life cycle of the virus. The virus multiplies within the tissues of the insect and accumulates within the salivary gland of the insect so that it is transmitted to the mammalian host during the intake of a blood meal by the insect. Research on this aspect is fundamental to an understanding of the ecology of the vector and the epidemiology of arboviruses but very little attention has been paid to this aspect outside Australia.

Effect on imported animals

When animals are exported to countries using protocols based on the OIE standards, these animals are certified as not possessing antibodies for a range of diseases. When imported into countries that do not have a complete history of endemic diseases, cattle and sheep from countries not having the disease such as Australia, are at risk and can become sick soon after arrival. In India, such animals have developed rinderpest which was known to be present in India so that it was accepted that the infection occurred after arrival. Australian sheep, when initially imported into Indonesia and Malaysia, developed bluetongue and it was thought that the sheep had brought the disease with them. However investigations within those countries subsequently established that bluetongue was in fact present in those countries but had not been recognised previously as the local stock

were tolerant to the disease. Australian cattle, which were pregnant at the time of shipment, were taken to China and became infected with Akabane virus. This virus attacked the developing foetus, causing abortion or deformities in the new born animal. Research has since established that Akabane virus occurs in a band of countries ranging from Japan to South Africa.

These illustrations serve to emphasise the point that it is valuable to know what viruses are likely to be encountered by imported animals after arrival in a country. When these are known, appropriate steps can be taken to protect the animals or to avoid the risk. There are various ways by which expensive Australian breeding animals can be protected, once the potential exposure is known. The simplest way is to import animals that have protective antibodies. These can be provided by the use of vaccines such as for bovine ephemeral fever with vaccination in Australia before departure. In the north of Australia, many cattle are infected with bluetongue and other viruses when they are young and develop life-long immunity. This has been utilised by Papua New Guinea which imports cattle from northern Australia that are seropositive. Recent research in Australia using baculovirus-expressed recombinant bluetongue core-like proteins (CLPs) showed that sheep vaccinated with CLPs did not react to challenge with two serotypes of bluetongue whereas control animals reacted to the disease. This indicates that CLPs may be suitable for protecting sheep that are exported to a country where bluetongue is endemic until they become exposed to the local serotypes.

The first step in determining what needs to be done to protect imported animals, however, is to determine the presence of each disease agent within the country. The technology for such a survey is well understood and can be readily applied in Vietnam.

Conclusion

This paper serves to indicate that it is important to establish the current state of animal diseases within a country by the conduct of a survey to determine the incidence of particular diseases. These diseases may be regional or widely spread throughout the country. Virus and particularly arbovirus diseases have been drawn upon to present the case for such a first step. These diseases do not recognise political boundaries and are usually determined by topography, climate and animal population movements and vector ecology in the case of arboviruses.

Family of Tabanidae in North Vietnam

Phan Dich Lan*

Abstract

The author detected 40 species of the Tabanidae family after classifying about 8000 samples of biting flies collected from different ecological regions of North Vietnam. These are most important veterinary insects as they suck blood of buffalo and cattle, and transmit Trypanosoma evansi.

The list of species of the Tabanidae family identified and classified is as follows:

***Chrysozona Meigen 1800**

1.1 *Chrysozona assamensis*, Ricardo
2.2 *Chr. formosana*, Chir
3.3 *Chr. fuscifrons*, Austen
4.4 *Chr. javana*, Wiedmann
5.5 *Chr. lata*, Ricardo
6.6 *Chr. latifascia*, Ricardo

***Chrysops Meigen 1800**

7.1 *Chrysops dispar*, Fabricius
8.2 *Chry. fasciota*, Wiedmann
9.3 *Chry. flavocinsta*, Ricardo
10.4 *Chry. sinensis*, Walker
11.5 *Chry. translucens*, Macquart
12.6 *Chry. vander wulpi*, Krober

***Tabanus Linnaeus 1758**

13.1 *Tabanus albicinctus*, Sterkhoven
14.2 *T. albopunctatus*, Sterkhoven
15.3 *T. angustistriantus*, Sterkhoven
16.4 *T. birmanicus*, Bigot
17.5 *T. brunneo* Thorax., Sterkhoven
18.6 *T. brunnipennis*, Ricardo
19.7 *T. ceylonicus*, Schiner
20.8 *T. citripilosus*, Sterkhoven
21.9 *T. flavimarginatus*, Sterkhoven
22.10 *T. flavistriatus*, Sterkhoven
23.11 *T. formosiensis*, Ricardo
24.12 *T. fumifer*, Walker
25.13 *T. griseipalpis*, Sterkhoven
26.14 *T. immanis*, Wiedmann
27.15 *T. insidiator*, Austen
28.16 *T. jucundus*, Walker
29.17 *T. kiangsuensis*, Krober
30.18 *T. laticinctus*, Walker
31.19 *T. mandarinus*, Chiner
32.20 *T. miser*, Szil
33.21 *T. palpalis*, Ricardo
34.22 *T. pseudorufiventus*
35.23 *T. rubicundus*, Macquart
36.24 *T. rubidus*, Wiedmann
37.25 *T. sanguineus*, Walker
38.26 *T. striatus*, Fabricius
39.27 *T. triangularis*, Sterkhoven
40.28 *T. pugnax*

* National Institute of Veterinary Research, 61 Truong Chinh, Dong Da, Hanoi, Vietnam.

The Result of Multiple Ovulation/Embryo Transfer (MOET) in Cattle

Hoang Kim Giao, Nguyen Duc Thac, Nguyen Thanh Duong, Do Kim Tuyen, Luu Cong Khanh, Nguyen Van Ly and Nguyen Thi Thoa*

Abstract

THE study of MOET in cattle has been carried out at the National Institute for Animal Husbandry, Hanoi (NIAH) since 1990. Dairy cattle with a yield of 3000–6000 kg per lactation have been selected as donor cows. These recipients were of good body conformation and had normal reproductive function.

Superovulation of donor cows was started on day 10–12 of the oestrus cycle using super 'OV' (Porcine Follicle Stimulating Hormone Pituitary, manufactured by AUSA International Inc) and prostaglandin$_{2\alpha}$ ($PGF_{2\alpha}$) Oestrus synchronisation of recipients was also carried out by using $PGF_{2\alpha}$ in the middle of the oestrus cycle. Non-surgical collection of embryos was carried out on day 7 after super heat, and non-surgical embryo transfer (ET) to recipients that had responded well to oestrus synchronisation. 73.91% of experimental cows responded to superovulation treatment with an average number of 6.27 corpora lutea per cow. The average number of recovered embryos in superovulated cows was 2.87 and the number of transferable embryos was 2.43.

From 1990–95, 47 recipients were used for ET and 10 calves were born by this technology. This is the first group of results from use of MOET in cattle at the National Institute of Animal Husbandry but a bright future is expected for development of dairy cattle production through its use in Vietnam.

* National Institute of Animal Husbandry, Thuy Phuong-Tu Liem, Hanoi, Vietnam.

Applications of Molecular Genetic Technologies in Livestock Improvement

D.J.S. Hetzel and S.S. Moore*

Abstract

In recent years there has been spectacular progress in understanding the molecular genetic basis of growth and development of living organisms. Whilst the knowledge base is still very limited, molecular genetic technologies are just starting to find applications in the livestock industries.

Although there are a large number of breeds and strains of livestock, the genetic similarity between them is largely unknown. Such knowledge is useful in designing conservation programs as well as in formulating breeding programs based on crossbreeding. Molecular genetic techniques can be used to construct a genetic profile for different populations/breeds/strains and thereby allow conclusions to be drawn about their similarity at the genetic level as distinct from the phenotypic (performance or appearance) level.

Molecular genetic technologies can also be used to identify genes associated with important production traits such as tick resistance in cattle and bacterial resistance in pigs. Such traits are frequently found in so-called undeveloped breeds which have evolved in challenging environments. Once gene markers are identified, they can be used to better identify genetically superior animals for these traits.

DNA-based fingerprinting systems are an efficient and cost effective basis for establishing pedigrees in many situations.

In general, successful livestock development programs are based on multidisciplinary approaches. It will be important that the molecular genetic technologies, when developed, are integrated with other genetic and reproductive technologies such as performance and progeny testing and artificial insemination so as to maximise their impact.

THE study of the molecular genetic basis of life processes is a relatively recent research field made possible by the dramatic technological advances in molecular biology. The work is fuelled not only by a desire to understand how organisms function, but by the early realisation that knowledge of genome structure and function may have wide-ranging application in agriculture, human medicine and environmental management. How much of the potential is eventually realised will depend on what the research uncovers. Applications in animal production may be far-reaching though much will depend on the complexity of the genetic control for the important production traits. This paper will briefly describe some of the basic tools for livestock genome research, with particular emphasis on cattle, and then consider applications of genome research in the areas of animal genetic resource definition, gene characterisation and DNA-based fingerprinting.

* CSIRO Division of Tropical Animal Production, Molecular Animal Genetics Centre,University of Queensland, Brisbane, Queensland 4072, Australia.

Genome Research Tools

Genetic markers

There are a number of different types of genetic markers, each of which tags a DNA sequence polymorphism. For example, nucleotide variation can be highlighted by bacterial restriction enzymes which cut genomic DNA at specific sequences. This is known as a Restriction Fragment Length Polymorphism (RFLP). Variation at the enzyme target site or insertions or deletions of DNA sequences between two enzyme sites produce fragments of variable length. The cut genomic DNA is size-sorted by electrophoresis in agarose gels and then transferred to nylon support membranes. The specific DNA fragments of interest can be highlighted on the membranes by hybridisation with labelled DNA probes.

Single Strand Conformational Polymorphism (SSCP) markers rely on the principle that the conformation of a DNA strand is altered by a nucleotide change, and this new conformation can be detected as a mobility shift in gel electrophoresis. The method does require either sequence information for

polymerase chain reaction (PCR) primer sites at the site to be analysed, or a DNA probe that will bind at the site.

Over the past six years, DNA microsatellite markers (Weber and May 1989) have become one of the major tools for genome research. The extensive use of such sequences has resulted from their abundance and the high levels of heterozygosity found in most plant and animal species, coupled with the speed and accuracy of analysis using PCR and polyacrylamide gel electrophoresis on DNA sequencing gels. There are now large numbers of microsatellite markers available in many livestock species (Hetzel 1993). Fortunately it has been found that a large proportion of markers isolated in one species could be used in other closely related bovid species (Moore et al. 1991).

Genome maps

Genome maps have three main functions. First, they serve as repositories for gene mapping data, that is the location, order and spacing of genes or genetic markers. Second, maps can be used to facilitate mapping of new genes by providing reference points for searches. Third, by cross-referencing gene mapping information from one mammalian species to another, homologous chromosomal regions can be identified, thereby permitting the extrapolation of information on gene location. Thus genome maps are an extremely valuable resource for mapping studies.

Genetic maps

Genetic or linkage maps document the order and spacing of genes or genetic markers where distances are measured in recombination units. The frequency of recombination between homologous chromosomes, a normal event in meiosis, is generally proportional to the distance between two linked loci and can therefore be used as a unit of chromosomal length. The unit is known as the Morgan (M), and one centimorgan (cM) corresponds to the distance separating two loci exhibiting a 1% recombination rate. For short distances, for example, less than 30 cM, the relationship between physical distances and recombination rate is essentially linear. However over longer distances, interference and the occurrence of double crossovers can reduce the concordance.

Data for map construction come from the genotyping of families for polymorphic markers. New techniques have made it possible to rapidly genotype animals for a wide range of highly variable loci. This has led to the development of dense linkage maps for the most important domestic species (e.g. Bumstead and Palyga 1992; Barendse et al. 1994; Crawford et al. 1995; Rohrer et al. 1994). These maps provide the basis for detection and exploitation of genes segregating at loci which have a major influence on commercially important traits; these are referred to as quantitative trait loci (QTL). However, for the genome to be efficiently and systematically searched for QTLs, linkage maps need to be based on a sufficiently large number of highly variable markers. As few as 150 well-spaced markers can ensure complete genome coverage for studies in large mammals (Botstein et al. 1980).

Physical maps

Physical gene maps indicate the location of genes on specific chromosomes, chromosomal regions or syntenic groups. The latter comprise groups of genes known to reside on a chromosome of unknown identity. The coordinates and therefore units of a localisation will depend on the mapping method used. For example, somatic cell hybrid analysis in cattle can map genes to either the chromosomal or syntenic group level. However, in situ hybridisation results in assignment to chromosomal region with reference to a banded karyotype. Physical maps for cattle and sheep currently comprise more than 350 genes or markers (Fries et al. 1993; Echard et al. 1994)

Comparative maps

Comparative gene mapping is the mapping of homologous gene loci in multiple species. Although the ultimate goal of comparative mapping is to understand the pathways by which chromosomal evolution has accompanied speciation, it has proved to be a very powerful means of extrapolating mapping data from one species to another, based on the establishment of conserved chromosomal segments.

Extensive gene and chromosomal homologies have now been identified between man, mouse and the cow (O'Brien et al. 1993). Although the boundaries of conserved segments need further definition, it is now possible to both interpolate and extrapolate the position of genes between these three species. Thus as genes are mapped as one species, their likely position in the other species can be predicted. This will be an important source of mapping information in the future since genome research in humans and mice has accelerated rapidly.

Marker analysis

Microsatellites are currently the marker of choice for many types of genome research. The analysis of microsatellites relies on PCR amplification with primers flanking the repeat region, separation of the amplified fragments on polyacrylamide gels and visualisation using a number of techniques including autoradiography, staining with ethidium bromide or silver and more recently by the incorporation of a fluorescent dye on one primer. Efficiency can be

increased by loading the products of more than one PCR reaction in a single lane of a gel or co-amplifying more than one locus (multiplexing) in the same PCR reaction. In the last few years, semi-automated genotyping has been developed. However the equipment is expensive at present and is only cost effective for high volume use.

Defining the Genetic Resource Base

The selection of breeds or strains of livestock for conservation or improvement programs can be hampered by an inadequate description of population structure both within and between populations. Geographic isolation over time has built up a plethora of genetic types but the magnitude of genetic differentiation has rarely been quantified. The situation is further clouded when recent cross-breeding has occurred. A key element of a conservation strategy for animal genetic resources must be the characterisation of breeds and strains to provide an overall picture of genetic diversity.

The choice of appropriate populations for conservation or improvement should be based on a combination of phenotypic and genetic data. DNA (genetic)-based measures of variation are potentially very useful in this work. The procedure basically involves four steps:

- obtain representative samples from described populations—sample numbers will be determined from breeding structure and planned analysis methods;
- measure between and within population genetic variation by estimating allele frequencies at a number of gene/genetic markers. Microsatellite markers are increasingly used;
- calculate indices of genetic similarity/dissimilarity between populations; and
- construct phylogenetic trees to describe both the current population structure and the evolutionary history of sub-populations.

A number of population studies, some coordinated by FAO, are in progress.

Associating Genes with Phenotypes

There are basically two approaches to mapping genes for which the gene product is unknown. The first of these, referred to as the candidate gene approach, relies on some background biochemical knowledge and is therefore limited in its application. The second approach which defines a linked genetic marker as an intermediate step towards cloning the gene is more generally applicable because it requires no knowledge of gene function. The two approaches are not mutually exclusive. Once the search for a gene is narrowed down to a discrete region, other genes may suggest themselves as candidates where previously they were not obviously connected. So in practice, a combination of both approaches is appropriate, especially as mammalian gene maps become denser, providing a larger number of potential candidates.

Candidate gene approach

The candidate gene approach is an attractive option because it may give a quick answer and involves an element of hypothesis testing. However, the selection of candidates should be based on solid biochemical data or physiological observations. It should be appreciated that an altered level of a particular enzyme or other gene product does not imply an alteration in the structural gene for that product. Gene expression is frequently very complex, involving a number of regulatory genes, in some cases located on distant parts of the genome to the structural gene. Nevertheless, the hypothesis of whether variability at or around the site of a gene exists, can be tested wherever appropriate reagents and pedigrees are available. The requirements include multi-generation pedigrees with appropriate genotype and or phenotype data. The optimum pedigree structures will differ depending on whether simple or polygenic inheritance is expected. Secondly, there is a requirement to measure genetic variability at the candidate gene locus. DNA markers are most frequently used for this purpose. By analysing for co-segregation at the candidate gene locus and locus of interest, the hypothesis can be tested. Since the candidate gene marker effectively tags a segment of DNA, the involvement of other genes on that segment is tested simultaneously.

Positional cloning approach

Another approach to isolating genes involves an initial localisation to a chromosomal segment generally via anonymous genetic markers. Detailed analysis of the segment can refine the localisation and lead to isolation. This approach, referred to as positional cloning, is inherently more laborious, but if used methodically has a higher probability of success. The approach is equally applicable to simply inherited and polygenic effects although the optimum pedigree structures will vary and there is a limit to the size of gene effects detectable in the polygenic situation.

The basic procedure involves genotyping multi-generation families, which have been phenotyped for the trait of interest (Fig. 1).

The probability of detecting a linked marker or markers is directly related to the distribution of markers and the number of informative matings for

linkage analysis. The markers will be chosen from a genetic map to ensure complete screening of the genome with a minimum number of markers. Assuming there are sufficient informative meioses to be analysed, linkage between one or more of the markers and the gene or associated phenotypic effect should be found. By localising the markers, if they have not already been mapped, the chromosome carrying the gene of interest can be defined. This is a very significant step for two reasons. First, it considerably narrows down the area to be analysed for closer markers. Second, an approximate localisation of a gene allows a re-evaluation of possible candidate genes that have previously been mapped to this region. Homologous regions in other genomes can also be surveyed, thereby expanding the number of potential candidates. Alternatively, chromosome walking towards the gene can be pursued. Once the gene is isolated, it can be analysed in more detail.

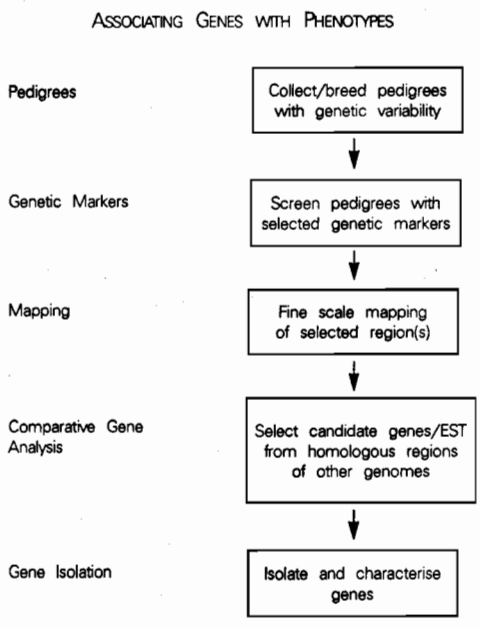


Figure 1. A general strategy for positional cloning of a gene.

Published markers

A number of microsatellite markers have now been shown to be linked with potentially important genes in bovids. The poll gene, affecting horn development in European cattle has been mapped to the centromeric end of bovine chromosome 1 via linkage to microsatellite markers in this region (Georges et al. 1993). A gene responsible for muscular hypertrophy in sheep has been found linked to a bovine-derived microsatellite on sheep chromosome 18 (Cockett et al. 1994). Another gene responsible for increased fecundity in sheep, the *FecB* or *Booroola* gene, has been linked to microsatellites on sheep chromosome 6 (Montgomery et al. 1993) a region identified as homologous to a region of human chromosome 4q using Type 1 loci.

QTLs have recently been mapped in domestic animal species. Andersson et al. (1994) have described a cluster of QTLs on pig chromosome 4 affecting growth rate, fatness and small intestine length. QTLs responsible for milk production traits such as total milk yield, protein and fat yield and percentage protein and fat in dairy cattle have also been mapped to five chromosomal regions on bovine chromosomes 1, 6, 9, 10 and 20 (Georges et al. 1995) demonstrating the ability to detect genes responsible for production traits even in highly selected pedigrees.

Marker assisted selection

Marker genotypes can be used to assist selection decisions, increasing the frequency of favourable QTL, or targeting their introgression into other lines. The value of this depends on a number of factors:

- where heritability is low, the value of information on individual QTL tend to be higher;
- where the trait(s) of interest cannot be measured on one sex, marker information gives a basis to rank animals of that sex;
- if the trait is not measurable before sexual maturity, marker information can be used to select at a juvenile stage; and
- if a trait is difficult to measure or requires sacrifice (as with many carcase traits) marker information can be used instead.

When QTL have been detected, it is possible to choose closely linked markers. However, there can be a need for appropriate population structure plus statistical analysis to exploit QTL effects with useful reliability.

DNA Fingerprinting

Blood typing has formed the basis of pedigree verification in the cattle industry for many years and has proved a powerful tool for this purpose. DNA microsatellites provide a highly efficient means of parentage determination in domestic animals (Vankan et al. 1994; Moore and Vankan 1994). Not only can exclusion probabilities and the proportion of correct parentage be increased by combining a number of microsatellite markers, but the ability to

co-amplify more than one locus means significant cost savings can be achieved. Thus, the test becomes viable for use in large scale applications such as sire assignment in multisire joined cattle herds. Further to this, the test does not rely on blood as the only tissue source. Thus semen, muscle, hide, hair root and buccal swabs are all useable tissue sources.

DNA fingerprinting techniques can also be used to determine the degree of relatedness between animals. Such an application would be useful in the sampling of unpedigreed animals to form a nucleus herd since it would ensure a broad genetic sample with which to initiate a breeding program.

Concluding Remarks

In general, successful livestock development programs are based on multidisciplinary approaches. Although there is considerable potential for the future application of molecular genetic research, it will be important that the technologies, when developed, are integrated with other genetic and reproductive technologies so as to maximise their impact. To this end, effective performance and progeny testing programs on a regional and national basis are part of the necessary breeding infrastructure into which molecular genetic technologies will fit. Thus, there is a strong case for setting up regional genetic improvement programs that utilise an open nucleus breeding scheme. Nucleus herds can make use of more intensive high-tech breeding methods as well as be used for ongoing R&D to improve the efficiency and effectiveness of breeding. To be successful, genetically superior animals from the nucleus herd need to be disseminated via an effective multiplication and distribution network.

References

Andersson, L., Haley, C.S., Ellergren, H., Knott S.A., Johansson, M., Andersson, K., Andersson-Eklund, L., Edfors-Lija I., Fredholm M., Hansson I., Hakansson J. and Lundstrom, K. 1994. Genetic mapping of quantitative trait loci for growth and fatness in pigs. Science, 263, 1771–1774.

Barendse, W., Armitage, S.M., Kossarek, L.M., Shalom, A., Kirkpatrick, B.W., Ryan, A.M., Clayton, D., Li, L., Neibergs, H.L., Zang, N., Grosse, W.M., Weiss, J., Creighton, P., McCarthy, F., Ron, M., Teale, A.J., Fries, R., McGraw, R.A., Moore, S.S., Georges, M., Soller, M., Womack, J.E. and Hetzel, D.J.S. 1994. A genetic linkage map of the bovine genome. Nature Genetics, 6, 227–235.

Botstein, D., White, R.L., Skolinck, M. and Davis, R.W. 1980. Construction of a genetic linkage map in man using restriction fragment length polymorphisms. American Journal of Human Genetics, 33, 316–331.

Bumstead, N. and Palyga, J. 1992. A preliminary linkage map of the chicken genome. Genomics, 13, 690–697.

Cockett, N.E., Jackson, S.P., Shay, T.L., Nielsen, D., Moore, S.S., Steele M.R., Barendse W., Green R.D. and Georges, M. 1994. Chromosomal localisation of the callipyge gene in sheep (*Ovis aries*) using bovine DNA markers. Proceedings National Academy of Science USA, 91, 3019–3023.

Crawford, A.M., Dodds, K.G., Ede, A.J., Pierson, C.A., Garmonsway, H.G., Beattie, A.E., Nguyen, T.C., Maddox, J.F., Lord, E.A., Kappes, S.W., Schwaiger, W., Epplen J.T., Matthews, M., Montgomery, G.W. and Beattie, C.W. 1995. A genetic linkage map of the sheep genome. Proceedings of the XXIV International Conference on Animal Genetics.

Echard, G., Broad, T.E., Hill, D. and Pearce, P. 1994. Present status of the ovine gene map (*Ovis aries*); comparison with the bovine map (*Bos taurus*) . Mammalian Genome 5, 324–332.

Fries, R., Eggen, A. and Womack, J.E. 1993. The bovine gene map. Mammalian Genome, 4, 405–428.

Georges, M., Drinkwater, R., King, T., Mishra, A., Moore, S.S., Nielsen, D., Sargeant, L.S., Sorensen, A., Steele, M.R., Zhao, X., Womack, J.E. and Hetzel, D.J.S. 1993. Microsatellite mapping of a gene affecting horn development in *Bos taurus*. Nature Genetics, 4, 206–211.

Georges, M., Nielsen, D., Mackinnon, M., Mishra, A., Okimoto, R., Pasquino, A.T., Sargeant, L.S., Sorensen, A., Steele M.R., Zhao, X., Womack, J.E. and Hoeschele, I. 1995. Mapping quantitative trait loci controlling milk production in dairy cattle by exploiting progeny-testing, Genetics 139, 907–920.

Hetzel, D.J.S. 1993. Livestock genome research on the march. Nature Genetics, 4, 327–328.

Montgomery, G.W., Craxford, A.M., Penty, J.M., Dodds, K.G., Ede, A.J., Henry, H.M., Pierson, C.A,. Lord, E.A., Galloway, S.M., Schmack, A.E., Sise, J.A., Swarbrick, P.A., Hanrahan, V., Buchanan, F.C. and Hill, D.F. 1993. The ovine Booroola fecundity gene (FecB) is linked to markers from a region of human chromosome 4q. Nature Genetics, 4, 410–414.

Moore, S.S., Sargeant, L.L., King, T.J., Mattick, J.S., Georges, M. and Hetzel, D.J.S. 1991. The conservation of dinucleotide microsatellites among mammalian genomes allows the use of heterologous PCR primer pairs in closely related species. Genomics, 10, 654–660.

Moore S.S. and Vankan D.K. 1994. The application of DNA fingerprinting to Parentage Verification in cattle. Australasian Biotechnology, 4 107–8.

O'Brien S.J., Womack J.E., Lyons L.A., Moore K.J., Jenkins N.A. and Copeland N.G. 1993. Anchored reference loci for comparative genome mapping in mammals. Nature Genetics, 3, 103–112.

Rohrer G.A., Alexander L.J., Keele J.W., Smith T.P. and Beattie C.W. 1994. A microsatellite linkage map of the porcine genome. Genetics, 136, 231–245.

Vankan D.M., Moore S.S., Bell K. and Hetzel D.J.S. 1994. Evaluation of DNA microsatellites for parentage and paternity testing of cattle. XXIV International Conference on Animal Genetics, Prague. Animal Genetics 25, Supplement 2.41.

Weber J.L. and May P.E. 1989. Abundant class of human DNA polymorphisms which can be typed using the polymerase chain reaction. American Journal of Human Genetics, 44, 388–396.

Determining the Estimated Breeding Value (EBV) in Pig Herds in Vietnam

Nguyen Van Thien*, Tran The Thong†, Nguyen Thien*, Dinh Hong Luan§, Le Thanh Hai†, Dang Vu Binh†, Nguyen Que Coi#, Tran Kim Anh#, Vo Hong Hanh#, Vo Van Su*, Ta Bich Duyen* and Nguyen Minh Tam*

Abstract

To determine the EBV is one of the important stages in the selection procedure. Most countries advanced in animal husbandry have used the EBVs in selecting superior breeding stock. In Vietnam, since 1970 we have applied a Selection Index (SI) in determining EBV in indigenous pig breeds (Mong Cai and I) and exotic pig breeds (Yorkshire and Landrace).

Six simple SIs and six modern SIs of sows were determined for Mong Cai, I and Yorkshire pig breeds. The characters used for determining the Sow Selection Index (SSI) were the number born alive (X_1), litter weight at 21 days (X_2), litter weight at 60 days (X_3), piglet number at 60 days (X_4) piglet weight at 60 days (X_5) age at first farrowing of sow (X_6) and interval between 2 farrowings of the sow (X_7). One simple SI and six modern SIs of young boars were determined for Mong Cai, I, Yorkshire and Landrace pig breeds. The characters used for determining the Young Boar Selection Index (YBSI) were average daily gain (X_1), feed conversion ratio (X_2) and backfat thickness (X_3).

The above SIs for reproductive performance of the sow and growth rate of the young boar for the Mong Cai, I, Yorkshire and Landrace reflect the genetic value, economic values and their phenotypic and genetic correlations. It is possible to use them for grading the animals after measuring their performances. Currently, with the assistance of ACIAR (Australia) and technical experts, we have been developing a selection schedule for pigs which uses a Best Linear Unbiased Prediction (BLUP) method to determine the EBV of pigs. In the future we propose to supplement the selection procedures with molecular genetic information.

THE Breeding Value (BV) of an animal is a description of the value of an animal's gene to its progeny. We can never fully know what an animal's EBV is; however we can estimate it. We can calculate an animal's EBV from various sources of information.

* National Institute of Animal Husbandry, Thuy Phuong, Thu Liem, Hanoi, Vietnam.
† Institute of Agricultural Sciences of South Vietnam, 121 Nguyen Binh Khiem, District 1 Ho Chi Minh City, Vietnam.
§ Company of Animal husbandry and Foodstuff of 1st Region, 6 Nguyen Cong Tru St, Hanoi, Vietnam.
# National Institute of Agricultural Sciences, Van Dien, Thanh Tri, Hanoi, Vietnam.

Where a single trait is being measured for an individual its EBV for that trait will be:

$$EBV = h_2 P$$

where: h_2 is the coefficient of heritability; and P is the deviation of phenotypic value from average of the population.

When selecting simultaneously for many traits EBVs will be determined by a selection index or SI (Hazel 1943) or by Best Linear Unbiased Prediction known as BLUP (Henderson 1973).

Recently, Marker Assisted Selection method (MAS) is being developed as a supplementary method in selection. Most countries advanced in animal husbandry have used EBV for selecting superior breeding stock.

Determination of EBVs in Pig Herds in Vietnam in the Past

Since 1970 we have carried out the SI method for determining EBV on indigenous pig breeds (Mong Cai and I) and exotic pig breeds (Yorkshire and Landrace).

The selection indices of reproductive performance for sows

The traits have been used for determining the Sow Selection Index (SSI) as follows:

- Piglets born alive number (X_1)
- Litter weight: 21 days or 30 days ($X_{2.21}$ & $X_{2.30}$)
- Litter weight at 60 days (X_3)
- Piglet number at 60 days (X_4)
- Piglet weight at 60 days (X_5)
- Age at first farrowing (X_6)
- Interval between 2 farrowings (X_7)

The method of maximum and minimum

MONG CAI PIG BREED

For the first farrowing

$I = 2X_1 + 0.46\,X_{2.21} + 0.176\,X_3 + 0.027\,(720 - X_6)$

From the second farrowing:

$I = 2X_1 + 0.46\,X_{2.21} + 0.176\,X_3 + 0.055\,(360 - X_7)$

I PIG BREED

For the first farrowing:

$I = 2X_1 + 1.599\,X_{2.30} + 0.522\,X_3 + 0.027\,(720 - X_6)$

From the second farrowing:

$I = 2X_1 + 1.599\,X_{2.30} + 0.522\,X_3 + 0.055\,(360 - X_7)$

YORKSHIRE PIG BREED:

For the first farrowing:

$I = 2X_1 + 0.570\,X_{2.30} + 0.147\,X_3 = 0.027\,(720 - X_6)$

From the second farrowing:

$I = 2X_1 + 0.570\,X_{2.30} + 0.147\,X_3 + 0.055\,(360 - X_7)$

The method of Cunningham (1969)

MONG CAI PIG BREED:

For 4 traits:

$I = X_1 + 0.84\,X_{2.21} + 0.52\,X_3 - 0.02\,X_7$

For 3 traits

$I = X_1 + 1.10\,X_4 + 0.45\,X_5$

I PIG BREED:

For 4 traits

$I = X_1 + 0.33\,X_{2.21} + 0.59\,X_3 - 0.07\,X_7$

For 3 traits

$I = X_1 + 2.57\,X_4 + 0.26\,X_5$

YORKSHIRE PIG BREED:

For 4 traits

$I = X_1 + 0.068\,X_{2.21} + 0.092\,X_3 - 0.004\,X_7$

For 3 traits

$I = X_1 + 1.76\,X_4 + 0.08\,X_3$

The selection indices on growth rate for young boars

The following traits have been used for determining the Young Boar Selection Indices (YBSI):

- Average Daily Gain (X_1)
- Feed Conversion Ratio (X_2)
- Backfat Thickness (X_3)

The method of positive and negative

$I = (X_1 - \overline{X}_1) - (X_2 - \overline{X}_2)$

(for all kinds of young boars i.e. Mong Cai, I, Yorkshire and Landrace)

The method of Gadoud and Surdeaun (1975)

MONG CAI PIG BREED:

$I = 100 + 0.16\,(X_1 - \overline{X}_1) - 11.99\,(X_2 - \overline{X}_2)$

I PIG BREED

$I = 100 + 0.04\,(X_1 - \overline{X}_1) - 6.6\,(X_2 - \overline{X}_2)$

YORKSHIRE PIG BREED

For 3 traits

$I = 100 + 0.31\,(X_1 - \overline{X}_1) - 26.4\,(X_2 - \overline{X}_2) - 24.4\,(X_3 - \overline{X}_3)$

For 2 traits

$I = 100 + 0.27\,(X_1 - \overline{X}_1) - 28.8\,(X_2 - \overline{X}_2)$

LANDRACE PIG BREED

For 3 traits

$I = 100\,(X_1 - \overline{X}_2) - 32.1\,(X_2 - \overline{X}_2) - 6.7\,(X_3 - \overline{X}_3)$

For 2 traits

$I = 100 + (X_1 - \overline{X}_1) - 47.4\,(X_2 - \overline{X}_2)$

Thus all the above selection indices for reproductive performance of the sow and growth rate of the young boar for the Mong Cai, I, Yorkshire and Landrace have reflected all genetic values, economic values and phenotypic and genetic correlations. So this method has the advantage over single trait selection of being able to put selection pressure on a number of traits. Moreover, calculations are relatively easy and can be performed on farms with a programmable pocket calculator.

But the disadvantages of the selection index method are:

- the comparison of animals for selection must be done within the test group, we cannot compare the selection indices of the different test groups; and
- the genetic trends over time cannot be assessed to evaluate the effectiveness of the breeding program by selection indices.

The Determination of EBV on Pig Herds in Vietnam in the Future

For determining more exactly the EBV of pigs and improving the efficiency of pig selection, with the assistance of ACIAR, CSIRO and AGBU, Australia we have been developing a pig selection scheme which uses the Best Linear Unbiased Prediction (BLUP) method and supplements it with molecular genetic information, the Marker Assisted Selection procedure (MAS) as in Figure 1.

Further progress will be reported.

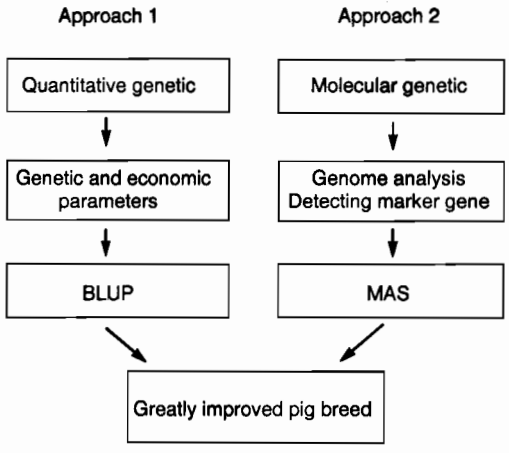


Figure 1. New selection scheme for pig breeds in Vietnam.

References

Cunningham, E.P. 1969. Animal Breeding. Theory Institute of Animal Genetics and Breeding. Agricultural College of Norway, Landbruksbokhandelen/ Universitets for Laget, Vollebekk/Oslo.

Gadoud, R. and Surdeaun, P. 1975. Génétique et sélection animales, Tome I, Génétique Animale, éditions Baillière J.B., 19, rue Hautefeville, Paris 6.0.

Hazel, L.N. 1943. The genetic basis for selecting indexes. Genetics, 28, 476–490.

Henderson, C.R. 1973. Sire evaluation and genetic trends. Proceedings of the Animal Breeder and Genetics Symposium in Honour of Dr J.L. Lush ASAS.

Pig Breeding in Central Vietnam and its Improvement

Hoang Nghia Duyet and Nguyen Kim Duong*

Abstract

Pig production is an important industry for this economically poor part of Vietnam, and over one quarter of the national pig herd is located here. The many local breeds, though resistant to the harsh conditions, have low productivity. Breeding programs have sought, by successive phases, to improve this situation. The imported and improved Mong Cai together with exotic breeds have produced F_1 sows of greater productivity as has the Trang Phu Khan, a hybrid between the Yorkshire and local breeds in the south central region. Latterly, three-way crosses have been produced and further gains obtained.

The question of optimum feeding regimes for three-way crosses and exotic purebreds needs research along with development of further breeding programs allied with environmental protection in areas being developed for pig production.

THE central region of Vietnam consists of 13 provinces extending from Nghe An to Thuan Hai province. It is very wet and cold in the winter and very hot and dry in the summer. Three quarters of this region consists of high mountains and narrow agricultural valleys and it is an economically poor part of Vietnam. The pig population is about 3825 million (27.5% of total pig population in Vietnam) and sows comprise 13.5% of this. There are many local pig breeds such as Co, Meo and Tau Pha. The characteristics of the local breeds are: good resistance to bad climate and poor nutritional supply; low litter size (6–8 piglets born alive and 5–6 weaned pigs/litter); poor mothering ability; low body size (weaned weight: 3–4 kg, 8 months of age: 20–30 kg, 1 year of age: 30–40 kg, >36 months of age: 50–60 kg); low carcase yield (60–65%); low growth rate (3–5 kg/month); poor meat quality (lean meat <30%); and high feed conversion (6–8 kg feed/kg liveweight gain). To improve productivity, these local breeds have been replaced by Mong Cai and Trang Phu Khanh breeds and also some exotic breeds have been imported for pig improvement purposes.

* Hue University of Agriculture and Forestry, 24 Phung Hung, Hue, Vietnam.

Imported Mong Cai for Improvement of Local Breeds

The Mong Cai (MC) is the main breed in the north and central areas of Vietnam. It originated in the north-east of Vietnam. MC pigs have been imported to this centre since 1975 from government farms at Dong Trieu, Tam Dao and Thach Ngoc. The MC which are black and white with a white hair band around the shoulder similar to Hampshire pigs are only used as sows. Through selection and adaptation, we have obtained the results shown in Table 1.

The MC has been shown to have good mothering ability, large litters, good milk production, a high number of litters per year, larger body size and an average of 14 teats.

High heterosis production effects have also been obtained with two-way crosses with exotic breeds. Some growth and carcase data of crosses with three exotic breeds are given in Table 2.

The above data show that the crossbreeds between Large White (LW) or Landrace boars and Mong Cai sows have good growth rate, large body size, high lean meat content and low feed conversion ratios. But the Cornwall cross produced poor quality meat (high fat in the carcase, poor colour) leading to its rejection for use. The LW/MC cross has now become very popular.

Table 1. Average reproductive performance of Mong Cai sows in the central region of Vietnam.

	Gilts		Sows < 2 years		Sows > 2 years of age	
	n	Mean ± SE	n	Mean ± SE	n	Mean ± SE
Age of first mating (month)	275	8.6				
Liveweight (kg)	275	39.6 ± 0.32	427	60.80 ± 0.85	475	86.50 ± 0.75
Litter size at birth (n)			925	8.87 ± 0.08	948	10.76 ± 0.07
Litter size at weaning (n)			925	7.85 ± 0.07	948	9.25 ± 0.09
Weaning weight (kg)			115	5.45 ± 0.12	150	6.05 ± 0.10
Total LW 21 days (kg)			25	19.50 ± 0.45	55	25.25 ± 0.36
Cycles of litter (days)			545	209.10 ± 1.00	450	195.30 ± 0.80
Litters/year				1.74		1.87

LW: liveweight
Source: Duyet 1992.

Table 2. Production effects of two-way cross between Mong Cai (MC) sows and Cornwall (CW), Large White (LW), Landrace (LR) boars.

	CW/MC	LW/MC	LR/MC
LW at 8 months (kg)	75–76	78–80	89.1
LWG (g/d)	414	430	446
Carcase ratio (%)	70	72	
Lean meat (%)	47	50	
Lean meat for export (%)			36.2
Feed conversion kg/kg	4.0	3.9	4.6

LW: liveweight
LWG: liveweight gain
Source: Duong 1992, Hai and Vien 1991.

F_1 (Exotic Breeds/MC) Sows

In order to examine three way crosses, we used F_1 sows (exotic breeds/MC) with production results as shown in Table 3.

These data show that although many of the indices were similar between the groups, litter size at birth and weaning, and weaning weights were lowest in the F_1 sows from CW/MC. The F_1 sows from LW or LR showed good mothering ability, high fertility, high litter numbers/year. Therefore, as sows these crossings are judged to be valuable for breeding purposes.

With the aim of improving lean meat production, investigations were carried out into three-way crosses between exotic breeds and F_1 sows from MC sows. Some carcase and growth results were obtained and are shown in Table 4. The data show that these hybrids (especially Yorkshire (Y)/(LR/MC) have good growth rates (450–500 g/days), reach slaughter weight early, have good lean meat content and a low feed conversion rate. But they need high quality feed to produce well.

Table 3. Productivity of F_1 sows (MC mated with Large White [LW], Landrace [LR] and Cornwall [CW]) mated to LW boars.

F_1 sows:	LW/MC	LR/MC	CW/MC
Litters (n)	81	75	10
LW at first oestrus (kg)	70	70	70
LW at first mating (kg)	90	90	90
Age of first mating (month)	9–10	9–10	9–10
Pregnancy stage (days)	114	114	114
Post-weaning oestrus (days)	6	6	6
Litter size at birth (n)	10.35	10.25	9.4
Litter size at weaning (n)	10.0	10.0	8.
Weight at birth (kg)	1.05	1.02	0.95
Weight at weaning (kg)	8.10	8.20	7.50
Litters/year (n)	2.0	2.0	1.9

Source: Duong 1993.

Table 4. Growth and carcase results from three-way crosses.

	Y/(LR/MC)	LR/(Y/MC)
LW at 8 mth) (kg)	97.9	92.2
LWG (g/day)	490	464.4
Lean meat export (%)	40.5	39.4
Feed conversion (kg/kg)	4.0	4.6

Source: Hai and Vien 1991.
Y: Yorkshire; LR: Landrace; MC: Mong Cai; LW: liveweight
LWG: liveweight gain.

Table 6. Growth rate of fattening Trang Phu Khanh pigs.

	n	Mean ± SE
Liveweight at start (kg)	90	11.2 ± 2.25
Liveweight at finish (kg)	88	88.3 ± 12.8
Liveweight gain (g/day)		435.0 ± 71.4
Feed conversion ratio (kg/kg)		5.5 ± 0.86

Source: Doanh 1990.

Table 5. Growth rate of Trang Phu Khanh sows.

Age	Liveweight (kg)		Body length (cm)		Girth (cm)	
(months)	n	Mean ± SE	n	Mean ± SE	n	Mean ± SE
2	101	11.2 ± 2.10				
4	222	23.4 ± 2.80				
6	220	40.1 ± 5.80	220	105.0 ± 12.1	187	100.6 ± 10.6
8	206	62.2 ± 7.40	201	113.5 ± 07.4	201	104.0 ± 11.2
12–16	221	98.0 ± 13.5	198	123.0 ± 16.2	186	109.0 ± 14.3
16–18	202	119.0 ± 20.1	179	134.0 ± 19.2	179	117.0 ± 17.6
18–24	192	145.0 ± 26.1	240	142.0 ± 18.1	132	124.0 ± 18.6

Source: Doanh 1989.

In the past, most farmers from Nghe An to Binh Dinh provinces have been very interested in using MC as sows because of their good mothering ability and economic characteristics and for 10 years efforts have been made to improve the MC breed by selection. With changing economic policy, however, the MC breed is faced with the risk of a decline in quality and continued improvements to it are needed.

Use of Trang Phu Khanh (TPK) Breed for Southern Central Region

The TPK is a hybrid between Yorkshire and local breeds and is in popular use as a sow in the south central region. Some performance data are recorded in Table 5.

These data show that TPK sows have good body size, high growth rate (9–10 kg/month), and that the girth index is always lower than 100%, with the significance that TPK is a lean meat breed and also that the females are not as fat as MC sows.

Some observations on growth rate of fattening TPK pigs are shown in Table 6 and the data indicate that TPK breeds have high growth rates, high lean meat percentage (43%), but also a high feed conversion ratio.

When hybrids of Y/TPK are used growth can be increased by 10–15% compared with pure TPK breeds.

TPK sows are also used in central Vietnam. Some data on their reproduction and that of F_1 sows from LW/TPK crossing and from Edel/TPK crossing are shown in Table 7.

The data show that TPK sows have good fertility and good mothering ability (large litter size and good piglet weight at birth and at weaning showing high lactation yield).

When using F_1 as sows, the highest heterosis of the breeds tested was obtained from the crossing of LW/TPK (litter size at birth and at weaning, birth weight and weaned weight and high milk yield about 7–10% higher than pure TPK breed). Because of this sort of performance most farmers from Binh Dinh to Thuan Hai provinces prefer to keep TPK type sows.

Use of Exotic Breeds

Besides the use of local breeds, exotic breeds including Cornwall, Large White, Yorkshire and Landrace have been imported since 1975 to improve production. Among these breeds the Cornwall, although having good adaptation to living conditions here, was found to have high fat content in the carcase, limited

Table 7. Mean reproduction in Trang Phu Khanh and F_1 sows (exotic/TPK).

	Sows (n)	At birth litter size	At birth wt/pig (kg)	At 21 days litter wt (kg)	At 55 days litter size	At 55 days wt/pig (kg)
TPK Tuy Hoa farm	65	9.40	1.15	32.55	7.80	8.4
TPK Suoi Dau farm	25	8.63	1.10	32.25	7.22	8.7
F_1 (Edel/TPK)	12	9.10	1.30	33.80	7.70	9.0
F_1 (LW/TPK)	11	9.30	1.33	35.20	8.10	9.4

LW: Large White.
Source: Doanh 1989.

Table 8. The semen qualities of Landrace (LR) and Large White (LW) boars kept in the central region.

	LR boars (Mean ± SE)	LW boars (Mean ± SE)
Ejaculate vol (mL)	224.90 ± 2.40	188.26 ± 1.26
Abnormal (%)	0.80 ± 0.01	0.81 ± 0.01
Count (millions/mL)	287.93 ± 3.34	262.86 ± 3.40
V × A × C (billions)	52.45 ± 1.06	40.55 ± 0.74

A: % of good sperm activity.
C: concentration.
V: Volume of sperm.
Source: Nha 1995.

fertility and undesired colour, so was rejected for general use. The Large White, Yorkshire and Landrace were imported about 20 years ago for artificial insemination purposes to improve pig meat production. Some data on the semen characteristics of these two breeds are reported in Table 8.

These data indicate very good fertility with each of the beneficial indices at a high level.

Conclusions and Recommendations

- in the central region of Vietnam for 10–20 years, effort has been put into selecting and aiding adaptation of the MC and TPK breeds which now have very good mothering ability and productivity and high heterosis when crossed with exotic breeds;
- exotic boars have been used to improve meat production in fattening pigs—hybrids now show good growth rate (430–500 g/day), high lean meat ratio (around 50%) and low feed consumption; and
- step-by-step increase in the proportion of exotic blood in meat pigs has brought accelerated improvement in lean meat production.

It is recommended that there be:

- immediate establishment of breeding areas for MC and TPK for their continuing improvement;
- improved national policies for farmers engaged in sow breeding;
- experimentation to determine optimum feeding regimes for three-way crosses and exotic purebreds; and
- environmental protection including erosion control when developing areas for pig production.

References

Doanh, Pham Huu. 1989. Selection pure bred multiplication, to build up the breed group, Phu Khanh White pig (in Vietnamese). Magazine of Vietnamese Agricultural Sciences and Techniques, January 1989, p. 31.

—— 1990. Ibid. October 1990, p. 595.

Duong, Nguyen Kim. 1992. The results of experimental rearing F_1 (Large White × Mong Cai) in Thua Thien, Hue province (in Vietnamese). Conference of Scientific Research of the Agricultural University of Hue, 1992, p. 84.

——1993. Selection of two way crosses for sows (in Vietnamese). Magazine of Hue Agricultural University Scientific Research, p. 67.

Duyet, Hoang Nghia. 1992. Results of investigating the reproduction ability of Mong Cai sows kept in Central Vietnam (in Vietnamese). Conference of Scientific Research of the Agricultural University of Hue, p. 80.

Hai, Le Thanh and Vien, Nguyen Thi. 1991. Research on the crossbred combination for improving meat production in pig in the central region of Vietnam (in Vietnamese). Magazine of Vietnam Agricultural Sciences and Techniques, March 1991, p. 227.

Nha, Giang Thanh. 1995. Evaluating semen quality of Landrace and Large White boars kept in Binh Dinh province (in Vietnamese). Animal Science Workshop of the Agricultural University of Hue, p. 91.

Design of Structured Livestock Breeding Programs

Scott Newman* and Gerard Davis†

Abstract

The primary tools in genetic improvement of livestock are selection and crossbreeding. Within-herd selection provides sustained, continuous improvement in breeding value. Crossbreeding represents an opportunity to enhance productivity through combining economically important characters of different breeds (complementarity) and exploiting heterosis. Whether a breeding program is based on within-herd selection, crossbreeding, or a combination of the two (composite breed development), any successful breeding program will be developed in a logical sequence. The purpose of this paper is to discuss the development of breeding programs with reference to a specified series of events.

THIS paper discusses the development of a structured livestock improvement program through a logical sequence of steps:

- definition of the breeding objective;
- choice of selection criteria;
- development of a pedigree and performance recording scheme;
- genetic evaluation; and
- use of selected individuals

Ponzoni (1992) and Harris and Newman (1994) provide reviews of the design of livestock improvement programs.

Methods

Define the breeding objective

A breeding objective (H) is simply a statement (model) describing the relationship between various biological traits and income and expense in the particular livestock industry. The objective is developed to maximise socioeconomic benefit in the most populous unit, be it smallholder, village or large-scale farm. In its most formal sense the breeding objective is an algebraic model of the form:

$$H = trait_i \times a_i + trait_j \times a_j + \ldots$$

where a_i is the economic value of trait i.

Defining H involves four phases: specification of the breeding, production and marketing system; identification of sources of income and expense at the fundamental production level; determination of biological traits influencing income and expense; and the derivation of the economic value for each trait.

Specification of the breeding, production, and marketing system

This phase involves defining the role of the breed, for which the breeding objective is being developed, in the production system. The role may be general purpose, maternal line, or terminal paternal line. The role of the breed determines the fraction of genes present in the various segments of the production system.

Specification of the production and marketing system consists of establishing the way in which livestock are fed and managed, the age composition of the herd, the replacement policy, and age(s) at slaughter.

Identification of sources of income and expense in commercial (village) herds

This would include the price of slaughter animals and the costs of husbandry and marketing, if relevant. The identification of sources of income and expense in village herds enables the development of

* Cooperative Research Centre for the Cattle and Beef Industry (Meat Quality), CSIRO, Division of Tropical Animal Production, Tropical Beef Centre, Box 5545, Rockhampton Mail Centre, Queensland 4702, Australia.

† Molecular Animal Genetics Centre, CSIRO, Division of Tropical Animal Production, University of Queensland, St. Lucia, Queensland 4072, Australia.

a profit equation, where profit (P) is a function of income (I) and expense (E):

$$P = I - E$$

Determination of biological traits influencing income and expense

The profit equation is now expressed as a function of biological traits influencing income and expense. For beef cattle these might be calves weaned, carcase weight and food intake. For pigs the breeding objective might include litter size, survival to weaning, days to market, backfat thickness, and feed intake. At this stage we are interested only in the economics of the production system and not how expensive or difficult it might be to measure economically important traits.

Derivation of the economic value of each trait

The economic value of a trait is defined as the effect on producer net profit of a marginal increase in the level of that trait (Hazel et al. 1943; Melton 1994). This is simply the partial derivative of the profit equation for each trait in the objective, evaluated at the mean level of all other traits.

Not all traits in the breeding objective will be expressed with the same frequency or at the same time in commercial herds. To account for this, the 'discounted gene flow' method can be used (McClintock and Cunningham 1974). This method takes into account the number of times a trait is expressed and the time of expression, and converts the expressions to present value by applying a discount rate.

Choosing appropriate selection criteria.

Once the breeding objective has been developed, it is necessary to decide on the selection criteria that will be used to estimate the value of animals as parents of future generations and to select replacements. Selection criteria should be heritable, be measured relatively early in life, be inexpensive to measure, and most importantly be genetically correlated with traits in the breeding objective.

The characters used as selection criteria need not be the same as the traits in the breeding objective. Information required at this step includes phenotypic and genetic parameters for the traits in the breeding objective and for the characters chosen as selection criteria.

Various types of selection schemes exist to make genetic improvement. The three most common are tandem selection, independent culling levels, and index selection. We assume index selection to be the preferred method because it considers genetic information and economic information simultaneously and therefore provides optimal selection decisions. The selection index takes the form:

$$I = \sum_{i=1}^{n} b_i X_i$$

where the b_i are weighting factors calculated in such a way that the correlation between the breeding objective and the selection index is maximised. The weighting factors are estimated by solving the equations

$$b = P^{-1}Ga$$

where b is a vector of unknown weightings to be solved for, P is a matrix of phenotypic variances and co-variances among the selection criteria, G is a matrix of genetic variances and co-variances between the selection criteria and the traits in the breeding objective, and a is a vector of economic values.

Organising a pedigree and performance recording scheme

Steps one and two have identified what kind of information we need to collect, and it is in this step that we develop the scheme to collect information to make selection decisions in a timely and accurate manner.

Livestock recording has one aim: to produce accurate information which can be applied to livestock selection and farm management decision making (Uljée and Rennie 1990). How and where the data is collected, however, will depend to some extent on how genetic improvement will be disseminated to producers. The result may be the need for data collection in an elite nucleus, multiplier herds and at the village and/or smallholder level. The requirements for an ideal recording system would include: accurate identification of individual animals; ability to determine partial or complete pedigrees; easy, accurate, and reliable measurement of traits; and, reliable and consistent reporting procedures. Accurate animal identification is most often achieved through the use of permanent tags which are commercially available and easy to apply. For a national scheme it is important to relate an animal's tag number to its identification in the total recording system. This may require allowing for codes for ownership, village or province in the recording system.

Pedigrees may be most easily recorded at or around the time of birth for the dam side of the pedigree. Single-sire mating and/or AI may facilitate the recording of sire pedigrees. However, when a number of males may be potential sires, a parentage test may have value. DNA fingerprinting using a system of single-locus microsatellites will be a valuable addition to pedigree recording (Moore and Vankan 1994). The use of DNA fingerprinting, though likely to improve the accuracy of pedigree assessment, would require the availability of an inexpensive and reliable service and would add to the recording overhead costs.

Initially, recording schemes in most livestock industries have focussed on collection of weights as these are relatively easy to measure and very often form a significant part of the breeding objective. Over time more traits are added to the selection criterion (index). In the Australian beef recording scheme it is possible to record information on liveweights, reproductive traits, structural measurements, scanned carcase traits and traits measured on the hanging carcase (Graser et al. 1995). Genetic evaluations to compute estimated breeding values (EBV) are not provided for all of these traits at present but unless a trait is part of the recording scheme accurate genetic evaluations cannot be produced for it.

For those traits that remain difficult to measure, evaluations may be derived from using genetic marker information. For example, where resistance to a disease is a significant requirement at the commercial level, but measuring such resistance would have too large an effect on production, genetic markers known to account for variation in the trait may be used to provide an assessment of an individual's resistance level.

Genetic evaluation could be carried out at one or more central facilities, or be fully distributed, allowing individual producers to carry out their own evaluations or in some combination. The first approach is preferred but requires the ability to concentrate the information collected at the distributed sites and also the ability to disseminate the results. Thus data collection and reporting become key issues and a recording system needs to be designed to allow transfer of information in an accurate and timely manner—timely particularly in the sense of being able to influence breeding decisions. The second approach of a fully distributed genetic evaluation system has the advantage of the results being easily available and immediately relevant but rarely encompasses the power derived from across-herd evaluations where the most significant gains are often to be made.

Using recorded information to make selection decisions

Documenting performance and pedigree records is of little or no value in itself. Unless the performance records are used in some way as an aid in making selection decisions, they will not make a positive contribution to any breeding program.

Estimated breeding values (EBV) are calculated by solving systems of linear equations using information extracted from the recording scheme. Modern genetic evaluation combines the use of either full or partial pedigrees; systematic non-genetic sources of variation, such as age at measurement, age of dam, sex and herd, and observed measurements (phenotypes) on one or more traits.

The type of model used for such evaluations varies according to the information available and the importance of genetic and non-genetic sources of variation but all have the following form

$$Y = X\beta + Zu + e$$

where Y is a matrix of observations, β are systematic non-genetic sources of variation, u are genetic effects and e is random error. Design matrices X and Z relate fixed and random effects, respectively, to observations. Examples of variations in the model include:

- single trait animal model—the most simple model used to analyse a single measurement per animal;
- single trait animal/maternal model—where effects for dams' genetic contribution and environmental contribution to variation in the trait are included (and can be estimated);
- single trait repeatability model—a model used to analyse traits where there is more than one record per animal; or
- multi-trait animal model—where a number of traits measured on a single animal are analysed simultaneously accounting for variation and covariation between them.

Further examples of models used for genetic evaluation can be found in Van Vleck (1994).

Once EBV have been developed, they must be used in a selection procedure to make selection decisions. This means constructing a selection index using the EBV. Those animals with the most desirable index values could then be assessed in terms of visual suitability and those selected would become part of the parental generation.

Using the selected individuals

Ranking the animals according to their genetic merit and deciding which ones will be kept and which ones will be culled is not enough. Decisions must be made on the use of the selected animals. Maximising genetic progress requires tuning the flow of genes between groups of selected stock to the majority (unselected) population. At this point the consideration of size and structure of the population in which the selected individuals will be used is important.

To make genetic improvement in a population requires that an industry structure be developed that allows the dissemination of genetic gain. Ideally, maximum genetic gain will occur if the selection program involved included the whole population. However, this might prove a task too large for current resources.

In practice, near-maximum genetic gain can be made by concentrating the 'best' animals in a special nucleus or elite herd which becomes the supplier of breeding stock for the rest of the population. Dissemination of genetically improved livestock could be greatly enhanced through the development of nucleus breeding schemes (James 1977, 1978). In this situation, animals are measured and data collected from animals in the elite (nucleus) herd at one facility. Animals from the elite herds are transferred to regional sire breeding cooperatives to multiply the genetic superiority from the nucleus. Data collection at the nucleus and multiplier levels links parent data with progeny data to form the basis for progeny testing because pedigree and performance information is available. It would make good sense to have data collected at the cooperatives sent to a central facility where data from the elite herds is collected and stored.

Vietnam has a basic nucleus structure in place, based on the three main animal production systems available: state-run semi-industrial or industrial farms, medium size commercial farms, and the 'back yard' farms (Xuan et al. 1995). State-run farms are located in all agroeconomic zones in Vietnam, and provide commercial animals to the private commercial farms or village households. The commercial farms, with provincial and national government help, might act as multiplier herds to provide livestock to smallholders. The commercial farms might also play the role of evaluating genetically superior animals for possible transfer back to the nucleus (hence the name 'open nucleus breeding scheme').

Compared with closed nucleus schemes, open nucleus breeding schemes provide 10 to 15% greater selection response and lower rates of inbreeding (James 1977, 1978). Coordination, training, collecting and analysis of data might be achieved in partnership with a university and/or research institute. Decisions at this stage will help answer such questions as: how is the nucleus herd established? What is their relationship to commercial or regional herds? How large can the disseminated population serviced by the nucleus be?

Crossbreeding

The five steps highlighted above can be used to develop crossbreeding programs. Breeding objectives for programs involving more than one breed would require specialisation of the general breeding objective for the breeds contributing to the system. In particular, the objectives would be modified in terms of the traits included in the objective or their fractional involvement in the objective. For example, the breeding objective of the terminal sire breed in a terminal crossing system would not include traits for reproduction. Importantly though, the costs, returns and process used to define the breeding objective would remain the same for all breeds contributing to performance at the fundamental level of production.

Choice of selection criteria would be modified according to what is dictated by the breeding objective for component breeds in a crossbred production system. For example, there is no benefit for the commercial sector from measuring female reproduction in a terminal sire breed. In a situation where complementarity is to be taken advantage of, the traits of interest are likely to be somewhat different between the breeds complementing each other.

The recording system may be more sophisticated in the pure breeds contributing to the crossbreeding scheme to enable their successful genetic evaluation while recording at the production level may not be as highly emphasised. Genetic evaluation would be emphasised in the purebred herds with their additive improvements being passed through to the commercial sector. In particular situations there would also be merit in evaluating crossbred performance.

The structure of the crossbreeding system will dictate the way in which genetic improvement is disseminated, that is, how selected animals are utilised. However, that structure is dependent on breed and crossbreed parameters and breeding objectives and thus requires development. Some aspects of breed utilisation that will have to be dealt with include the fraction of the genes of the breed desired in the production system, the herd composition in commercial herds and the availability of purebred or crossbred stock of the required composition in breeding herds.

References

Graser, H-U., Goddard, M.E. and Allen, J. 1995. Better genetic technology for the beef industry. Australian Association of Animal Breeding and Genetics, 11, 56–64.

Harris, D.L. and Newman, S. 1994. Breeding for profit: Synergism between genetic improvement and livestock production (a review). Journal of Animal Science, 72, 2178–2200.

Hazel, L.N. 1943. The genetic basis for constructing selection indexes. Genetics, 28, 476–490.

James, J.W. 1977. Open nucleus breeding systems. Animal Production, 24, 287–305.

——1978. Effective population size in open nucleus breeding schemes. Acta Agriculture Scandinavia, 28, 387–392.

McClintock, A.E. and Cunningham, E.P. 1974. Selection in dual purpose cattle populations: Defining the breeding objective. Animal Production, 18, 237–247.

Melton, B.E., Willham, R.L. and Heady, E.O. 1994. A note on the estimation of economic values for selection indices: A response. Animal Production, 59, 455–459.

Moore, S.S. and Vankan, D. 1994. The application of DNA fingerprinting to parentage identification in cattle. Australasian Biotechnology, 4, 107–108.

Ponzoni, R.W. 1992. Genetic improvement of hair sheep in the Tropics. FAO Animal Production and Health Paper 101, Rome, 168 pp.

Uljée, B. and Rennie, N. 1990. Livestock recording for sheep and beef. New Zealand, MAF Technology, 121 pp.

Van Vleck, L.D. 1994. Selection index and introduction to mixed model methods. Boca Raton, CRC Press, 479 pp.

Xuan, V.T., Hai, L.T. and Loc, C.B. 1995. Research priorities for improving animal production by agro-ecological zones in Vietnam. ILRI Consultation Meeting for the South-east Asian Region, Los Baños, Philippines.

Production and Poultry Health—a Case Study, China 1983–1995

Trevor J. Bagust*

Abstract

From 1980, the Government of the People's Republic of China (PRC) has given high priority in agriculture to promoting poultry production. The PRC is now the world's largest producer of eggs and of poultry meat, particularly through the modern development of large intensive production sites around its cities. Production and consumption per person have risen from 60 eggs in 1983 to nearly 200 in 1993, whilst poultry meat intake has increased from 1.35 kg to 4.93 kg in this period, and China is now a major exporter of poultry meat to Japan.

Whilst such production achievements are impressive, significant barriers to continuing poultry industry growth are now being recognised. These include the present high levels of disease-associated losses during production ('intensivism is the friend of disease'), and difficulties ensuring adequate future feed supplies used in intensive production which are dependent on expensive grain-based rations. Animal production institutions and individual scientists need to collaborate more closely ('network') in future, to ensure that benefits from their studies can flow through extension efforts to producers. At village-level however, villagers still produce some 40% of the total poultry grown in the PRC, and 'specialised households' are generating good financial returns, using medium intensities of production.

Considering these experiences, Vietnam's best policy option for developing poultry production (chickens, ducks and other species) may well be to directly encourage the sustainable development of village-based systems by small-holders at medium intensity. This will require active support through a strong and revitalised system of delivery of agricultural extension and veterinary health in Vietnam, involving both Ministry of Agriculture and Food Industries and the Agricultural Universities.

IN context with the theme of this workshop, perhaps it may assist as an introduction to give some background to my personal experience of the growth of China's poultry industry. Commencing in March 1982 and continuously to present, my close involvement occurred first through designing and then implementing the development of national infrastructure scientific facilities in three regions of China through to 1992. From then, I have been a Project Leader for ACIAR in a collaborative research project aimed at the better control of several major infectious diseases of poultry in China. The objectives of this project have included the establishment of a scientific liaison and cooperation system amongst poultry health institutions representing seven separate provinces across China.

* CSIRO, Division of Animal Health, 11 Park Drive, Parkville, Victoria 3052, Australia.

The apparent sophistication of these development activities might appear somewhat removed from this first workshop which is being held to explore Vietnam's needs in animal production research. Any differences will be illusionary however and rather a function of time and the development route(s) taken, or not. Development needs careful and gradual application to achieve an improvement in the welfare of people. Amongst the most important moments in evolving a development strategy for a country therefore are those spent in planning the strategic approaches. This Hue workshop should be such a point in time for Vietnam!

Objectives of This Paper

Of the three main objectives, the first will be to outline the factors that have accelerated the development of China's poultry production over the last decade. The second will be to try to delineate some

of the practical constraints for continuing strong growth which are becoming apparent now as operational, educational, training, and resource limitations. These particularly apply to the modern highly-intensive production systems which have been established close to cities throughout China. The third objective will be to try to distil from my experience of the development of poultry industries in Asia, suggestions as to how Vietnam might choose the most beneficial direction(s) to increase its poultry production during the next 5–10 years.

China's Poultry Production: Then and Now

The first priority of any country's Government must be to ensure that its people can be fed—with China having 25% of the world's people but only 7% of the arable land, agricultural development was (and still is) critical. China's planning authorities determined within their 7th Five Year Development Plan (1980–85) that amongst the modernisations to be undertaken, the poultry industry was to receive priority in the agriculture sector (Hu 1990). The prime purpose of selecting poultry production (eggs and meat) was to be able to provide people with high-quality animal-origin protein, while requiring only limited amounts of land-space located primarily close to cities and their markets.

From the early 1980s, provincial governments have been encouraged to collaborate with 'foreign partners' either as joint venture partners or franchises for poultry breeding, production and feed milling. Special emphasis has been given to making suitable land and services available to such enterprises. Priority was also accorded to making subsidised grain stocks available for feeding animals, especially poultry.

Within the last 10–15 years, all of the 26 provinces and 3 municipalities (that is, the city-provinces of Beijing, Shanghai and Tianjin), have established large modern intensive poultry industries, often operated by Municipal Governments in conjunction with overseas companies as partners. Commercial arrangements and franchises have also provided access to imported grandparent poultry breeding stocks, equipment for feeding and watering, caging and egg-collection, as well as for slaughtering and processing of broiler meat. Further, through extensive feedmill development, China has become one of the world's largest compounders of animal feed, especially for pigs and poultry, and in 1993 produced more than 45 million t (an increase of 10 million t over 3 years!). Grains account for 75% of the raw materials used in poultry feed in China, compared with an average of 60% worldwide (in contrast, small farms largely use self-produced grain to feed their poultry and pigs).

China has moved to become the world's largest producer of both eggs and poultry meat, showing production increases of 10% or more each year (Table 1).

Further, and as can be seen from Table 2, the per capita consumption of animal-origin protein in the diet has increased from 19.5 kg in 1984 (27% of poultry origin) to a total of 42.2 kg (36% poultry origin) in 1993 (Huang and Simons 1995).

It should not be overlooked that animal-origin protein is the most readily assimilated and effective form of protein for the growth and maintenance of the human body, and that health and welfare benefit from dietary intakes of animal-origin protein.

In China, poultry production is occurring at four levels, these being:

- village production—scattered chickens
- specialised households—200–2000 hens
- state-operated production sites—10 000–100 000 hens
- very large intensive production sites—up to 500 000 hens or several million broilers p.a.

A most notable feature of Chinese poultry production is that some 40% of the chickens, ducks and eggs produced are currently grown within the first two categories, that is, rural-based production systems.

Table 1. Production for some Asian countries, chicken and poultry meat and eggs.

	Chicken meat ('000 t)		Poultry meat ('000 t)		Eggs ($\times 10^6$)	
	1991	1993	1991	1993	1991	1993
China	2126	3570	3463	5100	132 800	180 000
Thailand	620	720	717	807	2320	8200
Australia	388	519	416	551	3339	2842
Malaysia	348	568	352	606	4500	6034
Vietnam	135	130	168	178	1900	2274

Source: Watt Poultry Yearbook International 1992 and 1994.

Table 2. Poultry production and consumption (kg per capita) 1984 and 1993.

	Pork	Beef and mutton	Poultry meat	Eggs
1984	13.02	1.24	1.35	3.91
1993	24.03	3.12	4.93	10.14

Source: Huang and Simons, 1995.

Recent demographic statistics for the Chinese poultry industry by Huang and Simons (1995) would indicate that some 800 million (Huang and Simons 1995) people are now directly involved at least part-time in poultry production. The vast majority of these people will be rural inhabitants as some 70% of the Chinese population are still based outside the cities.

It is the dramatic increase in the numbers of chickens grown in categories 3 and 4 however, that has so multiplied the amounts of poultry meat produced. The use of compound (milled) grain-based feeds are necessary for such production systems because of the imperative for rapid growth in body size, or high egg production by the poultry breeds used. Further, the expenses inherent in maintaining highly intensive operations and for producing against guaranteed market conditions, have tended to fuel a drive to export poultry meat from China. The aim is to gain foreign hard-currency, always an attraction to a developing country.

Since 1991, and starting with a negligible export base, China has now moved to be in very strong competition with Thailand as a major supplier of poultry meat to Japan. Approximately 100 000 t of chicken meat were shipped to Japan by China during 1994.

Constraints to High Rates of Growth Continuing

Economic losses during production

Successful large-scale poultry production systems must have adequate technology, and be able to control these during production, in the fields of feed, housing, breeds, markets, product access and, most importantly in China's case, adequate poultry health (Bagust 1994). Intense poultry production systems need to control infectious diseases. There are some ten major viral poultry pathogens (disease-causing micro-organisms) as well as another five serious bacterial pathogens recognised, all of which occur widely in the intensive commercial poultry operations throughout Southeast Asia (Ideris 1993) and East Asia (China, and also Vietnam). Infectious diseases initiated by immunodepressive pathogens and complex mixtures of viral, bacterial and even fungal pathogens are commonplace in the absence of adequate control measures being applied. Good management of site hygiene and quarantine, vaccination, and parental-based eradication, where possible, are necessary to control disease and hence production.

Data from poultry industries throughout the world (Biggs 1982) show us that economic losses in the highly developed intensive USA and European industries are some three times more from sub-optimal production than are those from the obvious mortalities; and that the scale of economic loss is some one-third of the gross (farm-gate) value of production. In China's intensive poultry industry, serious disease losses occur due to major diseases such as infectious bursal disease, Marek's Disease, infectious bronchitis and Newcastle disease (see Bagust 1995). Many sites must therefore operate uneconomically for some of the time because of disease losses. Over-dependence on vaccination and lack of systematic attention being given to diagnosing, controlling and preferably preventing infectious disease closely reflects a lack of sufficient systematic training and development of expertise amongst the veterinarians and specialist institutions servicing the poultry industry in many developing countries in Asia (see Daniels et al. 1993) including China.

Housing, husbandry and staff training needs

The director of the Harbin Veterinary Research Institute and a poultry disease research expert in his own right, Professor Xu Yiwei, recently noted the following concerns (see boxed table).

Institutional networking and extension to farmers

China has numerous national and provincial universities and institutions that undertake research and related studies in poultry health. Until the last few years, there has been little tendency for institutions working in related fields to cooperate (other than on a person-to-person favour basis), and to compete directly with one another either as institutions or individuals. Widespread duplication of results, poor techniques and waste of resources has therefore been occurring. Only in the last few years or so has awareness begun to increase of the value in cooperation and ' networking' to share information on laboratory

Poultry Industry and Disease Control in China

- Intensive and smaller scale farming of chickens have been increasing simultaneously—40% of production is still from village based enterprises.
- Farm design and housing, feed quality and management techniques are still of poor quality on many farms, as is hygiene.
- Skill levels of staff on poultry farms is low.
- Higher costs and lower economic returns are now occurring.
- Inadequate Government disease control systems for poultry.

BUT

- Poultry disease research is developing rapidly.
- Research is closely integrated with poultry production practices.
- Exposure to international poultry research and technology is increasing.
- Cooperation between research institutes, extension services, quarantine bureaux, vaccine manufacturers and poultry farmers is contributing to research which provides economic as well as academic benefits.

Keynote Address, Prof Xu Yiwei, Director, Harbin Veterinary Research Institute. China Poultry Health Network Meeting, December 1994.

procedures and technology advances, to share specimens and results and to work collaboratively when clear mutual benefit can be gained.

In a similar move from their previous tendencies to separation and relative isolation, research institutions in animal production and health are now becoming far more involved in working closely with the farmers and poultry producers via Extension and Training Courses. China has now embarked (1994–2000) on a very significant program of strengthening its infrastructure for agricultural extension, training and education of provincial and district veterinary and animal production services with the assistance of a major program being funded through the World Bank.

Feed resources and export market concerns

For China to increase its poultry meat consumption per capita by a further 1 kg would require in the order of 3 billion kg (i.e. 3 million t) of grain-based feed. Already the competition for its limited arable land areas between grains grown for animal consumption and grains being grown for human consumption is heavy, and recently China has had to move to importing wheat just in order to make up for weather-damaged and poor crops. It is therefore doubtful as to whether China can, or will be able to greatly increase poultry numbers, as in the past, using low-price, Government-subsidised, wheat supplies.

While the scale and rate of expansion of poultry production by China up until now has been unsurpassed on a world scale, it should be remembered that expansions of poultry industries have been an historical inevitability in economically-developing countries in Asia, for example, Japan* (1950s–70s), Taiwan* and South Korea* (1960s–80s), India, Pakistan and Sri Lanka (1970s–90s), Thailand, Malaysia and China (1980s and 90s). In the earlier-developed countries (*), economic diversification over time has seen their industries mature, plateau and now decline as, through market forces and free trade, cheaper poultry products can be imported from those countries whose younger industries are still in active growth phases.

These countries are now most actively seeking export outlets for their surplus poultry production, that is Thailand, Malaysia and China. Inevitably however, head-on competition will occur between Asian countries with poultry surpluses, and once-profitable export markets will decline as supply exceeds demand. Further, intense competition can be expected from the highly developed poultry industries of North America and Europe. The Netherlands, for example, are currently 500% (!) self-sufficient in poultry production, and seeks access to markets world-wide including the Middle East and Asia.

Lessons from Case-study

From this case study of China's development of its poultry industry from 1983, several valuable lessons can be distilled. Vietnam's present stage of development of its poultry production capability would appear to closely parallel that of China around 1980.

- Government policies for promoting the development of an agricultural sub-sector or industry can begin to take effect within 5 years and the results be strongly apparent within 10 years.
- Increasing agricultural production has been firmly maintained as a plank of China's modernisation, and China can now feed some 25% of the world's people—a huge and unsurpassed

achievement. Increasing its poultry production capability has been an important sub-sectoral activity which is providing full or part employment and income generation to some 800 million people, as well as enriching the diet of the entire population.

- Positive effects of developing intensive poultry industries in China accrue through diet improvement, employment and upgrading of technology. There are also significant negative aspects including heavy utilisation of feed resources, a much increased need to control disease and the need to develop markets (local and export) to absorb production. In the context of the present workshop, it must be argued that overseas companies with technology for intensive poultry production should not be discouraged to operate in Vietnam, but neither should they be encouraged by the diversion of scarce resources to them. Rather, should they choose to enter, they should operate so as to make a profit that will justify the capital they have invested and have at risk.
- Local government health services should then aim to be sufficiently competent to assist such enterprises on a fee-for-service basis, but Vietnam's educational and extension resources should largely be devoted to the furthering of medium-intensity rural-based production systems rather than be diverted elsewhere.
- China has successfully retained strong elements of diversity in its poultry production through having some 40% of poultry production coming from their village-level and specialised households, which operate successfully at medium intensity. As well as chickens and ducks, China is now actively encouraging diversification of rural poultry production into turkeys, pigeons, quail and geese.
- Such rapid development of the highly-intensive sector of poultry production in China in recent years has tended to run ahead of the capabilities of personnel, veterinarians and poultry health institutions to adequately diagnose, control and prevent significant economic losses from infectious poultry diseases. These difficulties, as well as the need for more positive efforts in management and husbandry extension, are now being addressed as a priority.

Development philosophy

Vietnam's planners must soon determine whether the direction of the majority of the future development of their poultry production is to be largely internally driven by positive policy action, or to be passively pulled by local market forces and some overseas-based companies (production, breeding stocks, feed milling).

In consideration of the outcomes from this China-case-study, the best policy option for Vietnam would seem to be the ' middle road' of poultry production, that is predominantly rural-based production at medium intensity by small-holder families. Government facilitation can be through actively supporting production and health extension, micro-finance schemes for smallholders and facilitating access to markets in cities for their poultry products. Larger-scale intensive production should therefore chiefly be left by government, to be undertaken by wealthy local interests and/or overseas-based business corporations.

Acknowledgments

My professional colleagues in poultry health and production in China and Australia are gratefully thanked, and especially Professor Xu Yiwei and staff of the Harbin VRI. AusAID (previously AIDAB) and ACIAR are acknowledged for their positive involvement of my teams in official development assistance projects in China, as is ACIAR's financial support for travel to this workshop.

References

Bagust, T.J. 1994. Improving health for poultry production in Asia: A developmental perspective. Avian Pathology, 23, 395–404.

——1995. Poultry health networking in China. Poultry International, 34, 50–56.

Biggs, P.M. 1982. The world of poultry disease. Avian Pathology, 11, 281–300.

Daniels, P.W., Holden, S., Lewin, E. and Dadi, S. 1993. Livestock services for smallholders—a critical evaluation. Proceedings of a seminar. Yogyakarta Indonesia 10–15 Nov. 1992. AIRSRDF, Bogor, Indonesia, 377 pp.

Hu H-P. 1990. Aspects of poultry health in China. World's Poultry Science Journal, 46, 58–69.

Huang, S.B. and Simons, P.M. 1995. Rapid expansion in China. Poultry International, 34, 34–38.

Ideris, A. 1993. Poultry diseases in the Asia-Pacific region. Proceedings Xth International Congress of World Veterinary Poultry Association, Sydney, pp. 41–46.

Watt Poultry Yearbook International 1992 and 1994.

Breeds and Feed Components in the Cost Structure of Meat-line and Egg-line Chickens

Lo A Cau*

Abstract

General experience in commercial poultry enterprises has shown that the cost structure of these varies, depending on the time of year of production, management and flock size. Cost structures of two of the principle products of the poultry industry in Vietnam are:

At the present time, vaccination and sanitation are applied carefully, so there are very few disease outbreaks. In recent years some good experience in management and feeding has been gained. In addition, poultry housing and equipment have been given increasing attention. However, breeders and feed comprise a high percentage of the total cost, therefore, to improve the economics it is necessary to focus on these components.

Since the liberation of South Vietnam, some breeds such as Hubbard Comet and Cobb have become less popular. New breeds such as the Leghorn, Plymouth, Hybro were imported and since 1990 there has been a flow of importation of many breeds, resulting in the introduction of two to three exotic breeds each year. The current breeds of chicken are as follows:

- Egg-line breeds: Brown Nick, Isa Brown, Hi-line, Goldline 54 and Loghman Brown.
- Meat-line breeds: Arbor Acres (AA), Cobb, Hubbard and Avian BE88.

To select from so many breeds is a problem for farmers. Universities and research centres could well cooperate with farms to derive exact data on poultry performance, so that sound advice can be given on the importation of poultry breeds.

Progress has been made on the suitable processing of feed and establishment of adequate rations. However, prices of feed ingredients still fluctuate and are high. The government should establish plans to grow poultry feed crops such as soybean and maizewhich are currently very expensive. The high cost of feed results in high cost of poultry meat and hinders its exportation. Further studies focussing on the areas of breeding stock and feedstuffs are a priority.

	Cost structure/ table eggs	Cost structure/ day-old broilers
Feed	70–75%	60–65%
Breeders	18–20%	20–25%
Medication	1.5–2.0%	3.5–4.0%
Electricity, water, consumables	1.0–1.2%	2.0–3.0%
House depreciation	1.2–1.5%	1.5–2.0%
Deaths		4.0–5.0%
Labour	1.5–2.0%	2.5–3.0%
Other costs (operation costs, interest, tax)	1.0–2.0%	1.0–2.0%

* Viet-Thai Poultry International Co Ltd, 43 Province Road, Hoc Mau, Ho-Chi-Minh City, Vietnam.

Economic Efficiency of Duck-raising in the Mekong River Delta

Nguyen The Binh*

Abstract

The Mekong River Delta (MRD) is the main region where ducks are raised. Each year, within the MRD are sown 2.5 million ha of rice, thousands of ha of upland crops and valuable food crops. The MRD has in addition about 50 000 ha of canals, 30 000 ha of water surface used in agricultural pursuits and over 700 km of seashore. These provide a large potential for duck-raising development.

Many economic issues regarding duck-raising of the MRD need to be studied, assessed and summarised to help exploit the potential of duck-raising in the MRD. Since 1991, a project entitled 'The main economic issues for duck raising development in the Mekong River delta' has been studied by the Sub-National Institute of Agricultural Planning and Projection.

Results from the study have indicated the economic efficiency of duck-raising, determined the possibilities of duck-raising development and proposed solutions to increase duck-raising development in the MRD region.

THE duck (*Anas platyrhynchos*) a traditional animal of Vietnam, is raised for meat, eggs and feathers. Duck products are not only extensively consumed in the home, but are also exported abroad in many forms in order to raise foreign currency.

The Mekong River Delta (MRD) has 2.5 million ha sown annually for rice and thousands of ha of upland crops and valuable food crops. The delta also has about 50 000 ha of canals, with 30 000 ha of water surface used in agricultural pursuits and over 700 km of seashore. These are advantageous for duck-raising development. If regional resources of climate, soil, water surface, food and labour in the MRD are used for duck-raising, benefits for national economic development, in general, and farmer household economic development, in particular, will occur.

There are very large demands for duck-raising development in Vietnam, especially in the MRD. Many economic issues in duck-raising need to be summarised, assessed and studied in more detail to allow fuller exploitation of the duck-raising potential of the Delta.

* Sub-National Institute of Agricultural Planning and Projection, Ho-Chi-Minh City, Vietnam.

Since 1991, a project entitled 'The main economic issues for duck-raising development in the Mekong River Delta' has been studied by the Sub-National Institute of Agricultural Planning and Projection, Ho-Chi-Minh City (HCMC) as part of a more general program on agricultural development of the MRD.

Objectives of the Study

The study's objectives are:

- to analyse and assess the real situation of duck-raising in the MRD;
- to determine economic efficiency of duck-raising and factors which affect it; and
- to study the possibilities for duck-raising development and inputs needed to increase it the MRD.

Methods of Study

In the conduct of the study, the following methods have been used:

- dialectic materialism;
- data collection and analysis;
- practical survey and typical model study;
- advice of experts; and
- comparison and forecast.

Results of Study

The following results are presented to emphasise economic efficiency aspects of duck-raising in the MRD:

Productivity of duck breeds

Animal productivity is an indicator that mainly depends on breed characteristics and management conditions. Productivity is one factor that effects economic efficiency in duck-raising. Table 1 reports productivity in four management systems.

Production costs

Production costs of duck products is an indicator which varies with the season and depends on breeds, conditions of management and time-frame. Survey results collected in 1993, showed:

- Production costs of 1 kg meat from local ducks averaged 4970–5340 VND, for Cherry Valley Super-Meat ducks (CV Super-M ducks) average 4570–5150 VND (where ducks are released on rice fields) and 6480–6736 VND (where ducks are enclosed on state farms). Of total production

Table 1. Productivity of duck breeds and capital using efficiency in the Mekong River Delta.

Forms of duck-raising	Products	Duck breeds	Average productivity	Benefit/ cost ratio
Ducks raised in rice fields	Meat	Local duck	1.2–1.4 kg/head	1.3–1.4
		Hybrid duck	1.6–1.7 kg/head	1.5–1.6
	Eggs	Local duck	170–200 eggs/yr	1.6–1.7
		Hybrid duck	110–160 eggs/yr	1.5–1.6
Ducks raised on canals	Eggs	Local duck	180–200 eggs/yr	1.4–1.5
		Hybrid duck	120–160 eggs/yr	1.3–1.4
Ducks raised on the tidal seashore	Eggs	Local duck	180–200 eggs/yr	1.6–1.7
Ducks raised on settlement lands	Meat and egg	Hybrid duck	1.6–1.7 kg/head	1.8–2.0
			1.7–1.8 kg/head	2.0–2.2

Table 2. Average labour productivity in duck-raising by farmer households in the Mekong River Delta.

Products		Can Tho	Minh Hai	Tien Giang	Tra Vinh	Vinh Long	Average
Meat	Man days/100 duck	16.7	20.9	22.3	22.6	20.0	20.9
	Number of duck raised by one labourer (3 months)	600	500	450	450	450	500
	Duck meat in LW (kg) per labourer (3 months)	900	750	670	670	680	750
Eggs	Man days/100 duck	261	181	171	180	–	173
	Number of laying duck raised by 1 labourer (1 year)	210	200	200	200	–	200
	Eggs produced by 1 labourer (1 year)	3400	3450	3400	3400	–	3400

LW: liveweight.

costs, the percentage of food costs is about 51.54–52.72% for local ducks on rice fields, about 70.64–74.02% for CV Super-M ducks on state farms and 56.35–62.30% for CV Super-M ducks released on rice fields.

- Production costs of 10 eggs for local ducks released on rice fields averaged 3800–4000 VND and for CV Super-M ducks enclosed on private breeding farms they were 2415–2620 VND. As a percentage of total production costs, food costs were 63.34–67.44% for local ducks and 70.50–73.65% for CV Super-M duck raised on private breeding farms.

Labour productivity in duck-raising

The results collected from the surveys showed a difference between labour productivity of duck-raising in farmer household areas and in the state farms. In general, labour productivity of duck-raising in the MRD is still dependent on many factors. Table 2 records labour productivity from six locations in the MRD region.

In the state farms where duck-raising is practised, work regimes have been designed to contract and pay the workers on productivity, rate of loss and amount of food consumed. Some data collected from them have shown that where ducks have been kept on ponds and supplied with adequate food, one labourer can raise 800–1000 head of duck for meat or 400–500 head of duck for eggs.

Income and profit

Income concept represents both quantity and quality of the last product, and size and efficiency of production costs to generate that product. Our results collected from the survey conducted in 1993 (Table 3) show that the amount of income and profit from duck-raising in the MRD are affected by location and season.

In addition to the above indicators, the project will analyse production costs and economic efficiency of frozen processed duck meat for export. In general, because of high raw material and labour costs, total production costs are high and the rate of profit achieved averages only 10–12%.

Table 3. Income and profit of ducks for meat and egg production in farmer households in the Mekong River Delta.

	Can Tho	Minh Hai	Tien Giang	Tra Vinh	Vinh Long	Average
For 100 head of meat duck						
• production costs in VND of 1 kg of duck meat (liveweight)	4970	5450	5540	5280	5890	5430
• Sale price in VND of 1 kg duck meat (liveweight)	7060	7520	7400	8250	7720	7600
Gross income (1000 VND)						
• for 100 head of duck	465.8	480.4	521.7	625.8	521.9	523.1
• for 1 man-day	27.4	22.8	23.4	27.7	23.7	25.0
• for 100 days of material costs	0.89	0.90	0.91	1.20	0.81	0.94
Profit						
• for 100 head of duck (1000 VND)	359.2	332.9	362.2	466.2	367.7	377.2
• rate of profit (%)	57.2	48.8	49.4	68.4	47.6	54.3
For 100 head of laying duck						
• production costs, 10 eggs (VND)	3800	3800	4000	3900	–	3900
• sale price, 10 eggs (VND)	5820	5960	6100	6170	–	6012
Gross income (1000 VND)						
• for 100 head of laying duck	6513.7	7461.9	6918.0	7286.5	–	7033.7
• for 1 man-day	40.4	40.9	40.5	40.4	–	40.5
• for 100 days of material cost	0.98	1.01	0.99	1.04	–	1.0
Profit						
• for 100 head of laying duck (1000 VND)	4905.1	5596.0	5202.4	5486.5	–	5297.5
• rate of profit (%)	59.5	61.3	59.8	62.4	–	60.7

The project also analysed and compared production costs of duck-raising compared to other animal raising during the same length of time and survey location. It showed that the rate of profit in duck-raising with high productivity breeds is about 62.5%, with local duck breeds about 30.8%, industrially raised chickens about 30.7% and pigs raised in households about 28.7%. Although the study has not yet covered all possible comparisons and situations of each species, the results did show that profit from duck-raising is not less than that from raising other animals. Furthermore, this study showed that raising high productivity ducks was profitable and more economically efficient than rearing other animals .

Discussion and Conclusion

- Studies of the duck-raising process in Vietnam in general and in the Mekong River Delta in particular show that development in duck-raising is affected by recent innovations in agricultural management, government policy and application of high productivity duck breeds along with new technology. All of these as well as the input and output price and consumption markets are significant factors in this development.
- Using the indicators of economic efficiency in duck-raising, the study has shown that there is profit for duck breeders and that the amount of profit seems greater in farmer household areas than in the state farms. However, the economic efficiency in duck-raising is still affected by many factors, especially output price and consumption market factors. Thus a high level of stability and equality have not yet been attained. Of total production costs, food and breed costs still form a high percentage with a large difference between exotic duck breeds and local duck breeds in purchase costs.
- If the market for duck product consumption is improved, income from duck-raising will not be less than income from other animal raising, and duck-raising is seen to be a subsector that can improve income for breeders, thus contributing to change in the agricultural economic structure by promoting diversification and sustainability. Likewise as a social factor, duck-raising can contribute in generating jobs for labourers whether at the active or inactive stage of life.

Studies on Performance of CV Super-M Duck Breed in the Southern Provinces of Vietnam

Duong Xuan Tuyen and Nguyen Cong Quoc*

Abstract

Cherry Valley Super-Meat (CV Super-M) grandparent (GP) stock (male line and female line) which were imported from England in 1990 and 1991 are reared for selection and multiplication at Vigova Duck Breeding Farm, Ho-Chi-Minh City (HCMC). In the years 1991–5, many thousands of parent stock ducks were transferred to farmers in HCMC and other southern provinces.

Following three generations of selection at Vigova Duck Farm, performance of GP stock is being studied, as are parent stock (PS) and commercial ducks at private farms. The results of studies so far have generally shown improvement in weight gain, feed conversion and carcase quality, higher egg weights and fertility and good performance under commercial conditions.

Now CV Super-M ducks are located in all provinces of the Mekong Delta and exhibit good performance, returning high profit to farmers.

In the southern provinces of Vietnam, especially in the Mekong Delta, conditions for duck rearing are very suitable. There are many ponds, rivers and rice fields supplying natural feed (small fish, crab, shrimp, snail) for ducks. Moreover, duck meat is as popular in human diets as other meats. Duck flocks in this region comprise 60–65% of the total duck population of Vietnam.

In recent years, meat-type ducks in the South have been developed both in quantity and quality. The local breeds, Co ducks, have a slaughtering body weight of only 1.2–1.4 kg. Some exotic duck breeds (Pekin, Cherry Valley) have been imported from Hungary and Czechoslovakia. They have higher body weight and better carcase quality than locals, but are now considered to be inbred in large-scale production units.

In 1990 and 1991, under the UNDP/FAO/VIE 86–007 Project, The Centre for Animal Husbandry Research and Technology Transfer in HCMC imported from the Cherry Valley Company in England, the meat type CV Super-M duck breed (GP stock). Since then they have been reared for selection and multiplication at Vigova Duck Breeding Farm to produce parent stock for farmers in the southern provinces. Reports show that this breed is superior to any another duck breed in weight gain, feed conversion and carcase quality.

* The Centre for Animal Husbandry Research and Technology Transfer Vigova Duck Breeding Farm, To 40 F 17, Govap District, Ho-Chi-Minh City, Vietnam.

Materials and Methods

Study materials

- CV Super-M Grandparent Stock (GPS) imported form England (1st generation) and generations reproduced at Vigova Duck Breeding Farm (second and third generations).
- CV Super-M Parent Stock (PS) reared at Vigova Duck Breeding Farm and at three other private farms.
- CV Super-M Commercial ducks reared intensively (experiments at Vigova Duck Farm) and extensively (run on rice fields by farmers).

Methods of maintenance and multiplication of CV Super-M duck breed in the southern provinces

In 1991 the system for maintenance and multiplication of the breed was established. In this system Vigova Duck Breeding Farm has a duty to select and maintain GPS (male line and female line) and to produce PS for farmers. The other 30 private farms are keeping PS to produce commercial ducks.

Study observations

Reproductive traits of GPS, PS and performance of commercial ducks (weight gain, feed conversion, survival rate, carcase quality) were measured and recorded.

Results and discussion

Grandparent Stock (GPS)

Female body weight before lay

Table 1 sets out information on body weight at defined ages of females fed on restricted feeding regimes.

The body weight of females was controlled by restricted feeding to ensure good egg production later. The body weights obtained are close to the Cherry Valley Standards. The coefficient of variation (CV) was found to be below 10% indicating a high uniformity of this trait.

Egg productivity

Table 2 sets out data on egg productivity and laying rates through three generations. It should be noted that the male line (ML) and female line (FL) have been selected for two different purposes, the former for weight gain and carcase quality and the latter for reproductivity. Through 3 generations of selection, high egg production of FL has been stable at a range of 181.1–184.8 eggs.

Table 1. Female body weight reared on restricted feeding.

	Subjects	Body weight	
		Mean ± SE (g)	CV (%)
ML	G1	3015.6 ± 19.80	7.20
	G2	2918.6 ± 30.50	6.94
	G3	3135.1 ± 21.92	8.27
Cherry Valley		3198.0	
FL	G1	2578.2 ± 9.80	
	G2	2679.5 ± 23.32	7.29
	G3	2672.5 ± 13.28	6.90
Cherry Valley		2743.0	6.85

Male line (ML) 25 weeks, Female line (FL) , 23 weeks of age; G: Generation; CV: Coefficient of variation.

Table 2. Egg productivity and average laying rate through three generations.

		ML			FL		
		G1	G2	G3	G1	G2	G3
Laying Period	(weeks)	40	40	40	40	40	40
Egg Yield	(n)	169.2	169.0	158.90	184.80	181.10	182.00
Average Laying rate	(%)	60.43	60.40	56.80	66.00	64.68	65.02

ML: Male line; FL: Female line; G: Generation.

Egg weight

Egg weight data are recorded in Table 3. Egg weight of ML was found to be significantly higher than that of FL ($p<0.001$) but it should be noted that the egg weight remained stable in both cases through three generations.

Fertility and hatchability

Data on fertility rate and hatching rate of fertile eggs is presented in Table 4.

Fertility of both lines is high, but it is considered that more attention should be paid to the ML, which has been selected for fast liveweight gain. With regard to hatchability the results were obtained with hatching cabinets designed by Vigova Duck Breeding Farm. It is further considered that this index could be improved by the use of modern hatching machines.

Parent Stock (PS)

Performance of CV Super-M PS

A number of productive characteristics of PS in two different environments are recorded in Table 5. These indicate quite good fertility and hatchability and the fact that egg production of CV Super-M Parent Stock is much higher than that of other meat-type breeds imported to Vietnam before.

CV Super-M Commercial ducks

Table 6 records meat productivity of commercial ducks under intensive rearing conditions. The weight gain, feed conversion and carcase yield results are superior to those recorded of other commercial breeds of ducks reared in Vietnam.

Extension results in 1991–1995

Data obtained from some observations made under large-scale commercial conditions are shown in Table 7.

Table 3. Egg weight.

	ML			FL		
	G1	G2	G3	G1	G2	G3
Egg number (n)	770	384	540	2622	551	540
Egg weight ± SE (g)	82.41± 0.52	81.79± 0.36	81.80± 0.22	80.54± 0.14	80.0± 0.25	79.5± 0.20
CV (%)	9.76	8.63	6.20	8.90	7.54	5.90

ML: Male line; FL: Female line; G: Generation; CV: Coefficient of variation.

Table 4. Fertility rate and hatching rate of fertile eggs.

	ML			FL		
	G1	G2	G3	G1	G2	G3
Egg number (n)	4853	6054	5720	759	8494	9351
Fertility rate (%)	92.45	95.04	89.20	93.06	94.81	93.40
Hatching rate (%)	67.07	77.23	70.5	72.87	81.75	76.3

ML: Male line; FL: Female line; G: Generation.

Table 5. Some productive characters of parent stock.

		Vigova Duck Farm (n = 300 layers)	Three PS private farms[a] (n = 1590 layers)
Age at 1st egg	(weeks)	26.7	26.4
Female LW at beginning of lay	(g)	2717.2 ± 20.4	2700.0–2800.0
CV	(%)	6.66	7.1–8.50
Egg production /40 wk-laying		200.20	188.6–202.0
Average laying rate	(%)	71.50	67.3–72.10
Egg weight	(g)	79.68 ± 0.40	81.4–83.30
CV	(%)	8.89	7.8–9.20
Fertility rate	(%)	93.40	88.0–92.0
Hatching rate/fertile egg	(%)	81.96	67.3–78.50

[a]CV: Super-M Parent Stock reared at three other private farms.
LW: liveweight.
CV: coefficient of variation.

Table 6. Meat productivity of commercial ducks (intensive rearing experiments).

		Results
Slaughtering body weight at 56 days of age	(g)	3388.7± 23.0
CV	(%)	6.76
Feed conversion (kg/kg LWG)		
— to 49 days		2.59
— to 56 days		2.91
Survival rate to 56 days	(%)	98.00
Eviscerated carcase percentage	(%)	79.36
Thigh + breast (including skin)	(%)	31.10

CV: coefficient of variation.
LWG: liveweight gain.

Results show that the CV Super-M duck breed is quite suitable for farmers to rear not only intensively but extensively by running them on rice fields. In the extensive system the cost of production of duck meat is quite low and thus more profitable to the farmers.

Table 7. Some results of large-scale production in the region.

1000–10 000 layer PS farms (private) (n)	30
PS layers (n)	100 000
Commercial day-olds/year (n)	12 000 000–14 000 000
Survival rate (%)	90.0
LW after 75 days-running on rice fields (kg)	2.8–3.1
Feed conversion of supplemental feed (kg/kg LWG)	1.50

LW: liveweight
LWG: liveweight gain

Conclusion

The results of the study show that CV Super-M ducks imported from England have been adapted well to Vietnamese conditions. Performance of this breed is high and superior to that of any meat type duck breeds in Vietnam.

Now CV Super-M ducks occur in all provinces of the Mekong Delta and produce well, giving high profits to farmers.

Growth and Meat Performance of CV Super-M Ducks under Two Management Systems in the Red River Delta

Luong Tat Nho, Hoang Van Tieu, Dang Thi Dung, Le Xuan Tho, Doan Van Xuan and Nguyen Duc Trong*

Abstract

A meat-type duck strain, Cherry Valley Super Meat (CV Super-M), which was imported from the U.K. in 1990 under a UNDP funded project VIE/86/007 was tested for growth and meat performance under two management systems in the Red River Delta (RRD), intensive and semi-intensive. The test groups consisted of grandparent stock, parent stock and commercial ducks fed on local feedstuffs.

CV Super-M ducks showed high livability with no significant differences in livability at eight weeks of age between male line, female line and parent stock. There were significant differences among the three lines for body weight. Liveweight of broiler ducks was 2841 g at 56 days of age for intensive management but only 2708 g at 63 days of age for semi-intensive management. Feed consumption per kg liveweight gain (LWG) was higher for the intensive group than for the semi-intensive.

Broiler carcases were characterised by higher carcase yield, higher breast muscle, leg and thigh muscle content and lower abdominal and skin and subcutaneous fat than other duck breeds reared in the region.

The results indicated that CV Super-M ducks reared in the Red River Delta on local feedstuffs showed high livability and normal growth. Commercial ducks conformed to normal physiological status and yielded high meat productivity and quality under both rearing conditions, intensive and semi-intensive management.

CV SUPER-M is a high producing meat-duck strain which has been widely reared around the world. Ducks were imported from the United Kingdom in 1990 under a UNDP funded project, VIE/86/007. The objectives of the study were:

- to investigate the growth of CV Super-M ducks under intensive management using local feedstuffs of the RRD; and
- to determine meat performance of CV Super-M ducks under both intensive and semi-intensive management systems in the RRD.

Materials and Methods

The CV Super-M duck group used in the study consisted of 693 grandparent (GP) ducks and 729 parent stock (PS) ducks imported from the U.K. and 400 PS ducks and 1767 commercial ducks born in Vietnam.

Ducks were fed on local feedstuffs and managed as defined in the Management Husbandry guide from the Cherry Valley Farms Ltd, U.K. (undated a. and b.) Nutrient levels for broiler ducks were used as suggested by Dean (1985).

Growth of ducks and meat performance were determined using common methods.

Results and Discussion

Growth

CV Super-M ducks reared in the RRD showed a high rate (93.55–97.79%) of livability under both management systems as can be seen in Table 1. There were no significant differences among three lines (male line, female line and parent stock) for livability in the first eight weeks of life (Table 1).

Ducks showed body weight (Table 2) within a normal range at all stages measured though there were significant differences among three lines for body weight. Body weights of female ducks at point

* National Institute of Animal Husbandry, Chem, Tu Liem, Hanoi, Vietnam.

Table 1. Livability of CV Super-M duck under rearing conditions in the Red River Delta.

Rearing conditions		Number (n)	Livability: Mean ± SE (%)	
			Growers	Developers
Intensive	Male line	136	97.79 ± 1.26	94.10 ± 2.01
	Female line	557	96.59 ± 0,76	95.69 ± 0.84
	Parent	729	97.12 ± 0.62	93.55 ± 0.91
	Commercial	100	97.00 ± 1.71	
Extensive	Parent	400	97.25 ± 0.82	96.27 ± 0.43
	Commercial	1667	97.18 ± 0.41	

Table 2. Body weight of ducks by age.

Weeks of age	Male line		Female line		Parent stock	
	Mean ± SE) (g)	Standard duck*	Mean ± SE (g)	Standard duck*	Mean ± SE (g)	Standard duck[a]
4	1055 ± 10	1007	886 ± 5.6	886	1041 ± 14	950
5	1393 ± 13	1389	1028 ± 6.1	1222	1364 ± 13	1300
6	1822 ± 45	1829	1566 ± 8.2	1609	1758 ± 14	1700
7	2140 ± 18	2024	1845 ± 7.5	1781	2094 ± 19	1900
8	2298 ± 16	2220	1999 ± 6.7	1954	2273 ± 23	2100
10	2390 ± 18	2380	2168 ± 6.0	2095	2289 ± 18	2225
12	2560 ± 17	2541	2204 ± 5.0	2236	2298 ± 19	2400
14	2602 ± 36	1702	2250 ± 10.0	2378	2311 ± 22	2600
16	2650 ± 23	2864	2360 ± 9.0	2520	2325 ± 19	2700
18	2685 ± 35	2921	2500 ± 12.0	2571	2409 ± 16	2750
20	2730 ± 35	3002	2606 ± 14.1	2642	2406 ± 30	2800
22	2890 ± 30	3082	2653 ± 18.1	2712	2552 ± 20	2875
24	3094 ± 33	3163	2681 ± 19.0	2784	2793 ± 20	2925
26	3186 ± 42	3232			2883 ± 17	2975
28	3218 ± 43	3300				

Source: Cherry Valley Farms Ltd, U.K.

[a] Target body weight for ducks as requirement of the breed.

of lay were 3218 g, 2681 g and 2883 g for male line, female line and parent stock respectively and these were significantly different.

Meat performance

Body weight of broiler ducks and feed consumption under rearing conditions in the RRD are shown in Table 3.

Body weights of broilers were significantly different under two conditions of management at all ages measured. Broiler liveweights were 2841 g at 56 days of age for intensive management and 2708 g at 63 days of age for semi-intensive management. Feed consumption per kg body weight gain were 2.77 kg for intensive management and 1.98 kg for semi-intensive management. Feed consumption per kg body weight gain were significantly different between two rearing systems.

Carcase yield and carcase composition of these ducks are shown in Table 4.

The carcase and breast muscle yields were higher in all groups in the intensive management system at the same time as being lower in abdominal fat as well as in skin and sub-cutaneous fat. The former and

Table 3. Body weight and feed consumption of broiler ducks by age.

Age (weeks)	Intensive management			Semi-intensive management		
	n	Liveweight ± SE (g)	Feed consumption /kg LWG (kg)	n	Liveweight ± SE (g)	Feed consumption /kg LWG (kg)
1/7	100	47.53 ± 0.11		100	47.91 ± 0.16	
4	99	1118 ± 19	2.64	98	745 ± 48	2.53
8	97	2841 ± 32	2.77	96	1998 ± 44	2.11
9				96	2708 ± 33	1.98

LWG: Liveweight gain.

Table 4. Carcase yield and carcase composition of ducks.

		Intensive management			Semi-intensive management		
		Female	Male	Overall	Female	Male	Overall
Ducks slaughtered	n	10	10	20	6	6	12
Liveweight	g	2895	2980	2938	2691	2732	2712
Carcase yield	%	74.05	73.59	73.82	70.29	67.78	69.02
Breast muscle yield	%	15.39	15.50	15.44	12.26	11.02	11.75
Leg and thigh muscle	%	11.80	12.45	12.11	12.32	12.42	12.37
Abdominal fat	%	1.77	1.47	1.65	2.32	2.21	2.39
Skin and subcutaneous fat	%	21.12	20.51	20.37	28.20	27.03	27.67

other muscle percentages were much higher than those observed in other duck breeds reared in the region and this was generally true under both management systems tested in the RRD region.

Conclusion

The results showed that CV Super-M ducks reared in the RRD on local feedstuffs exhibit high livability and normal growth. Broiler ducks of the breed also showed normal physiological status and gave high yields of quality meat under both rearing conditions tested—both intensive and semi-intensive.

References

Cherry Valley Farms (undated a.). CV Parent Version 2. Cherry Valley Farms Ltd, Rothwell, Lincoln, LN7 6 BR, U.K.

Cherry Valley Farms (undated b.). Grandparent program for the Food & Agricultural Organisation of the United Nations, Hanoi, Vietnam. (Management and Husbandry Guide) Copyright—Cherry Valley Farms Ltd, Rothwell, Lincoln, LN7 6 BR, U.K.

Dean, W.F. 1985. Nutrient Requirement of meat type ducks. In: Farrell D.C. and Stapleton P., ed. Duck Production Science and World Practice. University of New England. pp. 31–57.

By-products from Food Industries: Processing and Utilisation for Animal Feed in Vietnam

Le Van Lien, Nguyen Thien and Le Viet Ly*

Abstract

By-products from certain food industries are not fully utilised for animal feed and also cause some environmental pollution. This study reports work on production processes for blood meal, bone meal and silage made from shrimp heads or animal blood and shows that these three animal meals can be produced by the use of coal and sun energy. Molasses was able to preserve animal blood or shrimp heads by anaerobic fermentation in an ensiling process which could have on-farm application.

Analysis of these products confirmed high protein levels in blood and shrimp-head meals and high calcium and phosphorous content of bone meals.

The nutritional value of these products was compared with a traditional protein source, fish meal, by assaying growth responses in pigs, chickens and ducks. From the results, the amount of these feedstuffs that could be used to replace fish meal was calculated. It was concluded that 3–5% of the processed meals can be used in pig and poultry diets.

WHEN animals are slaughtered, as much as 45% of their body weight is made up of inedible materials. Likewise, at the aquatic product processing enterprises, the quantity of by-product is considerable and it can be processed to yield animal feed of high protein content. The advantages of processing such offal are:

- it earns income from by-products;
- it helps ensure sanitary cleanliness of food factories and their environment; and
- it creates valuable resources in the form of livestock feed and thus indirectly increases the amount of meat produced in the country.

In Vietnam, food industry by-products are not yet fully utilised for animal feed, resulting in waste and pollution to the environment, while lack of quality feed supplies is a major constraint to increasing livestock production in our country.

In this study the availability of food industry by-products, its processing and utilisation for animal husbandry in Vietnamese conditions were investigated.

* National Institute of Animal Husbandry, Thuy Phuong, Tu Liem, Hanoi, Vietnam.

Availability of Food Industry By-products

Vietnam has 26 operational meat plants and 153 aquatic product processing factories which, respectively, are licensed to slaughter and process meat and aquatic product for export (Table 1).

These plants are mostly owned by the commercial trading agencies of the provincial or central government. With the decrease in demand for export pork meat, all abattoirs are significantly underutilised, with utilisation in 1991 and 1992 being less than 20% of the possible.

The animal by-products in Table 1 are mostly produced by small-scale private butchers and retailers. Aquatic by-products are mainly shrimp heads, waste-products of export factories producing frozen

Table 1. Availability of by-products from food industries in Vietnam.

By-products	Number of factories	Amount of by-products (t)
Animal by-products	26	495 000
Shrimp heads	153	46 496
Molasses	12	33 333

shrimp. Molasses is a by-product of the sugarcane processing industry and can be used as an energy resource for animal feeding.

Food Industry By-product Processing as Supplemental Feed for Livestock and Poultry

Blood Meal

A small scale blood meal manufacture was carried out to produce blood meal for an animal feeding trial. The steps in its production were boiling, pressing, drying and milling as shown in Figure 1.

The purpose of boiling is:

- sterilisation of material making it safe for use as feed;
- partial removal of the moisture which is squeezed out during shrinkage; and
- separation of fat—fat is removed for economic and keeping quality reasons.

An alternative step is to treat fresh blood with lime. Treatment with lime is a very simple and efficient way of saving blood, and it is strongly recommended where blood-drying equipment is not available. It is produced by adding 1% by weight of unslaked lime or 3% slaked lime to the blood. This converts it into a black, rubber-like mass which can be kept fresh for up to a week.

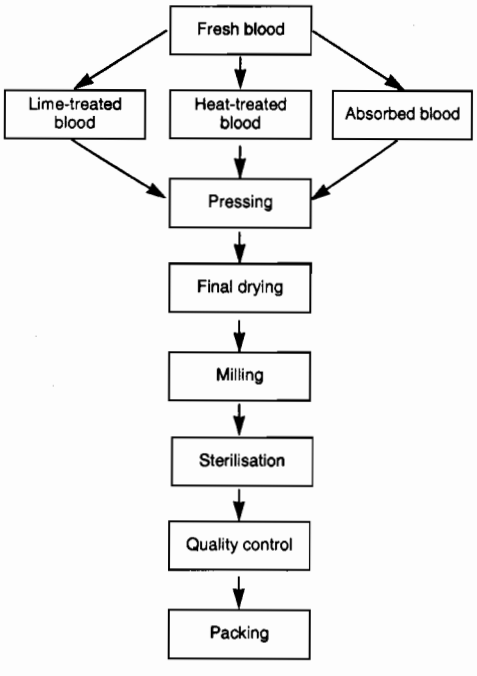


Figure 1. Steps in production of blood meal for stock feed.

A further alternative is for sun-dried ruminal contents or shrimp heads to be used as absorbents for blood. In this case 1.5 kg of blood is mixed with 1 kg of ruminal contents. It is possible to collect and mix blood with the absorbent before it starts coagulating. It is better to mix two components over a polythene sheet; this prevents the blood from seeping into the cement floor.

Both the lime-treated and absorbed blood meal must be sterilised before use, as with fresh blood.

Bone meal

Due to its richness in calcium and phosphorous, bone is a very important raw material for growth of livestock.

Table bones are those which have been used for cooking and are available from hotels and restaurants. These table bones were collected and processed for use as livestock mineral feed supplements. The process consisted of 'digestion' by burning or cooking at high pressure or treatment by coal energy (Figure 2). It took about 8–10 hours for the burning method, 2 hours for cooking under pressure and 6–8 hours for treatment by coal energy. Depending on the method of 'digestion', the end-products are respectively, bone ash, steamed bone meal and bone meal.

Silage Made of Shrimp Heads or Animal Blood and Molasses

Ensiling is the preservation of materials for feed by fermentation in the presence of lactic acid bacteria. To prepare this particular silage, the materials used were as follows:

Shrimp heads, animal blood, molasses (15–20%), common salt (3–5%), and starter culture (lactic acid bacteria). Containers used for ensiling were clay pots, plastic cans, cement tanks or nylon sheets.

Ensiling technology is simply the mixing of raw materials and their storage under anaerobic conditions for the conservation of animal and shrimp waste to produce a protein-rich feed in the most economic manner. In our studies the pH observations were used as indicators of the course of fermentation. The value of pH decreased up to 3.8–4.5 for blood silage on the 3rd day and 5.00–5.20 for shrimp silage on the 7th day. Under rural conditions ensiling could perhaps become the best technology to follow for preservation of animal and fish wastes.

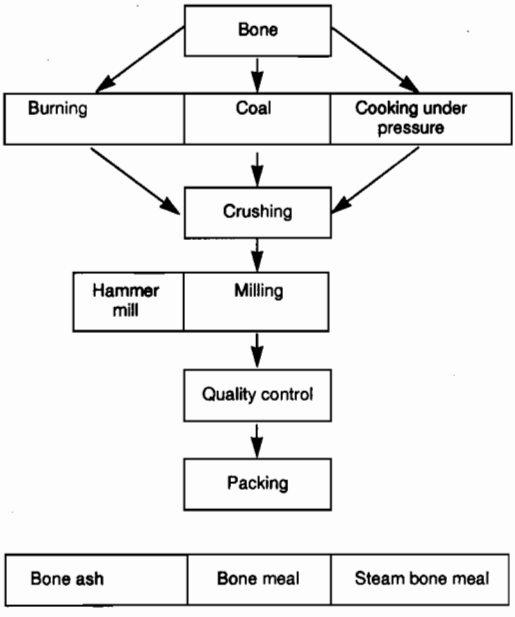


Figure 2. Processing of bone for animal feed.

Quality of Final Products

The final product should seek to have a low fat and moisture content, a high protein percentage, good keeping qualities, and a pleasant odour.

Products prepared by these various methods were subjected to analysis of some of the nutrients and other characteristics as can be seen in Table 2. The results confirmed the high protein level of blood and shrimp-head meals (85–35%) and the high calcium and phosphorous content of the bone meals. (Ca: 25.6–42.29%; P: 9.93–16.79%).

The pH of the silages were 3.8–5.2 indicating that the fermentation process was already taking place.

Feeding Trial with Livestock and Poultry

The nutritional value of each processed product described above was compared with a traditional protein feed source (fish meal) by assaying the growth responses in pigs, chickens and ducks. From the results obtained, it was concluded that the percentage of 'new' feed that could be used in the diets of both pigs and poultry is at the level given in Table 3.

The absorbed blood meal was used to replace 50% of the fish meal in the pig diet and 75% in the laying hen and growing duck diets. The heat-treated blood meal replaced up to 100% in the diets for pigs and 50% in chicken diets.

It was concluded that silage made of shrimp head, animal blood and molasses can be successfully used in cereal-based diets at levels up to 5% of the diet dry matter, replacing fish meal.

Table 2. Quality of processed products.

Products	Moisture (%)	Protein (%)	Ca (%)	P (%)	Colour	Aroma	pH
Heat-treated blood meal	8.0	85.3	0.73	0.26	bloody	stench	
Absorbed-blood meal	10.6	44.7	4.60	2.15			
Lime-treated blood meal	–	82.3	–	–			
Bone meal	8.6	20.3	25.60	9.93			
Steam bone meal (126°: 1.4A)	9.6	13.9	25.84	13.13			
Bone ash	–	–	42.29	16.79			
Shrimp-head meal	9.0	35.0	9.50	2.50	dark red	pleasant	3.80–4.50
Blood silage	72.4	17.8	–	–			
Shrimp-head silage	67.3	9.7	1.33	1.33	light red	pleasant	5.00–5.20

Table 3. Replacement effects of some animal by-product meals and silage.

Supplemental feed	Pigs		Growing chicken		Laying hen		Growing duck	
	% in diet (DM)	Replaced protein (%)	% in diet (DM)	Replaced protein (%)	% in diet (DM)	Replaced protein (%)	% in diet (DM)	Replaced protein (%)
Absorbed blood	5.0	50.0	2.5	25.0	7.5	75.0		75.0
Heat-treated blood meal	3.0–5.0	100.0	3.0	50.0	3.0	50.0		
Shrimp-head meal			5.0	62.0				
Shrimp-head/blood / molasses silage (5:3:2)	5.0	50.0						
Shrimp molasses silage							30.0 (Wet)	

DM: dry matter.

Conclusions

- Bone meal, blood meal and shrimp-head meal can be produced as animal feedstuffs by the use of coal and sun energy.
- Molasses can be used to help preserve the shrimp heads or animal blood for a long time by the method of anaerobic fermentation. This ensiling method is simple and effective in preserving under-utilised feed resources such as shrimp heads and blood and uses a local resource (molasses) as the additive.
- 3–5% of blood meal, bone meal and shrimp-head meal can be used in pig and poultry diets.

Aflatoxin in Animal Feeds and its Influence on Poultry Production in Vietnam

Duong Thanh Liem and Le Anh Phung*

Abstract

New methods of agriculture have resulted in the production of crop products with characteristics that may favour the presence of mycotoxins, which are capable of causing severe mortality rates in poultry. Some examples are recorded.

Experiments to guard against aflatoxicosis have centred on reduced use of feedstuffs known to be susceptible to high levels (peanut cake and corn), farming and processing methods to keep grain dry through the harvesting and storing processes and chemical treatment of affected grain to reduce the level of toxin if already present.

Recommendations are made to give effect to the three directions of these findings to allay the problem.

THE intensification of agriculture has caused problems that have not occurred in traditional systems. Among these problems is mycotoxication which occurs in poultry. The factors that cause this disorder include:

- the increasing number of crops which have forced farmers to use short-term varieties which have to be harvested during the rainy season when drying is very difficult;
- use of high yield variety grains which have high moisture content and take a long time to dry;
- in large-scale production, grains are preserved in large amounts so that fungal growth is easier; and
- use of high yielding commercial breeds of poultry which are very susceptible to aflatoxin intoxication.

Observations on Aflatoxication in Poultry

Aflatoxin in animal feed samples

Aflatoxin levels in some animal feed samples in Vietnam are reported in Table 1.

In these data aflatoxin content was highest in peanut cake followed by maize grain. The level was highest in maize harvested in rainy seasons compared with that harvested in dry weather. Rice and its sub-products showed a low content as did the protein cakes.

Table 1. Aflatoxin content in some animal feed samples.

Feeds	n	Average (ppb)	Maximum (ppb)
Maize grain	25	205	600
Broken rice	2	22	25
Soybean grain	1	50	50
Rice bran	3	29	55
Sesame oil cake	3	8	10
Coconut oil cake	7	17	50
Soybean oil cake	4	12	50
Peanut oil cake	29	1200	5000
Dry cassava flour	1	40	40

Source: Tran Van An 1992.

Observation of aflatoxin intoxication in poultry

A summary of recent outbreaks of aflatoxicoses in poultry is shown in Table 2 and demonstrates that very heavy losses are possible.

* University of Agriculture and Forestry, Thu Duc, Ho-Chi-Minh City, Vietnam.

Table 2. Observation of aflatoxin intoxication in poultry production.

Year	Farm	Loss
1983	Phuoc Long duck farm	2000 ducks
1991	Binh An chicken farm	50 000 eggs
1992	Duck farm for meat	20 000 ducklings

The first outbreak appeared in the exotic Cherry Valley Super-Meat (CV Super-M) duck breed fed on prepared concentrate. When the manager changed the rations to traditional feeds based on rice, duck health improved and production rose again.

The second was in breeding chickens when the embryonic mortality of eggs reached 80%. The intoxication was attributed to the use of peanut cake feeding.

The third occurred in exotic CV Super-M duck fed concentrate containing toxic maize. This intoxication killed more than 20 000 ducklings.

Pathology of aflatoxin poisoning

In all cases of aflatoxin poisoning, the common lesion is pathological damage to the liver of poultry. The lesion is variable, depending on the degree and duration of poisoning. General signs are a bright yellow liver and inflammation of the gall bladder. Later , hepatic swelling, bile duct hyperplasia and small spots on the surface of the liver occur, and sometimes there are necrotic foci. Finally, fatty changes in the liver are seen.

There is evidence that in aflatoxicosis, the immune response to Newcastle disease is significantly depressed, resulting in low haemagglutinin inhibition (HI) titres. Table 3 sets out results obtained in experimental intoxication of chickens in Northern Vietnam (Nguyen Nhu Vien 1990).

The results show that in aflatoxin-affected chickens the liver was hyperplasic and heavier, but the gland of Fabricius and the thymus gland were smaller and degenerated, resulting in low HI titre immune response to Newcastle vaccination.

Prevention of aflatoxin intoxication

The obvious method is to avoid the use of feeds that may be carrying high aflatoxin levels. Duong Than Liem (1993) measured the effect on egg incubation of substituting peanut cake with soya bean cake with the results shown in Table 4. He further studied the effect of limited-term substitution of peanut cake on egg incubation on a breeding farm with the results shown in Table 5. It can be noted that the change of feed improved the hatchability but that it took a long period of 1–2 months to make real progress.

Table 3. Effects of aflatoxin on the weight of the liver, Fabricius gland and thymus gland; on the HI titre in immune response of Leghorn chicken to Newcastle disease.

	Control	Experiment (aflatoxin toxicity)	P
Sample size (n)	20	20	
Body weight at the end (g)	223	112	< 0.01
Liver weight (g)	11.2	19.0	< 0.01
Fabricius weight (g)	1.2	0.6	< 0.01
Thymus weight (g)	2.5	1.1	< 0.01
HI titre (Newcastle)	1/264	1/38	< 0.01

Table 4. Effects of the substitution of peanut cake by soya bean cake on egg incubation.

Treatments	Incubated eggs	Embryonic egg ratio (%)	Lethal embryonic ratio (%)	Hatchability (%)
Peanut cake	3591	91.1	84.5	5.9
Soya bean cake	3391	95.2	34.7	56.4

Table 5. Effects of the substitution of peanut cake by soya bean cake on egg incubation in breeding farm.

Periods	Number of eggs	Hatchability(%)
Initial period of peanut feeding (3 months)	100 000	63.6
Final period of peanut feeding (3 months)	39 135	16.0
Initial period of soya bean substitution (2 months)	18 119	30.6
Final period of soya bean substitution (3 months)	48 669	80.4

The conclusion from this work is that the safest way to guard against aflatoxicosis is to avoid the use of maize and peanut meal in duck feeding where the diet is based on rice. It is interesting to note that consequent to the 1983 and 1992 outbreaks mentioned in Table 2, these farmers no longer use maize and peanut products in duck diets, which have been changed to rice-based diets.

Pre-treatment to eliminate aflatoxin in poultry feed

Efforts to eliminate aflatoxin from poultry feed have been made using a pre-treatment with ammonia. Table 6 describes data from Duong Than Liem and Le Anh Phung (1994) who attempted this pre-treatment as well as a substitution with soya-bean cake. The following treatments were applied:

Control diet with 15% peanut cake (2000 ppb aflatoxin); lot 1, diet with peanut cake pre-treated with ammonia; and lot 2, diet with soya bean cake.

The results showed that growth was greatly increased and mortality reduced by pre-treatment of peanut cake in the CV Super-M ducks.

A further study (Table 7) on breeding laying hens reported by these authors compared the effect of pre-treatment on the quality of chicken eggs. The treatments were similar and the results showed that the pre-treatment improved the fertility and hatchability of the eggs.

Conclusion

It is considered that poultry are very sensitive to aflatoxication in Vietnam and that three steps should be taken to allay this problem:

- use feeds with low content of aflatoxin such as rice and soya bean and do not use feeds easily intoxicated such as peanut and maize. Maize especially should not be used for duck feeding.
- it is necessary to improve on-farm post-harvesting activities to prevent crop products being toxic to poultry in the first place; and
- intoxicated feeds can be made useable for poultry when they are pre-treated.

Table 6. Effect of pre-treatment of peanut cake on CV Super-M duck.

Variable	Control	Lot 1	Lot 2
Liveweight of 8 week ducks (g)	2292	2671	2904
Feed conversion	3.5	3.1	2.8
mortality (%)	36.7	0	0

Source: Duong Thanh Liem and Le Anh Phung. 1994

Table 7. Effect of pre-treatment of peanut cake on quality of chicken eggs.

Ratio (%)	Control	Lot 1	Lot 2
Embryonic egg ratio	76.9	86.2	89.2
Hatchability	69.2	73.8	83.1

Source: Duong Thanh Liem and Le Anh Phung 1994.

References

Duong Thanh Liem. 1993. Effects of aflatoxin infested groundnut meal on reproduction of Isa-brown laying hen (in Vietnamese). Report at the Animal Science Workshop. Ministry of Agriculture and Food Industry. Ho Chi Minh City.

Duong Thanh Liem and Le Anh Phung. 1994. Effects of aflatoxin detoxicated groundnut meal on the production of super meat duck (in Vietnamese). Animal Science Workshop. Department of Agriculture of Ho-Chi-Minh City.

Nguyen Nhu Vien. 1990. Summary of PhD thesis on Aflatoxin (in Vietnamese). Hanoi.

Tran Van An. 1992. Report of Aflatoxin B1 level in agricultural commodities of South Vietnam (in Vietnamese). Food and Commodities Control Center.

Short Papers—Systems, Economics and Management

Action and Consequence: Sensible Economics for Rational Researchers

John Perkins*

Abstract

Most research-based recommendations are not adopted by smallholder farmers. The paper looks at some economic explanations. It is argued that inadequate definitions of profit and profitability can be a common cause. Most economic evaluations of research recommendations are limited only to the new or changed enterprises and ignore the effects of introduction upon the other components of the farming system. It is suggested that farmers judge new enterprises by their total effect on farm profitability. This can be estimated from additional income earned plus costs saved through making changes less new costs incurred plus income foregone from quitting some current activities. Secondly, it is further suggested that family labour must be valued within budgets to properly reflect the cost of redeploying the family's resources in new activities.

IT is a matter of concern to those involved in international agricultural research that most of their recommendations are not adopted by the intended clients —smallholder farming families. There are a number of pre-conditions that will boost the level of adoption including the following:

- that farmers be aware of the recommendations;
- that these are feasible, understandable and achievable;
- that they offer substantial improvements over current practices; and
- that they boost total income and welfare.

Yet, despite the fact that researchers might demonstrate the recommendations to be both technically sound and profitable, levels of adoption are usually insignificant.

The paper concentrates on aspects of change and profitability. It presents two linked points, acknowledging that many other factors will come into play in local situations. The first is that the usual definitions of 'profit' do not reflect how farmers judge profitability within the total farm. The second recommends a critical re-evaluation of the role of family labour on smallholder farms, particularly in regard to a priori assessments of profitability.

* Faculty of Agriculture Forestry and Horticulture, The University of Melbourne, Parkville, Victoria 3052, Australia.

Profitable Change

Before starting, a brief comment on the words 'profit' or 'profitability' as used here. In its broadest sense profit is usually interpreted as the margin remaining after deducting costs from income. Economists and managers are rarely happy with such a loose definition and prefer different terms for different circumstances, for example, net income, gross margin. Accountants seek even more precise words as there are implications for tax and other purposes, which will vary from country to country. These preferences are acknowledged but, for convenience, this paper reverts to the wider, simpler definition of profit, that is, income less costs.

Most research outcomes are not evaluated in economic and financial terms as the emphasis is primarily on technical issues. Some that move to the recommendation or extension phases are evaluated (most are not) and these usually consider only the income and costs directly associated with the new or changed circumstances—new income less associated costs of production equals 'profit'. This approach views the change as a single stand-alone enterprise (example 1):

PROFIT

Definition #1

Income	(Cash)
less	
Costs	(Cash)
equals	
Profit	

Example 1: First definition of profit.

Such an evaluation is a very necessary first step. After all, if estimated income is not greater than estimated costs the recommendation is most unlikely to prosper! At this stage there are two obvious omissions. These are non-cash items on both sides of the ledger which are very important. A rice farmer may sell half of his new rice crop for cash and consume the other half. He will judge the value of the crop by its total benefit so the consumed (non-cash) portion must enter the equation. Equally, any non-cash inputs, for example, animal manure used as fertilizer, should also be included as it is a cost even though its use did not require a cash expenditure. The first definition can be easily amended to incorporate these items (example 2):

PROFIT

Definition #2

Income	(Cash and non-cash)
less	
Costs	(Cash and non-cash)
equals	
Profit	

Example 2: Second definition of profit.

Now comes the application part of the process. A change is assessed as profitable by the researchers but farmers don't adopt it. Why not—where's the flaw? One possible explanation is a different perspective of the farming process. Consider Figure 1a below.

It represents the components of a farming system. Each wedge in the 'pie' represents a different enterprise on a farm, for example, rice, peanuts, pigs, etc. It is easy to suggest that the farm adds a new and profitable enterprise to those already in place—expand the size of the pie sufficient to slide in a new

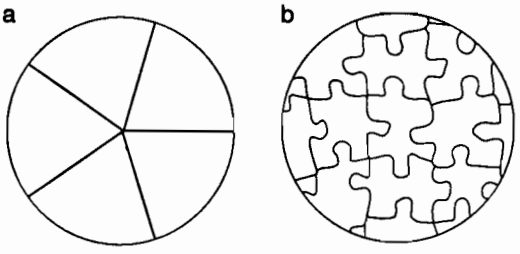


Figure 1. (a) Component enterprises of a smallholder farm. (b) Component enterprises of a smallholder farm—alternative view.

wedge and total farm profit will increase. For smallholder farmers, of course, this is not easy. The major resources of the farm, e.g. land, are extremely limited and credit may be impossible to raise. It is more likely that the farm must remain unchanged in total size (land, labour, capital) and that something must go out in order that the new enterprise, or changes, can be accommodated.

The farmer is more likely to consider the components of the farm as represented in Figure 1b.

Smallholder farms are already diverse, to reduce risk, and tightly enmeshed in an existing pattern of production. Introducing change requires that the pattern be rearranged. Change in one component will cause some change in most other relationships. Some things will be brought into the system, some will remain, others must be removed. On the income side of the ledger this will comprise new income earned plus costs saved through making changes; similarly, costs will include new costs incurred plus income foregone from moving out of some current activities. Both cash and non-cash items should be included, leading to a further redefinition of the profit from change:

PROFIT

Definition #3

Income	(New income earned plus old costs 'saved')
less	
Costs	(New costs incurred plus old income 'lost')
equals	
Profit	(Total benefit of change)

Example 3: Third definition of profit.

This indicates that the overall profitability of change is determined by comparing total profit before making a change to total profit earned after making a change. If total farm profit increases there is a greater chance that the recommendation will be adopted. And that increase in total profit has to be fairly substantial! Researchers are accustomed to testing the significance of very small levels of difference but, for farmers, a hypothetical five percent increase is not worth the risk. They look at levels of twenty or thirty percent increase before deciding to take the plunge.

It is not easy to convert theory to practice. A recommendation may be judged profitable but which other enterprises will be affected if the change is introduced on a farm? A researcher should approach this quandary in exactly the same spirit as the original work. Test it but, this time, test it on farms with farmers and seek their opinions—the classical Farming Systems Research approach.

Family Labour on Smallholder Farms

This issue links back to the second definition of profit, that is, the inclusion of non-cash items when preparing hypothetical budgets for smallholder farming systems. By definition, smallholder farms are small in size and have limited resources of all types yet they are also characterised by labour-rich farming practices. Labour is the most fluid and potent resource available to farmers who are short of land and capital. Typically it will be used wherever the greatest returns are earned—some combination which includes working on the farm; on other peoples' farms; in the non-agricultural sector; and for domestic and social needs. Benjamin White (1981) expressed the point well and it is worth repeating his summary, 'Each family survives on a basis of extreme "occupational multiplicity" and a highly flexible division of labour among family members.'

He was describing farming families in Indonesia but the points apply with equal power to Vietnam and elsewhere. Farmers know their labour has value. Economists call it 'opportunity cost': the cost of choosing to do something is the benefit lost from not doing something else. Farm families will try to maximise the returns to their limited resources of family labour. Explicitly or implicitly they rank available alternatives in terms of the return for days of labour invested, then choose to use as many days as possible in the most 'profitable' activity with the balance going into the next most profitable activity and so on.

Many researchers, extension staff, planners and economists still fail to recognise these internalised valuations of family labour. It is a common and erroneous assumption that smallholder farms contain substantial pools of underutilised labour. The family does not pay itself for its own time thus it is assumed to be a 'free' good. Most recommendations require a more specific and demanding use of labour resources (plus more demanding management) and assume that sufficient labour is automatically available. Changes to the feeding systems for large ruminants is a good example. Many smallholders invest substantial amounts of time in providing bare maintenance rations of cut-and-carry fodder. Researchers might suggest that better quality forages or the treatment of low quality residues will speed the growth of cattle and buffalo. The recommendations appear straightforward but, for the farmer, many additional hours will have to be invested in selecting better forage material or applying urea treatments to rice straw. Time costs money and if the return is uncertain the time will not be provided. The cash costs of a recommendation can be identified with relative ease but if the non-cash costs are ignored, the assessment will become skewed. A hypothetical budget is given in Example 4:

Calf-rearing enterprise

Buy calf; rear for two years; sell

	Cash ($)	Labour (days)
Buy calf	100	–
Veterinary expenses	80	–
Collect cut-and-carry feed	–	100
Sell calf	$400	
'Profit'	**$220**	

Example 4: Hypothetical calf-rearing enterprise.

The example suggests that the smallholder will earn a profit of $220 on the new enterprise and, in cash-only terms, this is correct. However, the family labour input has been ignored. If a value of $2/day had been placed in the budget (because the farmer could earn $2/day as a labourer in that district) the profit margin suddenly drops to $20 and the whole enterprise looks a lot less attractive.

To redeploy labour it must be 'worth' the family's time to commit themselves to a new or altered enterprise. Often a new technology does not meet the criteria required by smallholder farmers. It may be 'profitable' in that direct income is less than direct costs but these returns, however judged, may be less profitable or less attractive than continuing with

current practices. Farmers do not express concepts such as 'opportunity cost' or the 'internalised value of labour' but the astute researcher will commonly hear a phrase such as, 'We can't afford to hire someone for that work.' If it does not pay a labourer's wages, then perhaps it does not meet the family's needs either.

Conclusion

From these examples it can be clearly seen that sensible economics requires a shift away from simple definitions of profit and profitability. Recognition must be given to all components of the farm's system with labour being particularly important in the profit equation and ultimately, in the adoption of new technology by smallholder farmers.

Reference

White, B. 1981. Population, Involution and Employment. In Hansen, G.E. ed. Agricultural and Rural Development in Indonesia, Boulder, Colorado, Westview Press, pp. 130–146.

Buffalo Rearing in a Northern Mountainous Village, Vietnam

Mai Van Sanh*, Nguyen Duc Thac*, Dao Lan Nhi* and R.J. Petheram†

Abstract

Binh Son village was selected as a research site, to represent the Northern Mountainous agro-ecological zone of Vietnam, which contains 70% of the country's buffalo population. Data were gathered by rapid rural appraisal (RRA) methods.

The land comprised annual cropping land and gardens, perennial crop land (tea), and hill grazing areas; the average land area available was 1.1 ha per family. Most arable land (66%) was used for rice and the rest for maize, sweet potato, cassava, groundnuts and beans. Almost all farmers kept chickens and pigs, while 94% kept buffalo, primarily for draught purposes, but also as a manure source.

Cattle grazed hillsides during the day and were fed rice straw and other crop residues at night. Rice straw was stored by all rearers and fed in the drier season (winter). Some farmers fed rice bran or cassava or sweet potato tubers at special times. Farmers said herd size had not increased in recent years, because of lack of feed. Mating occurred during grazing. Male to female ratio was favourable, but bulls available were very small and fertility overall was poor.

Draught buffalo worked about 109 days/year, usually as singles with heaviest work periods in September–May. Body weights were low with no difference between sexes of the same age. The value of buffalo increased with age, reflecting draught capability of older buffalo.

Some recommendations are made for trials of introduced forages and other possible improvements in rearing methods.

THE three million buffalo in Vietnam are reared almost exclusively on smallholder farms. The main population (>70%) of these swamp buffalo is in the northern part of the country, with the highest densities occurring in the Northern Mountainous agroecological zone.

The study aimed to describe the essential features of the buffalo rearing system as efficiently as possible over a short study period of a few weeks. The intention was to develop rapid methods, and experience, in data collection for application in describing livestock systems in other areas, as a first stage of a farming systems research and development process.

* National Institute of Animal Husbandry, Thuy Phuong, Tu Liem, Hanoi, Vietnam.

† Victorian College of Agriculture and Horticulture, Longerenong Campus, RMB 3000, Horsham, Victoria 3400, Australia.

Procedure and Methods

The research procedure initially involved the selection of a research site, and then the adoption of RRA methods designed to collect essential information related to buffalo rearing at the site. The main criteria used in the selection of a research site (village) were:

- representativeness of land of the Northern Mountainous Region;
- reasonable accessibility, within three hours drive, to the research centre of the National Institute of Animal Husbandry (NIAH);
- medium to high density buffalo population;
- reasonable cooperation from local authorities; and
- minimal influence from nearby towns or cities.

Following the selection of a research village, the site description phase was planned. Most of the methods used could be termed RRA (Carruthers and Chambers 1981). These included walks by groups of scientists through the village with local farmers and

Cooperative members, farmer interviews, informal discussions with groups and observations of farmers' animals.

The data gathered were of five main types:

- secondary data provided from Commune Cooperative statistics;
- secondary data from other sources (e.g. climatic data)
- from interviews with 395 buffalo rearers;
- from group interviews with Commune Cooperative members; and
- from measurements and observations of 495 head of buffalo.

Results

General description of the site; land areas and human population

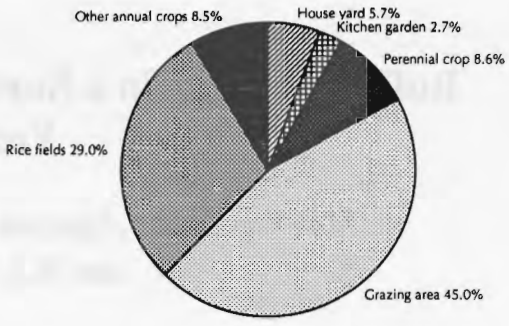
Implementation of the above criteria led to the selection of the research site of the village, Binh Son, which is about 100 km north-east of Hanoi in the Pho Ten district. It is in the mountainous province of Bac Thai at an average altitude of 500 m above sea level. There are about 180 600 buffalo in this province but only 21 800 cattle and the annual growth rate of the buffalo population is about 3.6% (Provincial Agricultural Department Statistics, 1994).

Binh Son village comprises 21 hamlets with six agricultural cooperatives, voluntary organisations established by farmers to assist in agricultural production. The land area of Binh Son is 1608 ha and the Kong River flows through the village. The population in 1994 was 6495 in 1394 households, giving an average family size of 4.7 and an average land area of about 1.15 ha per household or 2475 m^2 per capita. Much of the land, however, is hilly and only the valley floors are suited to cultivation of annual crops. In the sample of rearers surveyed, the average area of land operated per household was 0.37 ha for crop fields and 0.23 ha for gardens, with high variation between families. The soil is sandy and acid. Tea is grown on some slopes and there are large areas of 'natural' grazing. The proportions of the main land-use types are summarised in Figure 1.

There are five ethnic groups in Binh Son: the Kinh (4351 inhabitants, 67% of the total population), the Xandiu (1295), the Tay (651), the Nung (131) and the Muong (67) people.

Climate

The climate is strongly monsoonal, although the winter temperatures are lower than the average for this latitude. It is generally hot and humid in summer and cool in winter, with a wide range. The average temperature in winter is 12.9°C and in summer 32.8°C. The average annual rainfall is around



Source: Binh Son Cooperative Statistics

Figure 1. Percentages of different land-use types in Binh Son, 1994.

2168 mm. The hot season is also the wet season and the winter is the dry season.

Main crops and the cropping calendar

Most of the arable land in Binh Son (66%) is used for rice and the rest is cropped with maize, sweet potatoes, cassava, groundnuts and beans. Two thirds of the rice field area can be cropped twice per year and the other third is used for rice in summer and maize or sweet potatoes in winter. Approximate yields are said to be 4 t for rice, 2.4 t for maize and 4 t for sweet potatoes and also cassava. A planting calendar for some major crops is shown in Figure 3.

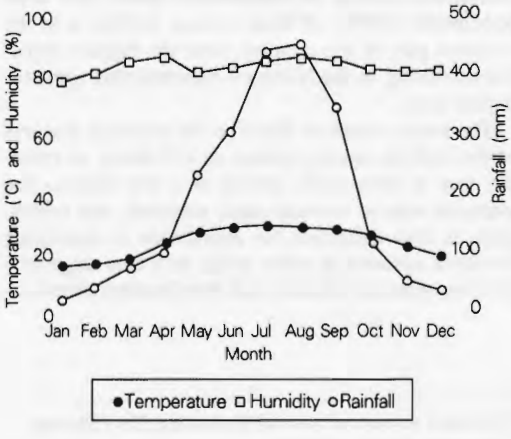
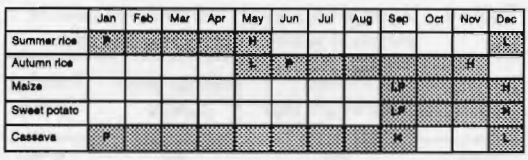


Figure 2. Average monthly rainfall, temperature and relative humidity in Binh Son.



P = planting, H = harvesting. L = land preparation.

Figure 3. Cropping calendar for some crops in Binh Son.

Table 1. Livestock numbers in Binh Son, 1994.

	n	Average head/household
Chickens	47 890	30
Pigs	2019	1.5
Buffalo	1951	1.4
Cattle	4	

Source: Village office statistics, 1994.

Livestock

Almost all farmers in Binh Son kept chickens, pigs and buffalo and very few kept cattle. The numbers of livestock in the village are shown in Table 1.

The buffalo rearing system

Buffalo were reared by 94.5% of families in Binh Son. As shown, the average ownership was 1.4 head. Most families (65%) had only one buffalo, while 29% had two, 4% of families had three and 2% had four buffalo. Buffalo were kept mainly for draught power, but also for supplying manure and as a long-term investment. There is no strong tradition of rearing calves for sale for slaughter, although many animals are sold for draught at about 24 months of age.

The average price of a buffalo at 24 months was $US120, which is very high in relation to farmers' annual income of about $US413 and their average land area of about one hectare.

The rearing system is based mainly on grazing the buffalo on unimproved hilly areas during the day (after working), and feeding rice straw and some other crop residues in the pen at night. The animals were herded mainly by children (84%) after school and by old people (13%).

Buffalo herd structure

The sex and age structure of buffalo in the sample are shown in Table 2. There is a marked decline in the number of animals after two years of age, which results from sales of stock as draught animals.

Table 2. Structure of the buffalo herd in Binh Son, 1994.

Age (months)	Number	Percentage	Sex	
			Male	Female
0–12	79	14.2	42	37
13–24	70	12.4	34	36
25–36	43	7.6	19	24
37–48	50	8.9	27	23
49–60	46	8.2	14	32
61–72	52	9.2	12	40
>72	223	39.6	33	190
Total	**563**	**100.1**	**181**	**382**

Source: Records of buffalo in a sample of 395 households.

Body weight and other body measurements in buffalo

The average body weight of buffalo in various age and sex classes is shown in Table 3.

Table 3. Age and body weight of buffalo in Binh Son.

Age (months)	Body weight (kg)			Weight gain (g/day)
	Male	Female	All	
7–12	99.8	114.4	106.4	
12–18	145.6	148.2	146.7	222
19–24	182.7	173.6	177.2	167
25–36	207.3	209.1	208.3	85
37–48	243.2	248.7	245.8	103
49–60	263.8	271.5	269.2	64
61–72	302.0	298.0	299.0	81
>72	326.8	312.3	314.5	

No data were obtained on body weight of calves under seven months of age because of difficulties in handling and hence in ascertaining weight and body measurements of calves under village conditions.

In general, the body weight of buffalo in Binh Son was low compared with that in other areas of Vietnam. There were no significant differences between males and females in body weight (or other body measurements) at various ages, and this may be an indication of a problem with the small size of bulls in the village. The average daily gain was 222 g in the 7–12 month age class and it declined rapidly after two years of age.

The farmers say that the village herd size has not increased markedly in recent years, mainly because there is a shortage of feed in the dry season and a lack of credit for the purchase of buffalo.

Buffalo breeding and reproduction

Most farmers have too few buffalo to justify keeping their own bull for breeding. Mating is largely uncontrolled and occurs by chance meeting of bulls and cows in the hilly grazing areas. The ratio of mature male to female buffalo in the village appears to be quite favourable (1:6) but the accessibility of bulls varies from hamlet to hamlet.

Estimates were obtained from farmers of the average age at first mating for bulls (33 months) and at first calving for cows (49 months), and of the average calving interval (25 months).

Draught animal power use

The main draught use of buffalo is in ploughing or raking of land, but some families (4%) use buffalo-drawn carts too. Most buffalo (57%) work for 90–120 days per year, and 29% work for 60–90 days with an average of 3.5 hours per day. It may be important to note that the heaviest period of work for buffalo is April–June, after the dry season, when feed has been in short supply and of poorest quality.

Both male and female animals are used for draught. Animals are always worked singly. Farmers train their buffalo to work at 24–30 months of age and spend 3–4 days in training them.

Market price of buffalo

Data on the value of buffalo were obtained by asking farmers to estimate the market value of each of their animals. These data were combined with data on body weight and are summarised in Table 4. The price per kilogram decreased with increasing age.

Table 4. Average body weight and estimated value of buffalo in various age classes in Binh Son.

Age (months)	Average body weight (kg)	Average price (USD)	Price/kg (USD)
7–12	106	81	0.76
13–18	146	101	0.69
19–24	177	116	0.65
25–36	208	129	0.62
37–48	245	143	0.58
49–60	269	152	0.56
61–72	299	153	0.51
> 72	314	154	0.49

Conclusions

Buffalo rearers in Binh Son rear their animals by a combination of grazing and hand feeding crop residues, especially rice straw. These practices appear to be well adapted to fit the existing landscape and farming systems.

A potential for improvement appears to be through the introduction of improved forages. Potentially suitable species could be identified and tested under village conditions with farmer participation.

Another opportunity may lie in the improvement of the feed quality of existing crop residues. Such methods need to be identified too, and trials run to test improved ways of storing residues and improving feed quality.

The herd reproductive rate appears to be reasonable, but the data should be verified by other RRA methods. If the small size of animals is shown to be a major problem, there would be need for some sort of 'improved sire' scheme to be recommended for introduction by local authorities, or the Cooperatives, such as selection of large local bulls or Murrah bulls.

While disease did not appear to be a major constraint in buffalo, there is a need to identify whether there are animal health problems that act as a deterrent or risk to rearing, and what can be done about these.

The rapid methods of data collection and description used show promise as a means of describing the livestock systems in a manner that is relatively efficient with resources. However, these methods need several modifications to make the results more valuable as a means of defining productivity and constraints and opportunities in livestock development. A next stage of data collection should be longer term in scope and should involve farmers in participation of farm monitoring and trials to improve their enterprises with resultant benefits to them.

Acknowledgments

Thanks are due to ACIAR for funding support, and to all the farmers and village officials, staff of NIAH and other persons who helped with this study.

Reference

Carruthers and Chambers, R. 1981. Rapid rural appraisal for rural development, Agricultural Administration, 8, 407–442.

Provincial Agricultural Department Statistics. 1994.

Farming Systems of Thai My Village, Saigon River Delta, with Special Emphasis on the Role of Cattle and Buffalo

Chau Chau Hoang* and John Perkins†

Abstract

Thai My village is in the Saigon River Delta, a lowland area similar in many respects to the Mekong River Delta 100 km further south. Cropping systems were dominated by rice production although multiple cropping was somewhat limited by unsuitable soils. Peanuts, vegetables and sugarcane, to a lesser extent, were the next most frequent crops. A sample of 210 farmers reared a total of 333 buffalo and 135 cattle. Feeds included grasses, weeds and conserved rice straw and peanut vines, with occasional supplementation. Feeding systems included a mixture of tethered and herded grazing and cut-and-carry. Large ruminants were important for draught animal power, a store of capital and intermittent income. Farmers mentioned few technical problems in managing their animals but were concerned about the profitability of buffalo and cattle production.

THIS case study summarises part of a larger survey of the management of cattle and buffalo by village farmers in Vietnam. The aim was to estimate some general parameters of current performance and relate these to farmers' management practices and the wider farming systems. It is hoped that the study might highlight any major constraints on performance or profitability of large ruminants and guide the next stages of research and testing. The paper is based on work in Thai My village in the Saigon River Delta of southern Vietnam and was conducted in October 1994. It concentrates on an analysis of the farming systems within which the management of cattle and buffalo took place.

Data Collection

Thai My is situated in the Cu Chi District some 40 km northwest of Ho-Chi-Minh City, one of four villages studied in Vietnam. It was selected as a site typical of the wet lowland zones of the Saigon River Basin where rice is the main crop and farmers are said to have a tradition of raising buffalo to supply draught power. No claim is made that Thai My is representative of similar agroecological zones but care was taken to ensure that it was not an atypical village within its own area. The main characteristics of Thai My village, being low and flat, within the humid tropics and dominated by the production of rice and other irrigated crops, are akin to those of the nearby Mekong River Delta.

The survey was conducted by staff and students of the University of Agriculture and Forestry, Ho-Chi-Minh City. Standard techniques from the Farming Systems Research approach were used to assemble a wide variety of information. Secondary data for Thai My village and Cu Chi district were collected from a number of sources and supplemented by discussions with village leaders, officials and farmers, plus village walks and informal observation.

Two sets of recording forms were developed. One concentrated on individual cattle or buffalo which were weighed, measured and characterised with regard to sex, age, condition, health and other parameters. Owners of all recorded animals were asked to respond to a questionnaire which covered the ownership, management and use of land, plus more specific information on the management of their large ruminants.

The original target had been to sample 100–150 cattle and buffalo: the group managed to collect data on 135 cattle, 333 buffalo and 210 farming households in the three weeks available for fieldwork. The questionnaires were not issued to farmers who did not rear cattle or buffalo, thus those results cannot be said to extend across all systems within the village.

* Faculty of Animal Science and Veterinary Medicine, University of Agriculture and Forestry, Ho-Chi-Minh City, Vietnam.

† Faculty of Agriculture Forestry and Horticulture, University of Melbourne, Parkville, Victoria 3052, Australia.

However, most cropping practices appeared reasonably homogenous. As with any cross-sectional study such data must be treated with due caution but, for an indicative survey such as this one, the speed with which the information is collated is an adequate trade-off for any increase in error.

Results

Thai My village

The village, situated approximately 106°E and 11°N, and with an average elevation some 3 m above sea level, comprises a total population of 9300 people in some 2050 households. Total annual rainfall is 1711 mm, concentrated in the May to October monsoonal period and with six dry months (<100 mm) per year. Irrigation water is delivered by canals from the man-made Dau Tieng reservoir (35% of irrigated lands) and river off-takes. The flat, low-lying delta area is prone to flooding in parts, with 6.5% of the area served by drainage systems. Most of the soils are classified locally as 'alum' (swampy) or slightly alum and not entirely suitable for rice-cropping, which may be one of the reasons for limits of 1–2 rice crops per annum in many parts of the village. Table 1 includes statistics describing households and land use.

Sample farms

Two-hundred-and-ten farmers provided information about their farms and farming systems. Almost 90% were landowners, averaging 0.64 ha of arable land per household. Total land area operated by the respondents amounted to 136 ha, of which 88% was irrigated. The major crops within Thai My include rice, peanuts, vegetables and sugarcane. The latter crop was particularly associated with the 'alum soil' areas.

Typical cropping patterns are presented in Figure 1. In the lower-lying parts of the village (a relative term!) three crops of rice may be produced, locally classified as 'main crop', 'winter–spring crop' and 'summer–autumn crop'. The diurnal range in temperatures is not great but volume and distribution of rainfall will have significant effects.

Peanut production is considered more profitable than rice but requires elevated, well-drained land. Farmers try to include peanuts within their rotations and many variations are devised. If adequate water is available they will be cropped: once or twice per year plus the main rice crop; as one crop of peanuts plus two cycles of rice; or as one crop of vegetables, one crop of peanuts and one main-crop of rice.

Vegetable production produces a high income but requires large inputs of labour, well-drained land with a good watering-system and heavy applications of fertilizers. As a consequence vegetables are produced on limited areas after harvesting the main rice crop and may be followed by a second crop of rice.

Table 1. Selected statistics, Thai My village.

			Number	Unit
Total number of households			2057	
Population			9302	people
Cattle and buffalo			2209	head
Agricultural land area			1142	ha
(a) annual cropping land			1127	ha
rice & secondary crops				ha
3 crops/year	275	}		ha
2 crops/year	459	}	1100	ha
1 crop/year	366	}		ha
other annual crops			27	ha
(b) perennial cropping land			15	ha
Forestry land			47	ha
Prospect forestry land			447	ha
Average annual cropping land/household			5479	m^2
Average annual cropping land/person			1212	m^2
Average aquaculture area/household			5	m^2

Sugarcane production is usually concentrated on the better-drained part of the 'alum soil' areas. The most recent cropping areas for the sample of farmers is given in Table 2. Note that their ownership and management of arable land amounted to 136 ha and thus a Cropping Index of only some 120% was achieved (163/136 ha). This might indicate that, in practice, the double and triple-cropping options cannot be used very frequently.

Cattle and buffalo within the farming systems

Statistics

The 210 farmers in the sample reared 135 cattle and 333 buffalo. Among the total were 12 oxen (castrated cattle) and 128 buffalo used for draught power. Both male and female buffalo were used as draught animals; neither female nor entire cattle were used

Table 2. Annual areas of land cropped by sample farmers, Thai My village.

	Area (ha)	% of total area
Rice	129	80
Peanut	21	13
Vegetables	10	6
Sugarcane	1	1
Total	**162**	**100**

n = 210 farmers.

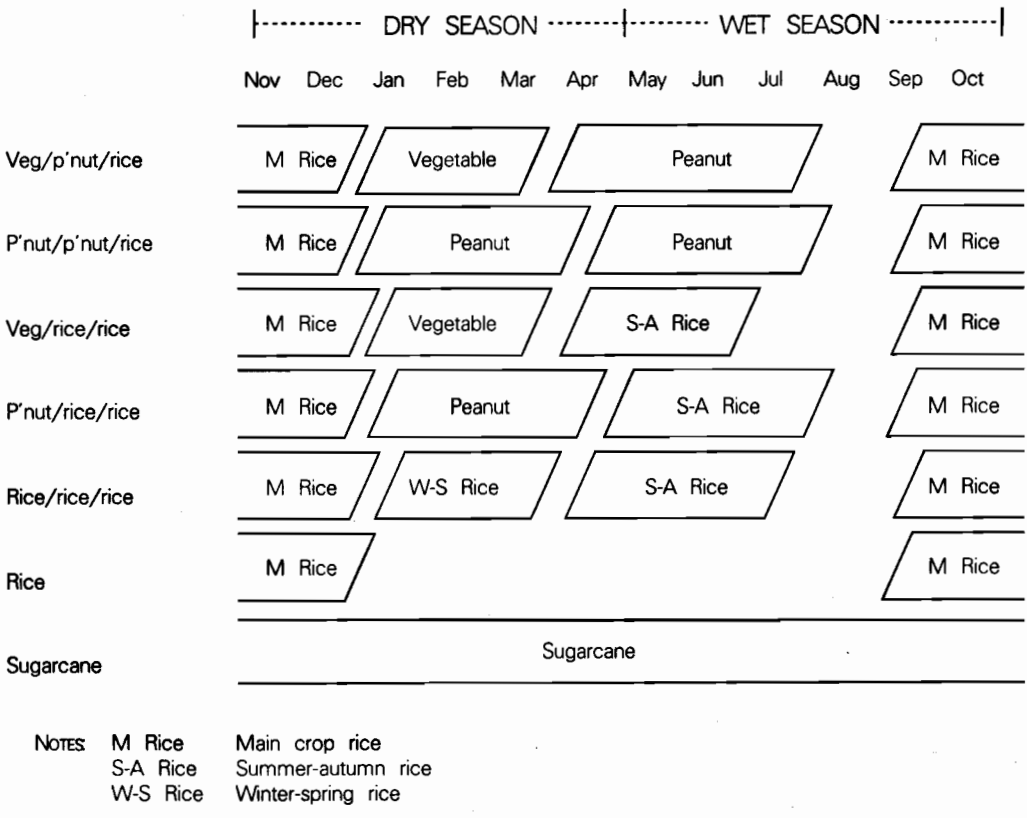


Figure 1. Typical cropping patterns, Thai My village

for these tasks, which included land preparation and carting. Distribution of the sample by age and sex is summarised in Table 3.

Some data are of immediate interest. The distribution of cattle is more skewed than that for buffalo whether measured by age or sex. The male cattle population numbered less than one third of the females and was concentrated in the younger age groups (<24 months). Farmers said they preferred females because of the potential extra income from the sale of calves and since female cattle were easier to handle. Male buffalo outnumbered females at a ratio of almost 2:1; both the older male and female buffalo (>24 months) formed c. 75% of their respective populations. The figures might reflect the importance of the buffalo as a draught animal in the Than My area.

Table 3. Composition of ruminant sample, Thai My village (n).

	Cattle				Buffalo			
	Male	%	Female	%	Male	%	Female	%
Age (months)								
1–12	7	23	32	31	25	12	18	14
13–24	14	47	19	18	47	23	18	14
25–48	3	10	21	20	70	34	32	26
>48	6	20	33	31	66	31	57	46
Total	**30**	**100**	**105**	**100**	**208**	**100**	**125**	**100**

Table 4. Other animals reared on sample farms, Thai My village.

	Number of households	% of total
Pigs	31	15
Poultry	35	17
Pigs and poultry	92	44
Pigs and fish	2	1
Pigs, poultry and fish	3	1
Only cattle and/or buffalo	47	22
Total	**210**	**100**

Table 5. Source of labour used for rearing cattle and buffalo.

	Number of households	% of total
Mainly husband	121	59
Mainly wife	36	18
Mainly children	23	11
All family	23	11
Total households	**210**	**100**

The average number of cattle or buffalo reared was around two per household although single cattle dominated the cattle-only households and two buffalo were most frequent in the buffalo-only households. A substantial number of the sample reared both cattle and buffalo; further, these tended to have more than two animals, which might indicate a preference to rear the buffalo for draught and the cattle for sale. Most of the farmers kept animals other than cattle or buffalo, with poultry and pigs the most common species (Table 4). It is very likely that almost every farm raised a few chickens for household consumption: they were probably not considered in terms of providing income.

Major Inputs

Labour

Almost every farm in the sample (99%) said that only family labour was used in rearing their cattle and buffalo. Among family members, the husband was said to be responsible for most tasks which mainly involved tasks related to feeding—herding, cut-and-carry forage collection and hand-feeding (Table 5.)

Nutrition

The animals were fed through various combinations of herded grazing, tethered grazing and cut-and-carry forages throughout the year. The main sources of feed included fresh grasses and weeds, fresh and dry rice straw, dry peanut vines and rice bran. Swine compound feeds or peanut meal are occasionally used as supplementary rations, depending upon the approach of individual rearers and the availability of feeds.

Conservation of forages was widely practised throughout the village (c. 60%) Rice straw and peanut vines were preserved by sun-drying and stacking: haystacks were a common feature. Although the feeds may have been of low nutritive value they appear abundantly available. Farmers apparently did not consider feed to be a major constraint to rearing cattle and buffalo.

Major Outputs

Insurance; store of wealth

Rearing cattle and buffalo is considered a relatively safe way of insuring part of the family's capital as the value of animals usually increases with time. The animals are sold to cover major expenditure by the family. Rearers were asked to estimate the sale value of their animals: the averages of these estimates are summarised in Table 6. Values rose reasonably consistently to about 60 months of age, at which point they level off.

Draught power

All draught animals in Thai My are worked in pairs and used for land preparation and carting. The farmers estimated that, on average, buffalo worked for some 80 days per annum and cattle around 70 days. Buffalo are preferred to cattle for draught work as they are considered more suitable for soil conditions in the wet lowlands.

For draught work, both male and female buffalo are used but only specialist oxen. These latter are worked in pairs and will remain on the farm for many years. Only a few such pairs were located in Thai My but, in other villages, they can be the main source of draught power. Female cattle are never used for ploughing or carting.

Both cattle and buffalo start draught work at around two years of age. Farmers said that male buffalo are usually sold for slaughter at about four years as they will be close to their maximum body weight and become more powerful and difficult to handle. However, these responses must be tempered with the fact that almost one-third of the male buffalo

Table 6. Average estimated value of large ruminants (million VND).

	Cattle		Buffalo	
	Male	Female	Male	Female
Age (months)				
1–12	1.8	1.8	1.5	1.5
13–24	2.5	2.0	1.9	1.9
25–36	2.6	2.2	2.5	2.4
37–60	n.a.	2.2	2.5	2.4
>60	3.0	2.2	2.4	2.4

were estimated to be >48 months in age and it is possible that most were still used for work. This point requires further study.

MANURE

Most rearers said that dung was collected from night stalls for their own use or for sale.

INCOME FROM CALF PRODUCTION AND RENTING-OUT FOR DRAUGHT WORK

As indicated in Table 6, the sale value of young animals is relatively high, which might explain farmers' preference to retain cows for calf production and profit. Income is also earned from renting-out draught animals to other farmers. The current rate for renting a pair of cattle or buffalo is said to be about 40 000 VND per day.

Conclusions

As in many countries in Southeast Asia and elsewhere there is a strong interdependence between large ruminants and other parts of the farming systems in Thai My village. Cattle and buffalo provide draught power for tillage, manure, income and a sink for capital. They utilise crop residues for feed but compete with other enterprises for the farm families' resources including labour, capital and land.

Farmers were asked to identify the major constraints on their management of large ruminants. The general response was that inputs appeared adequate: there were few comments on feed or labour, or the health and productivity of the animals. The most frequent response was 'profitability'—to remain attractive, cattle or buffalo production must become more profitable or it would start to lose ground in comparison with other crop or animal enterprises. This provides plenty of scope for further research, particularly with management strategies that increase the efficiency of calf production and boost early growth and sale.

Acknowledgments

The authors gratefully acknowledge staff and students of UAF who contributed to the collection of data for this study, particularly Mr Le Dang Danh, Nguyen Kim Cuong, Pham Trong Nghia, Tran Van Chinh and Nguyen Van Phat, and ACIAR's support of the research project.

Development of Dairying in Ho-Chi-Minh City—Economic Aspects of Production and Consumption

Nguyen The Binh and Luong Van Tac*

Abstract

The raising of dairy cows in Ho-Chi-Minh City (HCMC) and adjacent areas has developed quickly because of demand for fresh milk supply to the City's population. In the future, the population will continue to increase, especially in urban areas, and demand for milk and milk products will rise likewise. In practice, a belt of dairy cow production from west to east of HCMC has been established including 16 districts and spreading to areas of 400 000 ha with more than 3000 dairy cow breeder households involved.

However, there are still problems of economics, technology and the environment that need to be solved in aiming for stable dairy cow raising, increased milk production and improved income for breeders. Since 1990, a study entitled *'Economic efficiency of dairy cow raising in farmer households in Ho Chi Minh City'* has been conducted by the Sub-National Institute of Agricultural Planning and Projection.

Results have indicated that economic efficiency in dairy cow raising, especially economic aspects of production and milk consumption, determines the possibilities of developing dairy cow raising and solutions proposed are to increase development of dairy cow raising in HCMC.

DAIRYING in Vietnam has been concentrated in five main areas: Moc Chau, Lam Dong, Hanoi and adjacent areas, HCMC and adjacent areas and cities and towns in the Central region. HCMC and adjacent areas is the most important dairy region with 60% of the total number of dairy cows and 70% of national milk production.

Dairy development in HCMC and adjacent areas has been assisted by demand for fresh milk for the city's population. In the future, with a growing population especially in the urban areas, the demand for milk and milk products will increase.

Objectives of the Study

Based on a survey of dairying and its development in HCMC, the objectives of the study were to determine economic efficiency and the main factors which affect it in HCMC, then to propose solutions for increasing its economic efficiency.

* Sub-National Institute of Agricultural Planning and Projection, (Sub-NIAPP) 86, Hai Ba Trung St, District 1, Ho-Chi-Minh City, Vietnam.

Methods of Study

A number of methods were used to obtain the survey data: data collection and analysis; practical survey and typical model study; use of experts; and use of a method for comparison and forecast.

Results of the Study

The following results, which were mainly collected and surveyed in 1993 throw light on economic aspects of production and consumption of milk.

Effect of herd size on economic efficiency

Data reported in Table 1 show that herd sizes of 10–20 head and 21–40 head provide greater economic efficiency since families with such herds have enough capital but do not have to hire labour. Profit for producers with herds of these sizes was in the range of 20–40 million VND for one household, with a profit rate of about 40–45%.

Milk production costs and breeder's profit

Table 2 records milk production costs of cooperators in the survey. Production costs and benefits to the breeder have been affected by different factors. Our data collected from farmer households showed that breeder's **benefit** is still low compared with that of the labour hired for milking and transporting.

Table 1. Effect of herd size on economic efficiency of dairying in HCMC.

Size of herd n	Total income ('000 VND/yr)	Total production costs ('000 VND/yr)	Profit ('000 VND)	Production of fresh milk (VND/kg)	Rate of profit (%)	Average milk production (kg/day)
1–9	16 731.8	14 852.6	1879.2	1637	11.23	14.4
10–20	71 121.7	49 041.4	22 080.3	1307	31.04	15.7
21–40	110 717.1	75 460.2	35 256.9	1450	31.80	15.0
>40	213 036.7	178 086.8	34 949.9	1830	16.40	14.4

Amount of consumed milk and supply sources

The total milk consumption and its supply source is shown in Table 3. Fresh milk consumed in HCMC is mainly supplied by milk-cow breeder households in HCMC and adjacent areas.

Milk collecting and transporting

Milk, which is produced at breeder households, is brought to collecting stations and then transported to the processing plants. In some cases, milk from breeder households is directly brought to small processing houses but not through collecting stations. Milking and transporting is carried out by breeders themselves or their hired labourers. Table 4 records data on the manner of milk collection and transportation in HCMC.

Milk processing

Milk is processed both by industrial and manual methods in HCMC. The former is carried out by the VINAMILK Company mainly to produce a line of sterilised UHT fresh milk. Milk processing by manual methods is conducted by breeder households or by private small processing houses.

Milk consumption and the location of processing is set out in Table 5.

Milk marketing and distribution

Processed fresh milk is brought to consumers from VINAMILK's processing plants through nearly 200 retail agents in HCMC selling more than 40 kinds of milk and milk products. Distribution from small manual processing houses is through food and drink shops anywhere in the city, or direct to consumers without the involvement of agents and the shops. Table 6 records the manner in which milk is marketed in HCMC.

Discussion and Conclusions

Dairy cow raising in farmer households has recently become a suitable production model which has had economic efficiency and can improve the farmer's income. However, the collected results show that there is still variation and sometimes low production in some breeder households and herd sizes.

The main factors that directly affect economic efficiency of dairy production are productivity per day and per milking cycle, input buying prices, output selling prices and milk-cow raising experience of the farmer households. Milk productivity is very dependent on cow breed quality and feeding and management regimes.

Table 2. Average milk production costs and breeder profit.

		Buying price of VINAMILK* @ 2350 VND/kg (Before 1/3/94)	Buying price of VINAMILK @ 2550VND/kg (1/3/94–1/7/94)	Buying price of VINAMILK @ 3000 VND/kg (After 1/7/94)
Production costs	(VND/kg)	1650	1650	1950
Labour costs, milking and transporting	(VND/kg)	500	550	600
Breeder's profit	(VND/kg)	200	350	450

* VINAMILK is a cooperative dairy company that purchases milk for processing.

To further develop dairying in HCMC and adjacent areas there is a need to simultaneously improve factors such as selection of adapted milking cow breeds, diet, conducting agricultural extension activities—and generally transferring new technology to the farmer households combined with improved milk collection and preservation systems.

Table 3. Amount of fresh milk consumed and supply sources in HCMC as affected by season.

Items	Average	Dry season	Rainy season
Daily average consumption (L)	27 150	24 600	29 700
From dairy state farms	2800	2250	3350
• Inside HCMC	300	250	350
• Outside HCMC	2500	2000	3000
From breeder households (large scale)	750	650	850
• Inside HCMC	750	650	850
• Outside HCMC	0	0	0
From breeder households (small scale)	23 600	21 700	25 500
• Inside HCMC	23 200	21 400	25 000
• Outside HCMC	400	300	500
Total annual consumption (t)	9909.75	8979.00	10 840.50
From dairy state farms	1022.00	821.25	1222.75
• Inside HCMC	109.50	91.25	1327.75
• Outside HCMC	912.50	730.00	1095.00
From breeder households (large scale)	273.75	237.25	310.25
• Inside HCMC	273.75	237.25	310.25
• Outside HCMC	0.00	0.00	0.00
From breeder households (small scale)	8614.00	7920.50	9307.50
• Inside HCMC	8468.00	7811.00	9125.00
• Outside HCMC	146.00	109.50	182.50

Table 4. Milk consumed and methods of collection in HCMC.

	Average	Dry season	Rainy season
Average daily consumption (L)	27 150	24 600	29 700
Into collecting stations	20 000	18 000	22 000
• From state dairy farms	1960	1420	2500
• From breeder households (large scale)	18 040	16 580	19 500
Not into collecting stations	7150	6600	7700
• From state dairy farms	1590	1480	1700
• From breeder households (small scale)	5560	5120	6000
Total annual consumption (t)	9909.75	8979.00	10 840.50
Into collecting stations	7300.00	6570.00	8030.00
• From state dairy farms	715.40	518.30	912.50
• From breeder households (large scale)	6584.60	6051.70	7117.50
Not into collecting stations	2609.75	2409.00	2810.50
• From state dairy farms	580.35	540.20	620.50
• From breeder households	2029.40	186.80	2190.00

Table 5. Amount of milk consumed and processing areas in HCMC.

	Average	Dry season	Rainy season
Average daily consumption (L)	27 150	24 600	29 700
Milk processed in VINAMILK plants	18 000	16 000	20 000
Milk processed in manual processing houses	5336	5053	3620
• Milk from collecting stations	2000	1800	2200
• Milk from breeder house (small scale)	3336	3172	3500
Milk processed at breeder households	3814	3548	4080
• At breeder's house (small scale)	2224	2048	2400
• At breeder's house (large scale)	750	700	800
• At state dairy farms	840	800	880
Total annual consumption (t)	9909.75	8979.00	10 840.50
Milk processed in VINAMILK plants	6570.00	5840.00	7300.00
Milk processed in manual processing houses	1947.64	1844.00	2051.30
• Milk from collecting stations	730.00	657.00	803.00
• Milk from breeder households (small scale)	1217.64	1157.78	1277.50
Milk processed at breeder households	1392.11	1295.00	1489.20
• At breeder households (small scale)	811.76	747.50	876.00
• At breeder households (large scale)	273.75	255.50	292.00
• At state dairy farms	306.60	292.00	3210.20

Table 6. Milk consumption and marketing methods in HCMC.

	Average	Dry season	Rainy season
Average daily consumption (L)	27 150	24 600	29 700
Milk sold through VINAMILK agents	18 000	16 000	20 000
• Milk sold through retail food and drink shops	7614	7200	8000
• Milk sold to consumers	1536	1400	1700
Total annual consumption (t)	9909.75	8979.00	10 840.50
Milk sold through VINAMILK agents	6570	584000	7300.00
• Milk sold through retail food and drink shops	2779.11	2628.00	2920.00
• Milk sold to consumers	560.64	511.00	620.50

Helping to Improve Pig Production in Vietnam

D.N. Singh, C.P. McPhee and J.S. Kopinski*

Abstract

Pig raising contributed 73% of the meat produced by livestock in 1988, and is by far the dominant livestock sector in Vietnam. Pigs consumed 90% of the total high quality feed used by livestock. Ninety percent of pigs are reared on smallholder farms with the levels of good quality feed used dependent on breed type and feed availability. These smallholder pig breeders and fatteners depend primarily on purchased rice bran and home-processed or purchased fish meal for feed supplementation. Only 1.5% of the total pig herd is held on intensively managed state farms.

The 1991 report by FAO on Livestock Sub-Sector Review and Project Identification Mission to Vietnam recommended research into feed quality and breed improvement for pigs. This is in agreement with the objectives of the ACIAR PN9423 project 'Breeding and feeding pigs in Vietnam and Australia'.

In the project, genetic research is aimed at the development of breeds with efficient lean growth by applying techniques found successful in Queensland, where the environment is similar to Vietnam. Nutrition research is aimed at utilising unconventional feed material and industrial wastes from flour mills, breweries and sugar mills. Nutritional requirement studies are planned to optimise diets for maximum productivity of the breeds in Vietnam. A conceptual model of the project 'Breeding and feeding pigs in Vietnam and Australia' has been utilised.

Pig Production Systems

THE 1989 census recorded 12.19 million pigs of which 1.58 million were sows. In comparison cattle numbers were 3.12 million, buffalo 2.85 million and poultry 107 million. Clearly the livestock sector in Vietnam is dominated by pigs which, in 1988, contributed 73% of all meat produced (Hajas 1989). Pigs are reared predominantly on smallholder farms with the levels of good quality feed used dependent on availability and the breeds fed. The diet of pigs in smallholder farms is primarily rice bran and fish meal. Intensively managed state farms hold only 1.5% of the total pig herd.

The native and semi-native breeds of pigs are dominant, although, 53.1% of pigs in the south and 45% in the north are exotic crosses (FAO 1991). These breeds are predominantly Yorkshire, Landrace, Duroc and Hampshire, sourced from a number of countries and crossed with native breeds. Smallholder herds typically have 1–2 sows or 2–4 fattening stock. The average annual yield is estimated at 460 kg liveweight/sow/year or 7.1 head reared to an average liveweight of 65 kg at 11 months of age. In contrast, intensive state farm management systems using exotic breeds and higher quality feed produce about 1000 kg/sow/year. However, this is only 50% of production levels achieved in developed countries.

Trends in Pig Production and Distribution

Table 1 shows the livestock production trend in Vietnam from 1980 and 1991 (Lam 1993).

The potential pig feed crops in various regions are found in Table 2 which helps in explaining usage of different dietary feed components in pig diets for the various regions.

Pig production problems Vietnam/Australia

The native breeds in Vietnam are characterised by slow growth and high levels of carcase fat (Xuan et al. 1995). The exotic breeds have been introduced to satisfy the growing demand for large lean carcases but these are reported to be not as well adapted to the local environment as the native breeds. This is mainly because the exotic breeds have been developed on cereal-based diets of high nutritional value.

* Animal Research Institute, Queensland Department of Primary Industries, Locked Mail Bag No 4, Moorooka, Queensland 4105, Australia.

Table 1. Production of livestock and poultry ('000 head).

	1980	1985	1990	1991
Buffalo	2313.0	2590.2	2854.1	2885.6
Cattle	1664.2	2597.6	3116.6	3151.0
Pigs	10 001.2	11 807.5	12 260.5	12 140.4
Horses	115.6	132.7	141.3	–
Poultry	64.5	91.2	107.4	108.2

Table 2. Geographic distribution of pig industry and associated potential feed supply in various regions[a].

	Area (km^2)	Human pop'n ('000)	Pop'n density (n/km^2)	1990 Pig n (mill.)	Rice '000 t	Maize '000 t	Cassava '000 t	Sweet Potato '000 t	Peanut '000 t	Coco-nut '000 t
Whole Country	331 033	66 233	200	12.26	19 225	671	2276	1929	213	1039
Northern Region	166 582	33218	199	8.02	6962	433	1180	1404	93	27
North Mountains and Midland	102 938	11 260	109	3.09	1702	246	748	347	25	–
Red River	12 466	13 025	1045	2.88	3618	148	139	486	22	24
Centre Coast	51 178	8842	173	2.05	1642	58	292	571	46	–
Southern Region	16 4451	32061	195	4.24	12 262	281	1 095	524	120	1012
Central Coast	45 824	6846	149	1.34	1607	29	508	193	17	134
Central Highlands	55 569	2597	47	0.58	386	91	205	95	17	–
North East	23 484	8020	341	0.52	789	72	281	43	62	109
Mekong River Delta	39 575	14 598	369	1.81	9480	26	102	193	23	767

[a] (Modified from Lam 1993).

However, in the important pig rearing areas of Vietnam, climatic conditions and low quality pig feedstuffs limit the ingestion of sufficient nutrients to promote maximum growth of these breeds. Local feed ingredients in Vietnam are plentiful but many are of unknown nutritional value. Better diet formulation using these feedstuffs will require chemical analysis for nutritionally important components, for example, digestible energy and amino acid levels.

In Australia, particularly in Queensland, the climatic limitations and objectives for pig production are similar to those in Vietnam. In both regions, pigs are subject to high temperature stress and lean pig strains in both countries were sourced from Europe. Under high temperatures these suffer stress and reduced appetite, leading to depressed productivity.

Australia currently enjoys plentiful supplies of cheap grains and a range of good quality proteins. With increased demand from the human population for these, cost pressures will necessitate researching alternative sources of pig feed.

As 70% of the cost of pig production is related to feeding, both Australia and Vietnam have a continuing interest in finding new and cheaper feed ingredients. Therefore better characterisation and knowledge of these feed ingredients will facilitate the use of Least Cost Diet Computer Programs to lower the feed-associated costs in pig production.

Optimum economic return from pigs requires manipulation of the genetic potential of the animal, the nutritional status of the feed ingredients and the production environment (Fig. 1). The interaction of these factors also contributes to production and efficiency.

It is apparent that genotype and nutrition interaction studies are essential to maximise the efficiency of lean pork production in Vietnam. Further breed development and investigation of local feed ingredients to formulate better diets will assist the Vietnamese pig industry improve productivity and efficiency.

'Breeding and Feeding Pigs in Vietnam and Australia'

Objectives and Methodology

The project's primary mission is to develop and implement a research program focussing on nutrition and genetic research to improve pig production in Vietnam and Australia. The primary objective is to increase the production of lean pork per unit of cost. Two research directions will be followed. Firstly, the identification and development of genotypes which best meet this objective and secondly, the chemical and nutritional investigation of alternative feed ingredients for the formulation of cheaper, optimised diets suited to the particular strain or pig breed. Genetic research is aimed at the development of breeding techniques that emphasises good appetite and lean carcase under the environmental conditions of Vietnam. Nutrient requirement studies will optimise diet for the maximum productivity of the breeds using feed ingredients available. As genetic improvements occur and information about feeds and feeding become available, higher production levels will be achieved.

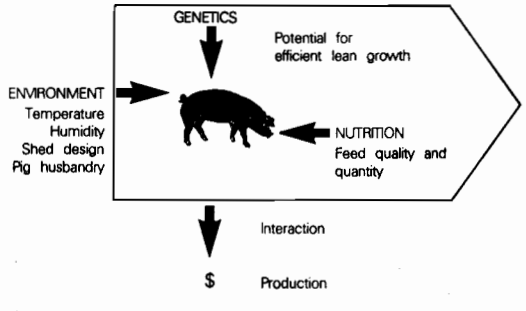


Figure 1. Factors affecting optimum economic return from pigs.

Genetic Studies

The main genetic part of this project aims to find the most productive of Australian and Vietnamese genotypes and an efficient way of developing a pig genotype with a high growth rate, a lean carcase, a good appetite and a high resistance to the types of stress likely to be encountered in Australia and Vietnam. A combination of the latest technologies will be applied to the task. These will include a specialised performance-testing diet, live-animal estimation of lean growth rate using ultra-sound, DNA testing for stress susceptibility genes and Best Linear Unbiased Prediction (BLUP) statistical techniques for increasing the accuracy of estimating breeding values. The developed genotype will be most suitable on which to carry out the projected nutrition investigations.

In Vietnam, use of European pig lines has been encouraged because of increase in domestic demand for lean meat and a need for exports (Molenat and Thong 1991). As in Australia the main breeding objective is for high growth rate and high lean and low fat content of the carcase. Emphasis on high lean content in the development of these breeds in Europe, has led, in many cases, to a reduction in appetite. This has been to the detriment of growth rate (McPhee 1981). When transferred to a hot climate, the poor innate appetite of these European genotypes is depressed further and this is likely to reduce growth rate and lead to reproductive failure in sows (SCA 1987). In addition to poor appetite, porcine stress syndrome (PSS) can be a problem for some European breeds raised in a high temperature environment. This is because of the presence of the halothane gene originally incorporated in these breeds to raise carcase lean content. In Australia, where pigs can encounter higher levels of heat and handling stress than in Europe, the gene has been shown to cause an increase in mortality and PSE (pale, soft, exudative pork) (McPhee et al. 1994, McPhee and Trout 1995). A similar situation has raised concern about the halothane gene in Vietnam (Molenat and Thong 1991).

The choice of an appropriate performance testing technique which would identify those animals to select for the breeding herd is important. A number of recent studies, for example, McPhee et al.(1988) and Stern et al. (1994) suggest that a diet high in nutrient density but restricted in amount might be the most suitable for performance testing. Such a diet satisfies the pig's requirement for maintenance and lean growth . Nutrients surplus to these needs are kept to a minimum as they are mostly converted to fat, making the accurate measurement of lean growth more difficult. For this reason ad lib feeding is not appropriate since it would add an amount of fat which would vary according to each pig's voluntary

food intake. A fixed amount of food given to all pigs over a fixed performance testing period avoids this unwanted variation. Pigs are selected on lean growth as estimated from ultrasonic fat and liveweight measurements. This form of performance testing appears to be effective for identifying pigs with genes for high appetite as well as rapid growth rate (McPhee et al. 1988). The identification of such pigs can be further facilitated by combining their own performance records with those of their relatives using BLUP statistical procedures (Keele et al. 1988).

Feed Evaluation Studies

For pig production, feed costs amount to a considerable proportion of total cost. In Australia 60–65% (PRDC 1991) of production cost is feed-related whereas in Vietnam a greater use of low cost by-products of local origin reduces the feed proportion of pig production costs. However, despite the lower cost of feed, the lack of feedstuff chemical characterisation information means that diets can be frequently imbalanced. This results in poorer pig performance and failure to meet market specifications for pig carcase quality, that is too much fat.

Pigs are generally regarded as 'opportunity feeders' in that they have the ability to consume all manner of feedstuff, and this presents opportunities to reduce feed costs. However, the economics of pig production will only improve if the amounts and proportions of these 'different' feedstuffs can be assessed to improve pig performance without having detrimental effects on carcase quality (fat level).

The research program for feedstuff evaluation will entail the examination of composition and nutritive value of feedstuff and their constraints; as they are important in determining Least Cost Diets. The geographical distribution of potential and actual feedstuff will influence the supply and price of the feedstuff component of Vietnam-based diet formulation.

Pig Feedstuffs in Vietnam

Blaha and Mudrik (1990) published a list of the nutritive value of some 35 Vietnamese feedstuffs. A total of 72 samples (low reps) from South Vietnam and North Vietnam were analysed for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen-free extract (NFE) and ash. On the basis of a very crude measurement of fibre and protein on limited samples, they concluded that the quality of cereals, legumes, groundnut and soybean oil cakes was good but that coconut and fishmeal were of poor quality. In their nutritional assessment no amino acid analyses were carried out, nor was the digestible energy value of these feed ingredients measured.

Another Vietnamese publication also reports on the nutrient composition of feedstuffs in Vietnam (Thuong 1992 quoted by Thong and Kinh 1993). The chemical analyses of some major by-products were illustrated in Table 7 of that document. Ingredients such as banana tree, *Avicenia verb.* leaf, water hyacinth, azolla, water spinach, rice bran, broken rice, soybean, fresh cassava pomace had their chemical composition illustrated. Again very basic chemical analyses were carried out. ME was reported, however it is unclear if this was a measured or calculated value. No amino acid values were given.

Nutritional evaluation of feedstuffs is undertaken for different purposes. The main ones are, firstly, to measure the extent to which one feed can replace another to support an animal function (i.e. a relative ranking of feedstuffs), secondly, to relate feed attributes to animal function (i.e. to give absolute values to feeds scaled according to an identified function, for example, provision of a first-limiting amino acid to support protein gain) and finally, to allow the prediction and/or control of animal performance through nutrition. For example, the performance responses of growing and breeding pigs to the energy and protein in any given diet is related to the amount of food eaten and to the concentration of digested, metabolised and subsequently used nutrients in the diet.

Thus, to optimise feed formulation for the pig requires a precise knowledge of the contents of digestible amino acids and energy in the feedstuff. This requires firstly, chemical analysis of amino acids and energy, combined secondly with measurement of digestibility.

Nutrient Requirement Studies

The performance of growing pigs is largely determined by the relationship between protein and energy intake. These relationships are modified by genotype and sex for any given weight. Although difference in growth performance have been reported between different strains of pigs by Campbell and Taverner (1988) and more recently by McPhee et al. (1991) and Singh et al. (1991, 1993), there is limited quantitative information on the effects of genotype on energy and protein metabolism in Australia—and practically no such information on Vietnamese strains of pigs.

The most definitive Australian information available on the responses of different genotypes to energy intake is probably that published by Campbell and Taverner (1988). Campbell and Taverner compared the performance in terms of protein deposition of a slow (A) and a fast (B) growing genotype. They showed that the protein deposition of strain A pigs increased linearly with energy intake up to 32 MJ digestible energy (DE)/day and then remained constant at about 132 g/day. In contrast to the B strain

pigs there was no evidence of a limit to protein deposition which increased linearly to about 190 g/day when fed ad libitum at about 40 MJ DE/day. This result suggests that the intense selection of these animals (strain B) has increased their ceiling for protein growth beyond the upper limit of appetite under ad libitum feeding regimes. Their findings are in contrast to McPhee et al. (1991), where the selected line reached a plateau at 32 MJ DE/day. However, this contrast could be because McPhee's line of pigs had not reached the same level of potential for lean growth as the fast growing line of Campbell and Taverner.

Knowledge of the relationship between liveweight and maximal protein and energy rates is basic to understanding how the nutrient requirements of the growing pig might change with pig growth. It is also needed to determine the body composition and growth capabilities of a pig at any stage of development between birth to maturity.

By determining lysine and energy (nutrient) requirements of the lines of pigs in Vietnam, and of the Adapted Strain, the target nutrition needs can be assessed. When combined with the data obtained from the feedstuff evaluation subprogram and incorporated in the AUSPIG model, pig production efficiency and profitability will be able to be improved, primarily because of optimised utilisation of feed resources for pig production.

Summary

The collaborative project between Australia and Vietnam has two main research directions:

- to investigate genetic methodologies to overcome the limits to efficient growth of lean pork mainly by factors that reduce the efficiency of food utilisation through high fat deposition and poor appetite; and
- to investigate chemically and nutritionally alternative feed ingredients as components for the formulation of cheaper, yet optimised diets for different pig breeds.

It is anticipated that improvement in pig meat quality and reduced production costs will result from research to be undertaken in Queensland into the genetic improvement of the efficiency of lean pork production. The research is expected to yield a strain of pigs with a high lean growth rate associated with high appetite and stress resistance.

Nutrition studies will be undertaken to determine the nutrient composition and availability of nutrient from alternative feed sources. This will be carried out simultaneously with nutrition studies to better determine the nutrient requirement of the improved strain in the typical environment in which it will be expected to perform, that is, determination on the most appropriate method to use these alternative feeds to optimise production and minimise costs.

The combination of a more efficient strain of pig with cheaper alternative (non-cereal) feedstuffs is clearly the best means to *'enhance competitiveness and sustainability of intensive pig production'*.

The results of the above applied research will be lost unless the technology transfer to the producer is in place. This research project has as an integral component; the transfer of technology and information to the pig producer. The main medium for transfer is the use of courses, both international and domestic, to train participants in areas of artificial insemination, genetic improvement and nutrition to ensure the flow of research results to the farm.

References

Blaha, J. and Mudrik, Z. 1990. A study on the nutritive value of Vietnamese feedstuffs. Agricultura Tropica et Subtropica, Universitas Agriculturae Praga 23, 89–94.

Campbell, R.G. and Taverner, M.R. 1988. Genotype and sex effects on the relationship between energy intake and protein deposition in growth pigs. Journal of Animal Science, 66, 676–686.

FAO 1991. VIETNAM: Livestock Sub-Sector Review and Project Identification Mission.

Hajas, P. 1989. Vietnam: Report on the Animal Production Sector, FAO.

Keele, I.W., Johnson, R.K., Young, L.D. and Socha, T.E. 1988. Comparison of methods of predicting breeding values of swine. Journal of Animal Science, 60, 3040–3048.

Lam, M.Y. 1993. A review of food research in Vietnam, with emphasis on post harvest losses. ACIAR Technical Reports, No 26.

McPhee, C.P. 1981. Selection for efficient lean growth in a pig herd. Australian Journal of Agriculture Research, 32, 681–690.

McPhee, C.P., Daniels, L.G., Kramer, H.L., Macbeth, G.M. and Noble, J.W. 1994. The effects of selection for lean growth and the halothane allele on growth performance and mortality of pigs ad libitum fed in a tropical environment. Livestock Production Science, 38, 117–123.

McPhee, C.P, Rathmell, G.A, Daniels, L.J and Cameron, N.D. 1988. Selection in pigs for increased lean growth rate on a time-based feeding scale. Animal Production, 47, 149–156.

McPhee, C.P and Trout, G.R. 1995. The effects of selection for lean growth and the halothane allele on carcase and meat quality of pigs transported long and short distances to slaughter. Livestock Production Science, 42 55–62.

McPhee, C.P., Williams, K.C. and Daniels, L.J. 1991. The effect of selection for rapid lean growth on the dietary lysine and energy requirements of pigs fed to scale. Livestock Production Science, 27, 185–198.

Molenat, M. and Thong, T.T. 1991. Pig Genetics and Production in Vietnam. Report 38 Department of the Centre for International Cooperation and Agronomic Research for Development. Jouy-en-Josas, France.

PRDC 1991. Research and Development Plan 1991–1996, Pig Research and Development Corporation.

SCA 1987 Standing Committee on Agriculture. In 'Feeding Standards for Australian Livestock: Pigs' CSIRO: Melbourne.,

Singh, D.N., Kopinski, J.S. and Williams K.C. 1993. Growth response of pigs to total dietary lysine: effect of breed and sex. In: Batterham, E.S., ed., Manipulating pig production IV. Australasian Pig Science Association, Attwood, Australia. p 223.

Singh, D.N., McPhee, C.P., Young, R. and Peters, R. 1991. Sex differences in lysine and energy requirements of growing pigs. In: Farrell, D.J., ed., Recent advances in animal nutrition in Australia 1991. University of New England, Armidale.

Stern, S., Johansson, K., Rydhmer, L. and Anderson, K. 1994. Performance testing of pigs for lean tissue growth rate in a selection experiment with low and high protein diets II, Correlated responses of lean percentage and growth rate. Agriculturae Scandinavica Section A. Animal Science, 44, 1–7.

Thong, T.T. and Kinh, L.V. 1993. The economic benefits of using farm by-products as feed for pigs in Vietnam. ACIAR personal communication, 1–10.

Thuong, N.V. 1992. In 'Handbook on nutrient composition of feedstuff in Vietnam' (in Vietnamese), Agricultural Publishing House.

Xuan, V.T., Hai, L.T. and Loc, C.B. 1995. Research priorities for improving animal production by agro-ecological zones in Vietnam. Proceeding of ILRI Consultation Meeting for the South-east Asian Region, IRRI, Los Baños, Philippines, May 1995.

Effects of Transport and Stunning on the Quality of Pork

Nguyen Ngoc Tuan, Dang Quan Dien and Luu Trong Hieu*

Abstract

One of the major concerns of processors, sellers and consumers is the quality of pork, which is known to be influenced by genetic composition, management, transport, slaughter and storage processes. Presence of pale soft exudative pork (PSE) is an indicator of bad quality.

In this study, experimental factors were applied to 600 pigs of pure and crossbred Yorkshire type, 718 pigs of Thuoc Nhieu (local breed in Mekong Delta) and 593 pigs of Bong (local breed in the coast of the Mekong Delta) to study incidence of PSE and other indicators of poor quality. These covered transport density, duration of pre-slaughter fasting, site of stunning and time of bleeding.

Density of pigs in the truck during transport strongly affected the occurrence of PSE. Fasting for 13 hours before transport lowered it compared with fasting for 1 hour although the difference was not statistically significant. The distance of transport from farm to slaughter house was also a causative factor, especially for exotic breeds of pigs. The effect of transport distance on PSE occurrence in Yorkshire pigs was stronger than in that of local breeds.

A method of stunning reduced the percentage of PSE by 18–22.3% and is now advocated. Overall, incidence of PSE meat in exotic breeds of pigs was 18.2–57.1% whereas it was 14–17.6% in local pigs. In exotic breeds, occurrence of PSE was highest in Belgian Landrace pigs, the next highest in pigs of adapted Landrace and lowest in Yorkshire and Duroc pigs.

HO-CHI-MINH City (HCMC) has a human population of five million who need daily about 260 t of carcases, of which 60% are pork, 21% red meat and 19% poultry. However, the production within HCMC meets only 22.7% of this requirement, hence there is a considerable movement of live animals from neighbouring provinces into the city. Most live animals are transported for from 4–24 hours by truck to the slaughter houses, a high number of which are small private abattoirs without basic hygienic facilities. Transport vehicles are unsophisticated and most butcher shops have no refrigerator, resulting in bad quality of meat. In this study, we applied some experimental factors related to transport and stunning to pigs of exotic breeds and local breeds in order to determine the occurrence of PSE which would be an indicator of poor quality of pork consumed in HCMC.

* University of Agriculture and Forestry, Thu Duc, Ho-Chi-Minh City, Vietnam.

Materials and Methods

The study was carried out with 800 pigs of purebred and crossbred Yorkshire type, 718 Thuoc Nhieu pigs (local breed in Mekong Delta) and 593 Bong pigs (local breed in the coast of Mekong Delta).

Experimental factors were applied separately in different experiments as follows:

- three levels of density of pigs of 80 kg liveweight in the truck during transport—0.30 m^2, 0.40m^2 and 0.60 m^2 per pig;
- duration of fasting pre-transportation: 1 hour and 13 hours;
- three distances of transport from farm to slaughter house : 36, 60 and 90 km; and
- four methods of stunning using low voltage (a–d, as shown below).

Methods	Duration of stunning (sec)	Location of stunning	Stunning–bleeding interval (sec)
a	10	Eye–opposite ear	25
b	3–5	Eye–opposite ear	25
c	10	Ear-ear	25
d	10	Eye–opposite ear	35

The animals were slaughtered at one industrial slaughter house and one small-scale slaughter house. Samples of 100 g from *M. longissimus dorsi* were removed and kept under refrigeration below 10°C. The quality of pork was assessed using the following parameters :

- ascertaining the pH at 1, 3, 8, 24 hours after slaughter using a pH meter (pH_1, pH_3, pH_8, pH_{24});
- determining water holding capacity as free water (FW) using the filter paper technique described by Pommier and Houde (1993); and
- checking for the occurrence of PSE using a colour-structure score for pig meat 24 hours after slaughter (Forrest 1963, cited by Dobrenov 1986).

Results and Discussion

Effect of density during transport

The incidence of PSE, water holding capacity as FW and pH under three transport densities is shown in Table 1.

All quality indexes showed that the higher the density, the worse the quality of pork, at least in the wet-hot climate of Vietnam. In Vietnam, the general densities recorded in industry use were 0.22–0.48 m^2 /80 kg liveweight (Bui Thi Xuan Thao 1994). According to Nielsen (1981) the maximum density should be 0.35 m^2 as there was a definite correlation between transportation and pork quality.

Influence of duration of fasting before transporting

The effect of a long and a short period of pre-transport fast is recorded in Table 2.

The fasting duration did not influence the occurrence of PSE meat and FW ($P>0.05$) in these experiments.

von Mickwitz (1981) stated that the increase in percentage of bad quality meat and in death rate due to transport stress resulted from a complex interaction of many factors including fasting and its duration pre-transportation. If animals were fasted for a long period, there would be a depletion of reserve glycogen in muscle, leading to dry, firm and dark (DFD) meat (Augustini and Fischer 1981). Our result did not accord with these findings. This may have been because of the small sample size and short distance of transport (20 km).

Table 2. Percentage of PSE meat and FW of pork related to pre-slaughter fasting duration[a].

Fasting duration	n	PSE (%)	FW (%)
1 hour	10	20	18.2
13 hours	10	10	18.8

[a] Density during transport was 0.6 m^2/pig.
PSE: pale, soft, exudative pork.
FW: free water.

Effect of transport distance

Results of observations made on pigs being transported three different distances to the point of slaughter are shown in Table 3.

Transport distance affected the occurrence of PSE in Yorkshire pigs more significantly than in local breeds ($P<0.05$). This finding was similar to our previous conclusion (Nguyen Ngoc Tuan 1989). As transport distance was increased, so the percentage of PSE increased in the crossbred experimental pigs which contained a high percentage of Yorkshire breeding.

Effect of stunning methods

Observations were made of four methods of stunning with low voltage instruments (see Table 4).

Table 1. Effect of transport density on indexes of meat quality[a].

Density (m^2/pig)	Sample size	PSE (%)	FW[c] (%)	pH_1[b]	pH_{24}[c]
0.30	20	75.0	21.5	6.14	5.71
0.40	19	47.3	19.5	6.24	5.77
0.60	12	16.6	16.8	6.58	6.06

[a] The transport distance was 60 km.
[b] pH 1 hour after slaughter.
[c] pH 24 hous after slaughter.
FW: free water.
PSE: pale, soft, exudative pork.

Table 3. PSE meat incidence of three genetic groups as effected by transport distance.

Distance	Yorkshire		Thuoc Nhieu		Bong	
(km)	n	PSE (%)	n	PSE (%)	n	PSE (%)
120	91	52.80[a]	100	34.00	93	15.10
90	108	37.04[b]	112	27.70	112	24.00
30	113	23.90[c]	na	na	na	na

a,b,c significant difference at P<0.05.
na: not available.
PSE: pale, soft, exudative pork.

The results showed that stunning for 10 seconds and a stunning–bleeding interval of 25 seconds was the best method to minimise PSE incidence.

The occurrence of PSE meat in genetic groups raised at farms in HCMC

Seven different genetic groups from this location were studied to determine incidence of PSE pork after slaughter (see Table 5).

Though sample sizes were not large, the data support the conclusion that the higher the amount of Landrace in the breeding, the higher the percentage of PSE meat is likely to result.

Conclusion

In the study it was found that the pre-slaughter density of pigs in the truck during transport strongly

Table 4. Variation of PSE occurrence in genetic groups due to stunning.

Stunning*	Yorkshire		Thuoc Nhieu		Bong	
methods	n	PSE (%)	n	PSE (%)	n	PSE (%)
a	102	24.5[a]	106	7.6[d]	100	14.0[g]
b	98	39.8[b]	106	31.1[e]	102	36.3[h]
c	112	32.1[ab]	100	21.0[de]	98	24.5[gh]
d	104	44.2[bc]	104	35.6[ef]	88	28.4 [hi]

* Details are presented in Materials and Methods.
a,b,c : significant difference at P<0.05 between stunning methods in Yorkshire pigs.
d,e,f : significant difference at P<0.05 between stunning methods in Thuoc Nhieu pigs.
g,h,i : significant difference at P<0.05 between stunning methods in Bong pigs.
PSE: pale, soft, exudative pork.

Table 5. PSE percentage in various genetic groups.

Genetic groups	Sample size	PSE (%)
Pure Y	15	20.0
½ Y × ½ L	16	31.3
½ Y × ½ Lb	10	40.0
¾ Y × ¼ L	16	27.7
¼ Y × ¾ L	14	42.9
¼ Y × ¼ L × ½ D	30	26.7
¼ Y × ¾ Lb	7	57.1
½ L × ½ D	11	18.2

Y: Yorkshire; L: Landrace; Lb: Belgian Landrace; D : Duroc.
PSE: pale, soft, exudative pork.

affected the occurrence of PSE pork. The effect of transport distance on the occurrence of PSE meat in Yorkshire pigs was greater than that of local breeds. Stunning for 10 seconds with the stunning–bleeding interval of 25 seconds reduced the percentage of PSE by 18–22.3% compared with other methods .

PSE meat in exotic breeds of pigs was 18.2–57.1% whereas it was 14–17.6% in local pigs. In exotic breeds, occurrence of PSE was highest in Belgian Landrace pigs, followed by pigs of adapted Landrace breeding and lowest in Yorkshire and Duroc pigs. These results are beneficial in the search for methods to improve the quality of pig meat in Vietnam.

References

Augustini, C. and Fischer, K. 1981. Physiological reactions of slaughter animals during transport. In: Moss, R. ed., Transport of animals intended for breeding, production and slaughter. London, Nijhoff, Martinus, pp. 125–132.

Bui Thi Xuan Thao. 1994. Surveying the transportation and slaughter process at Vissan (in Vietnamese). Bachelor Thesis, University of Agriculture and Forestry, HCMC, Vietnam.

Dobrenov, B. 1986. Studies on dry, firm and dark and pale, soft exudative pig meat. Master of Veterinary Science Thesis, University of Queensland, Australia.

Nielsen, N.J. 1981. Recent results from investigation of transpiration of pigs for slaughter. In: Moss, R. ed., Transport of animals intended for breeding, production and slaughter. London, Nijhoff, Martinus.

Nguyen Ngoc Tuan. 1989. Studies on PSE of pig meat (in Vietnamese). Journal of Agriculture and Forestry Science and Techniques 1,2, 43–50.

Pommier, S.A. and Houde, A. 1993. Effect of the genotype for malignant hyperthermia as determined by a restriction endonuclease assay on the quality characteristics of commercial pork loins. Journal of Animal Science 71, 420–425.

von Mickwitz, G. 1981. Various transport conditions and their influence on physiological reactions. In: Moss, R. ed., Transport of animals intended for breeding, production and slaughter. London, Nijhoff, Martinus, pp. 44–55.

Social Features and the Development of Swine Production in Vietnam

Le Than Hai*

Abstract

Pork contributes greatly to meat consumption in Vietnam. Swine production not only produces this meat but also lifts the income of poor farmers who utilise improved breeds.

After having selected upgraded indigenous breeds and crossed them with exotic breeds since 1980, improvements have been found in daily weight gain, feed conversion, duration of fattening, lean meat percentage and backfat thickness. These improved breeds match the need for commercial production. The above-mentioned results have been aided by the improvement of feed, animal care, technical management, disease control and husbandry extension services.

For swine production to develop further, more attention should be given to technical investment, breeding, veterinary management, desirability of stable production and efficient utilisation of feedstuffs in each ecological zone. On the other hand, problems of marketing, environmental sanitation and rural development should also be mentioned as requiring attention.

Basic Features of Pig Production and the Pork Market in Vietnam

VIETNAM is an agricultural country with more than 60% of its labour force involved in agricultural production. However, farmers' income is rather low, averaging less than US$300/per capita/annum. At present, the main food protein of animal origin is pork, which contributes more than 70% of total dietary meat consumed by the Vietnamese people. Therefore, it is necessary to develop livestock production, especially that of the pig, to fulfill the demand for meat for local consumption and to increase the income of resource-poor farmers.

In 1994, the country's total pig herd was 15 million head distributed between seven agroecological zones as in Table 1.

Breeding stock, feed resources and growing practices are quite different in different regions of the country. From the Central Coastal Region to the North, farmers grow mainly pigs of local breeds which have low growth performance and high feed conversion (FCR) Therefore, in this area, pig rearing is mainly a means of saving.

* Institute of Agricultural Sciences of South Vietnam, 121 Nguyen Binh Khiem Str. Dist 1, Ho-Chi-Minh City, Vietnam.

The breeding stock of the South-eastern Region is the best in the whole country. In this region there are extensive pork markets and plenty of formulated feeds; therefore, with good breeding stock farmers raise pigs as a commodity. In the Mekong Delta the two main improved breeds are Ba Xuyen and Thuoc Nhieu which have better growth performance than breeds of other regions; however, the fat proportion in the carcase of pigs of these two breeds is rather high.

Consumer demand for high quality pork is increasing and this has brought about a difference of 3000–4000 VND/kg in the price of very lean and high fat pork.

Pig manure is used mainly in crop production and to produce biogas to some extent. This helps to conserve the environment and to provide a stable energy source for home consumption.

Results of Research on, and the Development of Pig Production in Vietnam over the Past 15 Years

Artificial insemination for pigs

As mentioned earlier, the existing breeding herds in Vietnam are mainly of local breeds; only about 10% are of adapted exotic breeds which are kept in state and small-scale private farms. These farms are mainly in the South-eastern Region.

Table 1. Pig population in the seven agroecological zones of Vietnam.

	Agroecological zones	Total pigs ('000)	Breeding sows ('000)	Feeder pigs ('000)
1	North. Highlands and mountain areas	3957.9	563.6	3397.6
2	Red River Delta	3510.5	557.4	2936.7
3	Northern Central Region	2552.4	324.0	2220.0
4	Central Coastal Region	1475.5	198.0	1272.0
5	Central Highlands	573.0	90.0	483.8
6	South-eastern Region	1031.9	133.7	1009.0
7	Mekong Delta	2284.3	240.4	1985.4
	Whole country	15 564.0	2180.0	13 304.0

Source: Bureau for National Statistics 1993; Vo Tong Xuan et al. 1995.

The possiblities of artificial insemination are increasingly being recognised. Partly aided by this, crossbred feeder pigs have increased in number and reached 60% of the total herd. In provinces with a high proportion of local breeds, the crossbred has increased mean liveweights of finishing pigs from 45 kg to 65 kg/head (Tran The Thong 1988).

Selection and improvement of adapted exotic breeds in the humid tropics

Apart from pigs of local breeds, we have screened and disseminated the Yorkshire breed as a basic breed in the development of two-way and three-way crossbreds. These crossbreds help to increase pork production and carcase quality and fulfill consumer demand for such meat. After 15 years of selection, the genetic potential of the national herd has been much improved. Meanwhile, we have also defined three-way crossings of existing genetic resources to improve carcase quality of finishing pigs (Nguyen Thien and Pham Nhat Le 1985; Le Thanh Hai et al. 1995). Some data are reported in Table 2.

Feed

Good results on improving feed quality have been obtained, such as the determination of nutrients in different feedstuffs that can be used in the computation of different feed combinations; the determination of the requirements for protein, energy and other nutrients, mainly minerals, vitamins and amino acids for different breeds at different ages. The most significant progress in studies on animal nutrition has been the formulation of rations for breeding sows and feeder pigs at different production periods. These data help to increase economic efficiency (Le Thanh Hai and Nguyen Nghi 1994).

Rearing practices and technical management

During recent years, feeding and management of breeding sows, weaned piglets and feeder pigs have received much attention. Many production units have changed managerial practices for breeding sows and gilts by rearing each in a separate pen. This has helped to increase insemination success and birth rate because of fewer errors. In addition, improved

Table 2. Growth and carcase characteristics of screened Yorkshire and three-way crossbred pigs.

Breed	Av. daily gain (g/day)	FCR (kg/kg)	Days to 90 kg LW	Lean Meat /carcase (%)	Back fat thickness (mm)
Yorkshire					
1980	434	4.90	240	47.5	31.3
1995	523	3.65	210	53.0	27.7
Three-way crossbred					
1995	583	3.20	190	57.0	23.0

FCR: food concersion ration.
LW: liveweight.

feeding of piglets has brought about reduction of the weaning period from 45–50 days to 28–30 days, an increase in the birth rate of sows from 1.8 litters/year to 2.2 litters/year and an increase in the liveweight of weaned piglets from 12–14 kg/head to 19–22 kg/head. The use of crates for bearing sows has reduced the death rate of pre-weaned piglets from 18–19% to 12–13%. Technical progress in the feeding and management of breeding sows, pre-weaning and of weaned piglets have increased the daily weight gain of feeder pigs from 450–580 g/day, and reduced their feed conversion ratios (FCR) from 4.5 to 3.2.

Disease control

- vaccination is a popular practice in industrial and small-scale pig farms, but the quality of vaccines including their stability is not reliable; and
- the application of appropriate rearing practices, feed formulation and feeding and antibiotic supplementation alleviates diarrhoea in piglets—this reduces the death rate of pre-weaning and weaned piglets and increases the economic efficiency of pig production (Le Thanh Hai et al. 1994).

Agricultural extension and transfer of technology to farmers

Research and the education system have recommended and transferred advanced technology to farmers through agricultural extension with various communication media, such as radio and television, technical leaflets, training and technical advice to farmers. Research and the agricultural system have also established networks of technical staff, demonstration farms for appropriate feeding, rearing management, and a supply of certified boars, plus artificial insemination services and disease management. Therefore it is asserted that appropriate technologies have been transferred to production and this has helped farmers increase the economic efficiency of pig production and acquire new concepts in technical management for a better financial return.

Problems Confronting Pig Production

Policy

Research on and development of high quality breeding stock, animal nutrition, feed and feeding systems and appropriate production systems for each agro-ecological zone are not given enough attention. New rearing techniques are not well understood by small-scale farmers. In addition, credit and marketing systems are not well organised, therefore livestock production is not able to keep pace with the development of the national economy and demands of society. There is no appropriate investment policy for resource-poor rural areas.

Management

Breeding stock is not systematically managed. There are no recorded data for breeding animals or even for feeder pigs. There has been an attempt to increase the lean meat percentage of national herds but local technical staff and producers do not pay attention to the management of breeding stock (sows and boars); the culling of poor quality sows and boars is infrequently carried out. Therefore growth performance, carcase quality and the economic efficiency of pig production are still rather low.

Feed and feeding systems

Local feed resources are abundant, but both quantity and quality are not stable and not balanced throughout the seasons. For example in the southern provinces, during the maize harvesting season and rice exporting period, the feeding of energy-rich sources is common, but these feeds are very limited in the off-season. Therefore the processing and storage of feed to keep balanced feed resources all year round play an important role in the development of livestock production in the country. In addition, research on the efficient utilisation of locally available agro-industrial by-products should be carried out.

Veterinary aspects

The prevention of diseases and the control of epidemics are rather important in reducing losses in livestock production. Therefore, vaccination and disease control must be widely and effectively carried out in rural areas. Sanitation and environmental conservation in all livestock industries should be given full attention.

Marketing

The marketing of inputs and production outputs is facing many difficulties that inhibit the development of livestock production.

Agricultural extension

Agricultural extension plays an important role in the transfer of technology to farmers. Through agricultural extension farmers may have opportunity to learn about and adopt advanced rearing practices, production management and marketing. However, the infrastructure for extension is still far from meeting the need and thus is limiting the process of technology transfer to farmers. Therefore assistance to agricultural extension is required to aid the transfer of technologies to small-scale farmers.

Conclusions

- At present, the problem in rural areas of Vietnam is that of the more than 10 million farm households, about 22% are resource-poor and 40–50% of children under five years of age are malnourished. Programs for the development of livestock production are of highest priority. Appropriate technologies, especially indigenous knowledge, should be widely transferred to production. In addition, vaccination, the utilisation of locally available feed resources, the use of qualified breeding stock and the sanitation of pens are the musts for commercial production systems.
- In the near future, livestock production will not only provide enough food of animal protein origin for local consumption, but also for export.. Therefore, it is necessary to apply advanced technologies to livestock farms where there is sufficient capital to utilise them.

References

Bureau for National Statistics. 1993. Statistical data of 1992 (in Vietnamese).

Le Thanh Hai, Doan Van Giai, Le Pham Dai and Vu Thi Lan Phuong. 1995. Studies on the growing and fattening capacity of two-way crosses with exotic pig breeds under the tropical conditions in Vietnam (in Vietnamese). Pig News and Information, 16, 261N–263N.

Le Thanh Hai, Nguyen Nghi, Nguyen Thi Vien, Nguyen Huu Thao and Phan Bui Ngoc Thao. 1994. Results of studies and on-farm trials of different rations for pregnant sows of exotic breeds (in Vietnamese). Agriculture and Food Industry, 9, 345–346.

Le Thanh Hai and Nguyen Nghi. 1994. Attentions in the feeding to and management of pigs of exotic breeds in small-scale farms (in Vietnamese). Agriculture and Food Industry, 1, 22–26.

Le Thanh Hai, Nguyen Thi Vien, Tran Thu Hang, Nguyen Huu Thao and Doan Van Giai. 1995. The determination of several three-way crosses in order to produce feeder pigs having high lean meat percentage (in Vietnamese). 1995 Annual Scientific Report Review at IAS.

Nguyen Thien and Pham Nhat Le. 1985. Results of studies on the cross of 'Hybrid Pig' in Vietnam (in Vietnamese). Agriculture and Food Industry, 4/1985.

Tran The Thong. 1988. Pig production research in Vietnam (in Vietnamese). Pig News and Information, 9, 1/16–1/18.

Bureau for National Statistics. 1994. Statistical Data of 1993 (in Vietnamese). Statistical Publishing House, Hanoi.

Vo Tong Xuan, Le Thanh Hai and Chau Ba Loc. 1995. Research priorities for improving animal production by agro-ecological zones in Vietnam. ILRI Consultation for South-east Asian Region. IRRI, Los Baños, Philippines, 10–13 May 1995.

Customers for Animal Science Research in Vietnam: What Do They Need?

Chris Landon-Lane*, Nguyen Ngoc Kinh,† Nguyen Dinh Hung†, and Bui Khanh Ban§

Abstract

Research is valuable when people can obtain benefits from it. It is recognised that agricultural research can enhance agricultural growth and provide Vietnam with short-term and long-term benefits to the economy. The majority of livestock, pigs and poultry in Vietnam are produced by small farmers in a system which frequently includes all three types of animals and is integrated with a complex system of annual and permanent crops. In this paper, it is proposed that to achieve the potential benefits from animal science research, a large part of any research program and its methods must relate closely to the typical small farming systems present in Vietnam and the social, economic and environmental conditions in which these farmers work. Implications for research are drawn from a study of farm households in villages in the northern midlands, which is one of the major livestock producing regions of Vietnam.

Why Research in Agriculture?

AGRICULTURAL development is widely recognised as one of the primary components of national economic development strategy (see, for example, Meier 1989 and Todaro 1989), because besides improving the lot of rural people, agricultural growth generates food, employment and income for rural non-farm and related urban sectors of the economy. The majority of people in developing countries live and work in rural areas. Vietnam is no exception, with an urban/rural population distribution of 80% rural, 20% urban, with 71.9% of workers in Vietnam engaged in agriculture, forestry or fishing occupations (World Bank 1993).

The need to give greater priority to agricultural research and extension in Vietnam has been emphasised in a recent FAO report (Mellor 1993). Less clear are the optimal direction and strategies which agricultural research should adopt at each level of production. This paper begins with an overview of some of the factors underlying the current animal production situation in Vietnam. The focus narrows down to the small farming household to identify some of the major constraints to production and some of the opportunities for reducing these constraints through research in animal science and related fields. The interrelationships between components of the agricultural sector on a national scale parallel similar interrelationships at the level of the basic production unit, the small farming household.

Sectoral Interdependence Within Agriculture

Agricultural production is increasing in Vietnam, but demand may be increasing at a greater rate. In view of the already extremely low consumption levels of meat (around 12 kg liveweight/capita), and high income elasticity of demand for meat, demand for meat products is expected to rise with growing incomes (World Bank 1993). However, prices of cereals and food are increasing (17.8% for the first half of 1995), because of increasing demand, higher

* Faculty of Agriculture, Forestry and Horticulture, University of Melbourne, Parkville, Victoria 3052, Australia.
† Department of Agricultural Science and Technology, Ministry of Agriculture and Food Industry, Bach Thao, Hanoi, Vietnam.
§ National Institute of Nutrition, Hanoi, Vietnam.

incomes and inflation. Increasing prices for food will have the greatest effect on the majority of the population, that is, on people who have low or average incomes (Mai 1995). At the same time, there is a growing urban market which is becoming more discerning of produce quality, reflected in premium prices paid for high quality, lean and tender meat (World Bank 1993). Growth of livestock production is expected to come from the commercial sector and from backyard or small farm production, especially in areas of significant grain surpluses. This situation presents opportunities and threats to the animal industries in Vietnam, both of which influence optimal research strategy for animal sciences.

One opportunity is that increasing prices and demand for meat will encourage further investment in animal production. There is, however, the threatening possibility that increasing demand and price for cereals will constrain the supply of feed available for increased animal production. There has been a consistent overall surplus in cereal production over consumption since 1989, but this surplus may be eroded if the use of rice as animal feed increases from its current level of 5–15% of total paddy production (World Bank 1993). Import of feed grains is discouraged and production of potential feed crops (e.g. maize, sweet potato, and cassava) has been declining. Surpluses of rice could thus decline if rising incomes drove up the price of meat. In response, during the past year the government imposed strict export quotas and has even stopped rice exports if they threatened domestic food security (Mai 1995). Implied from these interwoven factors is that animal science research into profitable alternative feeds, animal health and farming systems will not only benefit the growth of animal industries, but also play a major indirect role in national food security and the ability of the country to generate foreign exchange.

Animal Production by Small Farming Households

To identify the developmental implications of these interrelationships for the animal industries, the authors studied a recently established database[a] on small-farm households in Vinh Phu province in the northern midlands of Vietnam. The main objective of this study was to identify and describe the economic relationships between animal production and other enterprises within the farming system. It was then possible to assess the critical factors in animal production at household level, and to identify the main animal enterprise to which capital and other resources were being directed by farmers.

For this study, the 200 households in the sample were stratified into five levels of wealth, using socio-economic indicators such as the size, construction and age of the family house, number of electrical appliances owned, vehicles for transport, and self-declared annual financial income. Annual production figures from each of the main components of the farming system for each household were extracted from the database. To facilitate comparison, the annual value of production from each component enterprise was imputed by multiplying the quantity of annual production by the average local market price for each product. These values were then expressed as averages for households in each wealth level. From the resulting information (see Table 1), three observations can be made:

- the value of production from each component enterprise of the farming system increases with increasing household wealth;
- the value of animal production is the second largest component of the farming system (after rice production) in all wealth levels except the poorest; and
- the proportional contribution of animal production to a household's total value of production increases with increasing wealth.

The first observation suggests an obvious conclusion, that is, that greater production leads to greater wealth. However the fact that production values from all component enterprises increase together highlights the integrated nature of the farming system, in which strategic use of resources results in multiple outputs. Certain benefits are internalised in the farming system, for example manure from livestock is a valued fertilizer, pigs assist in the safe disposal of household wastes, and free-ranging chickens reduce insect populations in home gardens. In their current situation the households prefer the outputs and benefits obtained from a mixed farming system. The preferred mix of outputs is determined in major part by a household's requirement for access to food throughout the year, but it is also determined by the quality and quantity of land, labour, capital and other resources available. The need for capital and the role of an effective agricultural credit system to provide it is widely recognised (e.g. World Bank 1993; FAO/UNDP 1994). The Government established a rural credit scheme in 1991 and has now made loans to 35% of all peasant households, but some 70% still

[a] The database, held by the statistics centre of the Department of Agricultural Science and Technology (MAFI), was established from surveys in Khai Xuan and Vo Lao communes conducted by the authors in 1992 and 1993. The database holds agricultural, social and economic information from 200 households and local markets.

Table 1. Value of production in one year from the main components of the farming system of households at different wealth levels. All values in '000 VND.

Wealth level	Rice	Other staples[a]	Animals[b]	Fish	Home garden
1	170	40	30	3	20
2	390	120	170	18	60
3	580	130	330	27	100
4	670	160	440	76	180
5	1270	280	1190	520	367

Source: survey of 200 households in Khai Xuan and Vo Lao communes, MAFI 1993.

[a] cassava, sweet potato, maize .

[b] cattle, buffalo, pigs, poultry.

lack sufficient finds for investment in production (State Planning Committee 1995). Lack of capital in the Vinh Phu study sample was cited by farmers as the main reason why they purchased (and sold) only one or two piglets and one calf per year. Other resource constraints are discussed later in this paper.

From the remaining two observations it is suggested that after a household achieves a certain basic level of food security through crop and animal production, an increasing proportion of the resources available to the household are directed into animal production.

The farmer, as a rational person, is most likely to direct any surplus into the type of animal production from which it is easiest to obtain a profit (financial profit or other benefit). Livestock numbers and species in the sample of Vinh Phu households increase with increasing wealth level, but the largest increase is in the number of poultry (Table 2). Poultry production, with pig production next, are the enterprises favoured for expansion by small farmers.

Table 2. Numbers of animals produced by households in different wealth levels in 1993.

Wealth level	Poultry	Pig	Cattle and Buffalo
1	13	1	0
2	13	1	1
3	17	2	1
4	19	2	1
5	21	2	1

Source: survey of 200 households in Khai Xuan and Vo Lao communes, MAFI 1993.

The Poultry Sector

Bagust (1994) observed that the poultry sector across most of Asia is undergoing rapid expansion, and identified feed availability and poultry health as the major constraints to stable development of poultry production at all levels of technology. He also explained that by improving the efficiency and quality of low to medium intensity production, there are social and economic benefits to be gained by large numbers of rural households and their communities. The preference towards poultry production in this study of Vinh Phu farm households is congruent with the main conclusion made by Bagust, which was that poultry is an ideal production vehicle for reasons of food needs, product value and the existing knowledge base. From this Vinh Phu study, it can be added that poultry production is ideal because of the capital (and other) requirements for expanded production are within the capacity of many households at village level. A recent FAO study found that hatcheries for the production of ducklings and chicks were generally quite profitable and in all cases a ready market was available for all output (FAO/UNDP 1994).

Food Security and Animal Feeds

Food security is nevertheless an important concern of small farming households, and it must reach a satisfactory level before resources will be diverted to animal production for the market. The level of food production that allows households a satisfactory level of food security is ultimately decided by each individual household. A simple estimate of the level of food supply that satisfies basic needs can be made from the per capita energy requirements of 2023 Kcal/day (World Bank 1993). This may be roughly translated into an annual per capita intake of not less

than 200 kg of rice equivalents[a] (King and Burgess 1993). In the Vinh Phu study sites, this level of rice production per capita is only achieved by wealthier households (i.e. at levels 3, 4 and 5). Households at the poorer two wealth levels (i.e. levels 1 and 2) are unlikely to have surplus staple crop production to divert into animal production. Feed for the livestock of those households with lower crop production is mostly obtained from grazing communal lands (e.g. bunds in rice fields), from cut-and-carry fodder collection, from grazing in forest lands, from rice hulls and household wastes.

Land and Forage

Land on which to expand feed production is very limited. In the study sites there was an average of 0.06 ha of agricultural land per household, compared with the national average of 0.1 ha per capita (Anon 1993). In general the amount of available land per capita is diminishing due to the population increasing at a national rate of 2.2% (State Planning Committee 1995). Pressure on forest land and watershed areas has been increasing, with the result that more than 160 000 ha of forest land is degraded (Thuan and Bong 1994). In 1994 Vietnam's Law on Environmental Protection was put into effect, and this law forbids the destruction of forests. Already there are calls for local administrators to promulgate concrete regulations forbidding the common practice of allowing cattle to forage freely (Thi 1994). Researchers in animal sciences must keep ahead of these changes to develop alternative forage resources within farming systems, and work with foresters to develop agroforestry techniques that provide forage while at the same time ensure trees are protected until harvest. The Government has indicated support for this argument stating the following guiding principles at the VII Party Congress in 1992:

'Sustainable rural development is to be tailored to local conditions in balanced multi-sectoral, multi-disciplinary and multi-cultural approaches involving agriculture, forestry and fisheries production and processing industries' (Party Central Committee 1992).

Support Services Activity

Many households have developed intensive animal industry activities (zero-grazed cows, pigs) and hatcheries without technical assistance, most having learnt by observing others (FAO/UNDP 1994). Lack of technical knowledge and funds has resulted in a highly variable technical and economic state of these activities at household level. Provision of agricultural support services research and extension services to farmers by government has been severely restricted by decreasing budgets, devaluation of civil service salary rates through inflation and other factors (World Bank 1993).

Those kinds of service that involve a marketable product or service (such as artificial insemination and seed certification) are continued with some success, but other areas such as smallholder agricultural research have been neglected. The necessity to generate funds from research and other services has led to competing research institutes. These sometimes see no advantage in limiting activities to, for instance, development of animal production technology while a rival institute reaps a financial benefit through sales of livestock for outgrowing. One opportunity to improve this situation is by negotiation of cooperative research and revenue-sharing agreements between institutes and universities, perhaps in collaboration with foreign partners of which there are a number of suitable candidates already present in Vietnam.

The supply of services on a contractual basis (fee for service) has sustained institutional enterprise and led the way for private enterprise competition in the supply of these services. A concern is that services are in large part reaching only the commercial sector which has the production capacity and capital to pay for these services. On the other hand, the potential of the small farm sector remains constrained by lack of knowledge, technology, and veterinary and other services. The productive potential of the small farm sector is undoubtedly high (see for example FAO/UNDP 1994 and World Bank 1993) and there are improved market-oriented production technologies which are suitable for adaptation to the situation and resources of typical rural households. For examples, the reader may refer to the models of Bagust (1994), the on-farm research of the University of Agriculture and Forestry near Ho Chi Minh City and the small-farm beef production techniques being extended by the Binh Dinh Department of Agriculture as a basis for frozen meat exports from that province.

Conclusion

The prospects for an expanded animal production industry in Vietnam are favoured by increasing demand and increasing incomes in some (mostly ur-ban) areas. The role of agricultural research and its extension will continue to be crucial in the development of

[a] Conversion ratios: 1kg paddy rice = 0.7kg maize = 2.3kg sweet potato = 2.3kg cassava = 0.5kg soya beans.

Vietnam's potential and for the better well-being of its people. Researchers, together with the hard-working farming population have in the past few years achieved great gains in agricultural productivity and other benefits. Their understanding and proximity to their major customer, the small farmer, is one of the factors which has led to these achievements, and this strategy should be continued and not neglected despite the current budgetary constraints. Small farmers are not only customers in the sense of revenue they can pay for services, but are also partners in developing the core business of research in agricultural science. Strategies for animal science research must be developed with an appreciation of its place in the wider agricultural sector, and in accord, rather than in competition with the basic needs and resources of the basic unit of production—the small farm household.

References

Anon 1993. Thanh Hoa District Agriculture Statistics 1992. Vinh Phu Department of Agriculture, Viet Tri.

Bagust, T.J. 1994. Improving health for a poultry industry in Asia: a developmental perspective. Avian Pathology 23.

FAO/UNDP 1994. Agro-industry for rural employment generation in Vietnam. TSS-1 Technical Support Services at Programme Level, Report No. VIE/94/O1T, FAO, Rome.

King F.S. and Burgess A. 1993. Nutrition for Developing Countries. Oxford University Press, London.

Mai, Nguyen 1995. Balancing growth against high inflation (in Vietnamese). State Committee for Commerce and Investment article in: Vietnam Investment Review 17–23 July.

Meier, G. 1989. Leading issues in Economic Development. (Fifth edition) Oxford University Press, New York.

Mellor, J. 1993. An agriculture-led strategy for the economic transformation of Vietnam: Policy and Priority. State Planning Committee of Vietnam/ FAO, Rome.

State Planning Committee, 1995. Vietnam's country report on social development. Prepared for the World Summit on Social Development, Copenhagen, 6–12 March 1995. Government of the Socialist Republic of Vietnam, Hanoi.

Thi, Le 1994. Gender, environment and development. Paper presented to a workshop on Canada/Vietnam project VIETPRO 2020, November 9–11, Hanoi 1994.

Todaro, M. 1989. Economic development in the third World (Fourth edition). New York, Oxford University Press.

Thuan, Cao Tien and Bong Nguyen Dinh. 1994. Report from the General Land Management Office (in Vietnamese). In: Clean environment and sustainable development. Science and Technology Publishing House, Hanoi.

World Bank, 1993. Viet Nam: Transition to the Market. Country Operations Division, Country Department I, East Asia and Pacific Region, World Bank, Washington DC.

Livestock Development in Relation to the Territorial Structure of the South-eastern Zone

Tong Quang Minh*

Abstract

The South-eastern agricultural zone (SEZ) comprises mostly industrial crop systems. Its animal products contribute only 23% to the value of agricultural production, but it is considered an agro-ecological zone of plentiful animal production with breeds of high quality available.

Although feed production is well developed, the exploitation of fodder still has some limitations that create an imbalance in feeding cattle. Industrial pig and poultry production are more favourable and techno-economic parameters of pig husbandry especially have been distinctly improved. In dairy cattle production, the zone has a diverse crossbred herd suitable for household farmers.

The development of dairy cattle, pig and chicken industries will be still accorded some priority in the reorganisation of socioeconomic activities included in the long-term planning of the SEZ . On the other hand, attention should be paid to the upland crop-animal systems in rural development and to the expansion of livestock production in the north and the west of the SEZ.

THE SEZ is located at the end of the Truong Son mountain chain, bordering the Central Highlands and Central Coastal zone to the east, the Mekong Delta to the west, Cambodia to the north and the East Sea to the south. The SEZ comprises Ho-Chi-Minh City (HCMC) and four provinces, namely Dong Nai, Song Be, Tay Ninh and Ba Ria-Vung Tau. The soil of the SEZ consists of two major groups, red basaltic soils and grey soils.

In 1993 the value of agricultural production was $US518 000 000 to which animal products only contributed 23% and comprised 64 500 million t of pig, 10 600 million t of buffalo and cattle, 10 200 million t of chicken and 11 000 million t of milk. Understanding the current status of animal production in the SEZ can assist approaches to research in animal sciences for this territory.

Method of Approach

This presentation focuses on recent livestock development as affected by the exploitation of the regional environment and availability of resources. Statistical data used in this paper have been elaborated from that of the Statistical Office of HCMC.

Future performance of animal husbandry will be influenced by existing livestock numbers, data which have been gathered by the Institute of Agricultural Science of South Vietnam (IAS) and the Agricultural Service of Ho-Chi-Minh City (ASH) which have been reported since 1993. In terms of identifying the trend of livestock development, the documents 'Strategic Directions for Socio-economic Development of the Southern Plain in the period 1991–2000' (Economic Institute of HCMC 1992) and 'Direction of Agricultural Extension Works and Their Needs for Investment Programs by the year 2000' (Ministry of Agriculture and Food Industry 1994) were studied taking account of the relationship between the animal sector and the environment, and planning for sustainable livestock development.

Achievement in Animal Production

In 1994, the animal population of SEZ was as follows (in '000s):

	Numbers in SEZ	% of national total
Buffalo	135.2	4.6
Cattle	208.5	6.0
Pig	832.2	5.3
Poultry	10 519.5	7.6

* Institute of Agricultural Sciences of South Vietnam, 121 Nguyen Binh Khiem St., Dist 1, Ho-Chi-Minh City, Vietnam.

Although the animal herd in the region is not large, livestock development has played an important role in South Vietnam, because of the presence of high quality breeding stock and good feeding. The SEZ has become an area of good breeding stock and animal feed for other zones. In 1993, the value of animal products from the SEZ was $US118 000 000 and with a contribution of 8.6% to that of the whole country.

In addition very modern slaughtering and processing equipment and many veterinary medical services and materials originate from HCMC. In Dong Nai Province, $US25 700 000 have been invested in six animal husbandry projects, feedmills and animal product processing-plants. Joint ventures of milk processing and poultry production were also established in HCMC and Song Be Province.

Status of Animal Breeds

Ruminants

The dairy cattle industry has become increasingly important in animal production in the SEZ. Specifically, there were 10 420 head in HCMC in October 1994 with productivity having increased from 9.5 L/cow/day in 1990 to 11.9 L in 1993. In 1990, 81% of small-scale dairy farmers kept a herd of 3.7 head (Cuong et al. 1993), herd size reaching 4.6 in 1993 when Holstein crossbreds comprised 93% of the dairy cattle population.

Dairy productivity in different breeds is shown in Table 1.

Thousands of French straw semen doses have been used in artificial insemination (AI) to produce these preliminary results in milk production. Recently, the SEZ also imported a great number of semen doses from Mexico, Spain and New Zealand. Dairy production can also be contributed to by buffalo and goat raising.

Straw semen of Alpine and Saanen goats from France are being monitored for use in AI at the Binh Thang Animal Research and Development Centre, an agency of the IAS. In addition, three other breeds of goat were imported from India, namely the Beetal, Jamunapary and Barbary which are being acclimatised at the Ruminant Research and Development Centre of the IAS. To realise their potential, Murrah buffaloes and their crossbreeds should be moved to the Mekong Delta as multi-purpose animals for rural development (Minh 1994). On the other hand, Song Be and Tay Ninh Provinces in the north and the west of SEZ, can be exploited for beef, whilst the use of male calves could be developed in Dong Nai Province and HCMC.

Pigs

There are now some pig breeding programs in intensive or semi-intensive pig production units designed to meet high quality export requirements of more lean meat and less fat. Householders in Bien Hoa and Go Vap together with state pig farms in Thu Duc and Thuan An have become breeding farms both for farmers in the south but also for those in the north of Vietnam.

After two decades, the techno-economic parameters of pig production have been distinctly improved (Table 2). The reduction of the growing period, the improvement of feed conversion and the increased number of weaned piglets/sow/year have brought beneficial results.

Table 1. Milk production of dairy animals in SEZ.

Breeds	Prod./lactation (litres)	Butterfat %	Source of data
Cattle			
Sindhi crossbred	1708	4.81	IAS 1993
Jersey crossbred	2357	4.23	IAS 1993
50%—Holstein crossbred	2557	3.75	IAS 1993
75%—Holstein crossbred	2660	3.73	IAS 1993
French Holstein crossbred (first lactation)	3879		IAS 1995
Brune crossbred	3533		IAS 1995
Montbeliarde crossbred	2596		IAS 1995
Pie Noire crossbred	2550		IAS 1995
Buffalo			
Murrah purebred	2376	6.70	IAS 1993
50%—Murrah crossbred	1212	7.53	IAS 1993
Goat			
Bach Thao (150 days of lactation)	160	4.05	

Table 2. Techno-economic parameters of pig production in HCMC since 1975.

Year	75–80	81–85	86–89	1990	1991	1992	1993	1994
Weaned piglets/sow/year (n)	11.03	12.05	12.91	13.91	14.75	14.85	15.36	16.38
Weaning age (days)	67	57	47	45.75	41.15	39.75	35.5	31.2
Litters/sow/year	1.4	1.7	1.79	1.87	1.97	2.0	2.04	2.11
Raising period (days)	220	229.6	208.3	207	208.5	199	186.2	173
Slaughter weight (kg)	90	96.8	91.1	89.45	85.75	87.08	86.06	87.06
Feed conversion								
• Fattening pig	6.0	5.66	4.59	3.94	3.87	3.80	3.15	3.0
• Degree pig	7.1	6.96	5.08	4.35	4.11	3.92	3.55	3.38
• Piglet	–	12.45	10.95	6.8	6.71	6.10	5.75	5.57

(Source: ASH, 1995).

Pig farms in HCMC can provide annually 40 000 piglets and 10 000 breeding boars and sows. In households in Bien Hoa town, the use of the model 'pig farm-biodigester' is popular. Farmers achieve a mean liveweight of 100 kg for their pigs with a growing period of more than five months and backfat of 28 mm. All small-scale farmers have their pigs adequately vaccinated and 97% of them are able to treat their pigs themselves. Recent experiments carried out under commercial pig production conditions showed that the three-way-cross combinations comprising:

Duroc boar × (Yorkshire × Landrace) sow,
Landrace boar × (Yorkshire × Duroc) sow,
(Landrace × Duroc) boar × (Yorkshire × Landrace) sow,

all gave good results of more than 55% of lean meat and a backfat thickness of 18–24 mm (Hai et al. 1995).

Poultry

The industrial flocks have been replaced recently by several imported new breeds such as AA and Cobb for meat production and Goldline, ISA Brown and Crownick for egg production. Most of these breeds are well adapted to tropical conditions. It is expected that poultry production will be developed further in response to the needs of both local consumption and export from the SEZ.

Besides exotic breeds, the backyard hen, which is a crossbred of a Goldline male and a Rhode-IR hen, has been transferred by the IAS to some areas of SEZ simultaneously with handcrafted incubators made through rural development programs with the object of improving family income of poor farmers. Egg productivity of backyard hens ranges from 185 to 218 eggs/year.

Duck, including the Muscovy, have also been developed in the south and south-west of the SEZ where rice fields are abundant. Vi Go Va farm is a supplier of breeding duck for farmers. Moreover, traditional incubators in HCMC can provide 10–12 million one-day-old ducklings per year.

In general, there is a need for studies on the resistance and disease control of higher quality breeds under SEZ conditions.

Food Production

In an area of 863 220 ha of agricultural land, in addition to fruit trees and rubber plantations, many valuable plants, such as cashew, banana, sugarcane, cotton, maize, soybean, cassava and pepper can be grown. These are sources of raw materials for the human food processing industries, but along with fishmeal, they also provide by-products and residues for animal feeding.

Concentrates

At present, production of concentrates in the SEZ is estimated at 200 000 million t/year which uses one-third of the capacity of feedmills. Feed quality has been more and more upgraded due to the presence of CP Group, Proconco and Viet Thai joint-ventures and such private enterprises as Tan Sanh, Thanh Cong, Thanh Binh and Binh Nham. Competition between them in the areas of price and quality could enhance livestock production. State farms used to produce formulated feed themselves, with a total production of 1000–4000 million t/year/farm. But the quality of concentrates for dairy cattle has not been sufficiently studied and farmers have used so much concentrate that the cost of milk production has increased.

Roughage

Household dairy farms have available 300–1000 m^2 for green forage production. They grow *Pennisetum*

purpureum and *Panicum maximum* under intensive condition with the application of manure and chemical fertilizers, but farmers have not paid attention to forage legumes. On the other hand, lack of factories for the processing of roughage sources such as rice straw, maize stalk and bagasse, creates an imbalance in cattle feeding systems.

The Way Forward

The territory of SEZ is being reorganised and the strategic direction of the economic development of the region has been determined for the structure of industry/agriculture services. As can be seen from the general map of the SEZ (Fig. 1) a Focus Triangle was identified, centring on three industrial centres: HCMC, Bien Hoa and Vung Tau, where the need for food and environment protection (Table 3) are very important.

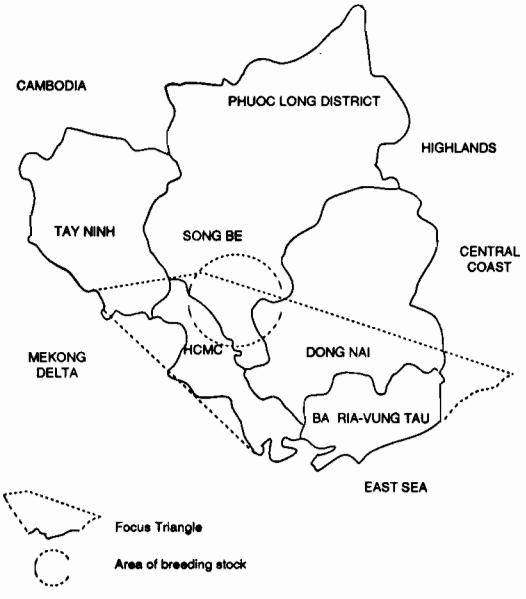


Figure 1. Map of South-eastern zone, showing focus triangle and area of breeding stock.

Most animal farms will be removed from the above triangle, in order to minimise pollution. Research in animal sciences should include a study of permaculture for the surroundings.

The change in geographical structure of the SEZ will add three eastern provinces: Lam Dong, Binh Thuan and Ninh Thuan thus increasing the animal herd in the SEZ with purebred dairy cattle in Lam Dong and goats and sheep in Ninh Thuan. Together with the government program of green cover, agroforestry systems should also be considered, incorporating cattle, goat and deer husbandry. The priority development of animal varieties in the SEZ could be approached in the following order (Xuan et al. 1995):

a) Dairy cattle, pig, chicken
b) Beef cattle, duck
c) Buffalo, goat, deer.

In considering fundamental investment for animal production in the South in the 1990s (Thong and Minh 1992), the National Food Program proposed two projects; the first being dairy production providing primary material for the processing industry and the second, pig production for export (Thong et al. 1990). The SEZ has become an attractive place for foreign investment in animal husbandry because of its marketing advantage.

Some socioeconomic research programs and technology transfer activities are being pursued by the IAS in Phuoc Long District (Fig. 1) in the north-east of the SEZ, with studies on rural development and economy of hilly lands, upland ricefields and

Table 3. Participation of IAS in the operation of animal research and development in SEZ.

Territorial structure	Research units	Economic structure		
		Industry	Agriculture	Services
SEZ	Binh Thang An Hus R & D Centre Ruminant R & D Centre	Feed production	Breeding animals	Testing
Focus Triangle	Centre for Training & Agri. Tech. Transfer 3 departments of animal research Department of farming systems	Animal product processing	Commercial animal production	Training Consulting

Need for food (including export) + Permaculture
Environment protection + Cooperation

mountainous areas. Animal husbandry and upland crops are focus subjects in the SEZ. It is necessary to develop animal production towards the north and the west of this zone so as to efficiently utilise the available resources.

References

Cuong, L.X., Tan L.V., Dung, C.A. and Minh, T.Q. 1993. Study on models of different size in household dairy cattle husbandry. Results of Dairy Cattle Research 1988–1993 (in Vietnamese). IAS, Ho Chi Minh City.

Hai, L.T, Vien, N.T. and Hang, T.T. 1995. Determination of some three-way cross combinations in pig breeding toward lean rate of more than 50% (in Vietnamese). Scientific Conference 22–23 May, 1995. IAS, HCMC.

Minh, T.Q. 1994. Research and development of buffalo draught power for farming in Vietnam. Symposium on Improving Draught Capacity of the Multipurpose Buffaloes in Small farm Systems 6–8 Dec., 1994. Bangkok.

Thong, T.T., Cuong, L.X. and Minh, T.Q. 1990. On strategy for livestock development in Southern Plain of Vietnam by the year 2000 (in Vietnamese). IAS, Ho Chi Minh City.

Thong, T.T. and Minh, T.Q. 1992. History of livestock development in South Vietnam (in Vietnamese). IAS, Ho Chi Minh City.

Xuan, V.T., Hai, L.T. and Loc C.B. 1995. Research priorities for improving animal production by agro-ecological zones in Vietnam. ILRI Consulting Meeting for the Southeast Asian Region. IRRI, Los Baños, May 1995.

Cattle Production and Research in the Central Region of Vietnam

Vu Van Noi and Le Viet Ly*

Abstract

In the Central Region of Vietnam cattle production is the most common form of livestock production and strategies are being developed to make it the biggest beef-producing region for both domestic and external markets. Production is currently constrained by the low productivity of the local cattle and poor feeding systems. Results of experiments where crossbreeding, initially with Red Sindhi, but later with improved beef breeds, showed marked gains in growth rates under grazing conditions.

Feeding experiments have shown that supplementation with urea-treated rice straw and molasses and cotton seed, have markedly increased growth of young crossbreed cattle. Further research is advocated including the testing of some breeds of tropicalised cattle.

THE Central Region of Vietnam, consists of two agroecological zones, the central coastline and the central highlands.

The central coastline stretching from Quang Nam-Da Nang province to the Binh Thuan province is characterised by narrow plains between mountain ranges running from the west to the sea in the east. This zone has a tropical climate with high temperatures and high rainfall (annual rainfall, 2000 mm). The rain is concentrated mainly in the wet season (from October to December) and causes serious flooding in the zone. The dry season often lasts seven months from February to August.

The highlands, generally, have a tropical climate with a high rainfall but with moderate temperatures where altitude and topographical configuration create a sub-regional climate. The wet season often starts in May and finishes in November, but in the dry season, because of low rainfall, water supplies to cattle and plants are a problem. With large land areas and low density of inhabitants, this zone has good potential for beef development.

* National Institute of Animal Husbandry, Thuy Phuong, Thu Liem, Hanoi, Vietnam.

Livestock Production

The livestock population in this region is 1 302 000 cattle (40.68% of the national population) 224 300 buffalo (7.7%) and 2 303 200 pigs (16.7%) showing the importance of the cattle industry. In accordance with a cattle development strategy for Vietnam, this region will be the biggest beef producing region for both local and external markets.

Some Constraints to Cattle Development

Constraints to cattle development in the region include the productivity of local cattle and suitability of feeding systems. The local cattle are well adapted to the environmental conditions but have a low body weight at maturity, 180–200 kg, and low muscle rate of 30–33%. The main feeding system is extensive grazing. Agriculture by-products and crop residues are used as cattle feed but in unprocessed forms. Energy- and protein- rich feed sources such as cotton seed, copra cake and sugarcane molasses have not been used for cattle.

In an effort to improve the productivity of local cattle, pure Red Sindhi bulls have been used. The F_1 (Red Sindhi × native cow) had a 30–35% higher body weight and a 5–8% higher lean meat content than native cattle. The carcase composition was not considered satisfactory, so observations were made on mating Red Sindhi crossbred cows (Laisind = LS) with beef breeds such as Charolais or Santa Gertrudis.

Table 1. Body weight of beef breed sire crosses × Laisind at different ages (kg).

	Feeding level	Birth		6 months		12 months		18 months		24 months	
		No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
F_1 Charolais	A[a]	110	23.12	50	91.1	53	121.0	33	161.0	21	221.4
	B[a]			46	115.9	43	173.0	35	232.0	20	296.4 (375[b])
F_1 Limousin	A	45	20.5	64	88.6	34	118.1	24	134.0	16	215.0
	B			6	119.0	8	139.0	9	170.0	3	265.0
F_1 Hereford	A	61	22.6	61	82.7	60	126.9	53	150.6	20	211.5
	B			30	118.2	14	145.8	15	178.9	5	247.5
F_1 Santa Gertrudis	A	56	18.7	19	76.31	18	113.3	15	153.3		
	B					3	163.0	3	183.3		
F_1 Red Sindhi	A	42	18.5	51	80.0	26	107.4	20	140.2	27	175.1
	B			12	106.0	7	122.6	7	156.1	6	212.2

[a] A = unsupplemented, B = supplemented.
[b] Data from another site (Bao Loc).

Results of the Beef Crossbreeding Program

After many years of conducting this program, body weights at different ages for both unsupplemented (level A) and supplemented (Level B) cattle were recorded with the results obtained in Table 1.

The results indicate that:

- Supplemented and unsupplemented improved beef crosses at 24 months of age reached more than 247 kg compared with 211–221.4 kg for those unsupplemented.
- The beef crosses had heavier body weights than those of Red Sindhi crosses at the same feeding level. If the body weights of Red Sindhi crosses at 24 months are categorised as 100%, then the body weights of unsupplemented F_1 crosses with Hereford, Limousin and Charolais are 120.5%, 126.44% and 126.44% respectively. Figures for the supplemented F_1 crosses with Hereford, Limousin and Charolais are 116.63%, 120.64% and 139.67%, respectively.
- At comparable feeding levels, F_1 Charolais crosses had the heaviest body weights which suggests the need for future research with them. The body weights of F_1 Charolais crosses at 24 months of age were 296.4 kg but in fact were even higher (375 kg) at a different location at Bao Loc. This finding agreed with the work of Tumwarson et al. (1982) in Thailand.

Table 2. Effect of urea-treated rice straw (UTRS) with molasses-urea block (UBM) on growth rate of grazing crossbred calves during a 90-day period in the dry season.

	Grazing only		Grazing plus UTRS ad lib + UBM	
Location	Ha Tam	An Nhon	Ha Tam	An Nhon
No. of animals	5	5	5	5
Initial weight (kg)	117.8	109.6	114.8	107.0
Final weight (kg)	139.4	128.5	153.4	143.2
ADG (kg/head/day)	0.24	0.21	0.43	0.40

ADG = average daily gain.

Table 3. Growth and feed conversion of crossbred calves fed urea-treated (UTRS) or untreated rice straw (RS) plus molasses and cotton seed on a 120-day grazing period in the dry season.

	Grazing only	Grazing + UTRS + cotton seed + molasses	Grazing + RS + urea + cotton seed + molasses
n	5	5	5
Initial weight (kg)	125.4 ± 14.39	125.6 ± 15.13	125.8 ± 15.85
Final weight (kg)	135.6	228.0	207.6
ADG kg/h/day	0.156	0.568	0.454
Feed DM conversion:			
— treated rice straw		2.5	
— untreated rice straw			2.1
— molasses		2.59	3.34
— cotton seed		2.62	3.40
— ME (MJ)		54.3	65.3
— DP (kg)		0.51	0.64

ADG = average daily gain.
DM = dry matter.
DP = digestible protein.

Feeding Trials with Various Crop By-products as Supplements for Crossbred Calves

Two feeding trials were conducted in Ha Tam (Gia Lai Province) and An Nhon (Binh Dinh province) where urea-treated rice straw (UTRS) supplemented with molasses-urea block was tested on grazing stock. Results were as shown in Table 2.

The results show that the combined use of the two supplements caused a dramatic increase of nearly double liveweight gain under the conditions of the observations. Economic evaluation is needed to assess commercial desirability of such a feeding supplementation system.

Further studies were carried out in Duc My, examining the effect of UTRS plus molasses and cotton seed on growth rates of grazing crossbred calves.

The results are shown in Table 3.

The results show that the two nutritional treatments gave major improvements in growth rate. Whilst it is not possible to dissect out the components of the diet and their specific effect on growth rate, it is likely that cotton seed is a valuable supplement for grazing crossbred calves, giving additional benefits to the use of UTRS.

Conclusions and Recommendations

- In earlier investigations the body weight of Laisind crosses (Red Sindhi Bull × native cow) had increased by up to 30–35% over local cattle. However, their carcase composition was not satisfactory so further crossing of improved cows was carried out with beef bulls such as Charolais, Santa Gertrudis, Hereford and Limousin.
- F_1 crosses (improved cow × beef bull) was heavier than the Laisind crosses (16.63–139.67%) and it appears that F_1 Charolais crossbreeds will have the highest body weight, daily gain and dressing percentage among crossbreed cattle available. With appropriate feeding, it is concluded that crossbred calves can gain 500 g daily or more.
- Crossbred calves fed 4% urea-treated rice straw plus molasses and cotton seed gained 568 g/head/day.

A priority in future research includes study of appropriate systems of beef production for smallholders using agricultural by-products and crop residues, especially oil seed cakes as a supplement for feeding and fattening crossbred calves.

There is also a need to study the economic efficiency of beef cattle production amongst smallholder farmers in this central region and to study the growth rate and meat production of local cattle crossed with Droughtmaster and Red Brahman, the so-called tropicalised breeds, in new cattle development projects.

Reference

Tumwarson, S., Prucsasri, P., Markvichitr, K., Rengsirikul, B., Innurak P. and Chantalakhana, C. 1982. Crossbreeding of Thai local cattle with American Brahman and Charolais sires. Proceedings of the 20th Animal Science Conference, Kasetsart University, Bangkok.

Development of Farming Systems on High Land Based on Livestock Raising Combined with Credit Programs

Duong Duy Dong and Luu Trong Hieu*

Abstract

A program of farming system research combined with credit provision for poor farmers in three villages in south-east Vietnam has been running since 1992. The program includes:

- provision of small loans to poor farmers to buy 100 day-old chickens or two piglets or one 10-month-old cow to raise themselves;
- return the loan without interest after six months in the case of native chickens, or after eight months with pigs—cattle raisers are to return two calves (the first and third calf) and may retain the cow and second calf.
- provision of support to protect animals by vaccination and other veterinary services; and
- training of farmers through practical workshops or short courses to develop their knowledge of husbandry and improved use of local resources.

Results after three years have seen:

- increase of profit for farmers from raising livestock using local feed;
- more work for farmers in the dry season when they are otherwise jobless;
- confirmation that the credit program is critical to the success of the project; and
- the conclusion that native chicken raising could be expanded for poor farmers because of low input, stable price and suitability of conditions in rural areas in Vietnam.

THE south-eastern part of Vietnam of about 1 000 000 ha comprises Song Be Province of 442 595 ha, Tay Ninh (354 375 ha), Dong Nai (226 716 ha) and a smaller area of Ho-Chi-Minh City (40 831 ha). The dominant characteristics of these three provinces is high land, quite poor soil and a lack of water in the dry season (from December to May).

As generally in Vietnam, in this area the agricultural population comprises 70% of the total. However, many are poor farmers by reasons of:

- low average cultivation area (0.4–1.5 ha/family);
- poor soil and no water for irrigating in dry season;
- low value and/or low yield of agricultural products; and
- not enough capital or knowledge for farmers to improve their performance—few have ever had jobs apart from farming.

Since 1992, the University of Agriculture and Forestry at Thu Duc, HCMC has undertaken a program to help poor farmers in two villages in Long Thanh district, Dong Nai province and in Cu Chi district, HCMC. In the program, provision of credit and sustainable techniques in raising and cultivating were used to improve the farmers' situation.

Methodology

Location

In Long Thanh district two hamlets were chosen as target areas for the program, Thien Binh and Long Duc. In Cu Chi district, the Lao Tao Trung hamlet and Trung Lap Ha village were chosen. These choices were made from benchmark surveys at the beginning of the program to target hamlets with characteristics representative of the poor high grey land of south-eastern Vietnam.

* University of Agriculture and Forestry, Thu Duc, Ho-Chi-Minh City, Vietnam.

Period

The program commenced in 1992 and will finish in 1995.

Components of program

Although poor farmers have many needs, they usually hesitate to apply a new component in their farming system. Therefore, in our trials, we always combined two factors, technology and credit to help persuade the farmer to accept new technology.

Technology and credit

The PRA (Participatory Rural Appraisal) method was used to find what farmers need and what they would like to do. Results showed that almost all farmers liked to raise some kind of animal along with land cultivation. These could be native chickens, pigs or cattle. However, farmers were also deficient in both capital and knowledge. Therefore, in 1992 we chose ten farmers for native chicken husbandry and four for pig raising to start the program. At the end of 1992 five farmers for cattle raising were selected. Farmers who were chosen were poor or medium farmers who were willing to collaborate with the University in applying new technology. A formal contract was signed called a "Collaboration Agreement" with conditions as follows:

- The University would lend a farmer the funds to buy animals ($US30 to buy 100 baby native chickens, or $US60–70 to buy two piglets or $US150–180 to buy a ten-month local calf) with 1% interest per month. (The farmer would have to pay at least 2.4%/month interest if he borrowed money from the Government Bank; or from 5–10% interest per month if he borrowed from neighbours.) We use the 1% interest as an attraction for the holding of workshops for farmers every six or eight months.
- Farmers were to return their loan plus interest after six months (chickens) or eight months (pigs). With cattle, we applied a kind of 'sharing raising' in the traditional Vietnamese manner where the owner buys a cow and sends it to a poor farmer to raise. The farmer arranges feeding of the cow but he keeps the manure. When the cow first gives birth, the calf belongs to the owner. The second calf will belong to the poor farmer and the system is repeated from then on. However, in this project we wanted to help farmers by avoiding high interest charges. Therefore we lent money to the farmer for buying a cow with the plan to then take the first and third calves when they were ten months of age. The farmer would retain the cow plus the second calf and later calves.
- If farmers had difficulties in managing their livestock, they had access to a project veterinarian who visited the village once or twice a week.
- He would assist farmers with preventative vaccinations. He was also to train one farmer per each village in basic veterinary treatment knowledge. It was hoped that each village would have one or two technicians to provide primary veterinary service after completion of the project.
- Farmers were needed to cooperate with the project in applying and extending knowledge of their good results to other farmers.

With the purpose of helping farmers improve their life by reusing local resources, we also proposed a simple technology to produce gas for cooking from manure by using a nylon biodigester which is very cheap and useful for farmers.

Collecting and analysing data

A nucleus of farmers with writing skills were used to collect data to determine indexes such as growth rate of animal, expenses for feed, housing, medicine for animals and cost benefit. Each month the project technician would take raw data for analysis to store in the computer using Lotus for Windows 4.1 and Minitab 9.

Results

Collaborating farmers

In the first year (1992) we conducted the program with a limited number of farmers because some farmers hesitated to cooperate. Vietnamese farmers neither like to borrow anything from an unfamiliar person nor in their neighbourhoods, except in an emergency. Table 1 describes the numbers of farmers collaborating with the different animal production systems.

In an area strange to project staff, loans were deliberately limited. We needed to choose farmers who were able to use the funds for earning money efficiently and return the loan on time.

Table 1. Number of farmers collaborating during the three years (1992–1994).

	Chickens	Pigs	Cattle	Total
1992	10	4	5	19
1993	25	5	11	41
1994	40	7	11	58
Total	75	16	27	118

The number of collaborating farmers has increased constantly over the three years. This has shown that our program was useful for poor farmers because they acquired both credit and knowledge to develop their work.

Results of native chicken raising

The raising of native chickens has been mentioned by many authors in developing countries (Dong and Man 1992, 1993; Nazir Ahmed cited by Priatna et al. 1994; Hadiyanto et al. 1994; Priatna et al. 1994). Although raising of industrial broilers is increasing, many people still like to raise native chickens because they are easy to grow in conditions of poor feed and management. In rural areas of Vietnam, most families keep a small number of native chickens to use when they have a party or when they greet visitors. The biggest problem in raising of native chickens is the incidence of disease. All farmers in our surveys responded that they would always like to keep native chickens if they had a warranty to prevent disease.

In Table 2 are shown the results of experiences with raising native chickens in the project.

Table 2 shows that after three years farmers achieved good results helped by a vaccination program in the project. In the first year, the farmers were not accustomed to using medicine for chickens and their chicken survival rate was very low (53%). However, with the assistance of the veterinarian, they accepted the use of vaccines twice annually to protect chickens against Newcastle and fowl pox disease.

The rearing of native chickens in the rural area has many advantages over the raising of industrial-type chickens. They are:

- ease of rearing;
- low input requirement. (Chickens can scavenge in field and take natural feed such as grass and insects. In addition there is no need for permanent housing.);
- possible lower incidence of disease;
- very stable price of the finished product and higher than that for broilers; and
- free choice for farmers of time selling chickens—they can keep mature chickens as breeders to produce eggs and baby chickens for the next rearing period.

Figure 1 shows the number of chickens over the three-year period.

From the figure it is seen that good performances were obtained with native chicken raising, that their number has grown and that the farmers are more interested in chickens overall.

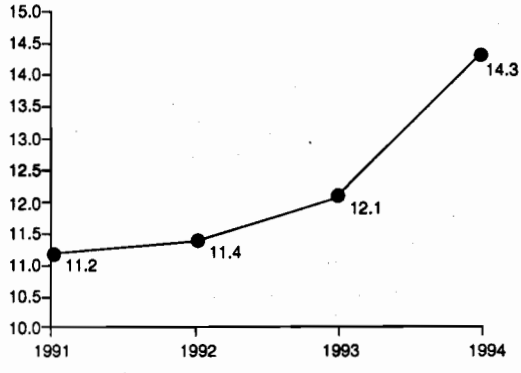


Figure 1. Number of native chickens through three years of the project.

Table 2. Results of raising native chickens by project farmers.

	1992	1993	1994
Farmers (n)	09	10	10
Chickens/family	114	117	95
Raising period (months)	6	5	5
Mean survival ± SE (%)	53.33 ± 16.31	68.20 ± 12.21	65.30 ± 10.04
Mean LW, 6 months ± SE (kg)	1.01 ± 0.48	1.38 ± 0.43	1.42 ± 0.35
Input/chicken ($US)	0.5	0.58	0.59
Output/chicken ($US)	0.66	0.78	0.90
Income/chicken ($US)	0.11	0.20	0.31
Income/month ($US)	2.09	4.57	5.92
Labour price ($US/day)	0.5–0.7	0.5–0.7	0.6–0.8

LW: liveweight.

Table 3. Results in pig raising over the two years (1992–1993).

	1992	1993
Families	4	4
Pigs/family	2	4
Duration (months)	5.5–6.0	5.2
Input/pig	94	109
—Breed	31	39
—Feed	58	63
—Others	5	7
Output/pig	118	95
Income/pig	27.7	–14
Income/month	9.4	–

Pig raising

Unlike native chicken husbandry, pig raising was unstable for two of the project's three years. In 1992 four farmers started with two piglets each and got good results. They continued to raise the number to four piglets/family. But in 1993, feed became very expensive while the price of pigs fell. All of the four collaborating farmers suffered a loss. However, many farmers still liked raising pigs because only a modest input was required. Moreover, farmers considered the pig as a kind of savings account that could be cashed at almost any time. To react to the farmers' desire, we suggested mixed livestock farming with both native chicken and pig raising. Such farmers would keep about twenty hens plus one cock and/or 70–100 growing chickens to sell as broilers during the holidays. The money from selling the chickens could form the capital to invest in pig raising. Then in due course the profit from selling the pig could be used for needs of the farmer's life.

Cattle raising

In villages that planted a lot of rice and cash crops such as groundnuts and vegetables, cattle raising was advised as money would not be needed for feeding cattle. After three or four years of cattle raising in the project, farmers could own a cow and one or two calves, valuable property for a poor farmer. After two years commencing with twelve cows and three calves, there are now twelve cows and ten calves between our collaborating farmers.

Biodigester

The notion of using a biodigester has been common for some decades. However, under Vietnamese conditions, most poor farmers would not have enough material or money to install a biodigester using cement or metal for its construction. Since 1993, based on the introduction and help of T.R. Preston and George Chan in a SAREC project between Sweden and Vietnam, we have studied and applied a new biodigester model using a nylon bag and plastic pipes. Cost of materials for one biodigester was about $US40–50, a reasonable price for farmers. The project has installed them for approximately 300 families and held two farmer-training courses on their use.

Conclusions

After three years conducting a program for poor farmers, it is concluded that:

- a farming system could be a suitable method to approach farmers and find out how to solve their problems;
- the simpler the technologies that are suggested, the greater the likelihood of good results for the farmer; and
- credit is often necessary to persuade farmers to examine or apply new programs.

Because of the results achieved, it is our intention to develop further programs for poor farmers with the support of local government as well as non-government organisations and government organisations.

Acknowledgments

The authors acknowledge the most valuable assistance given by the Farming Systems Research Team without whom this work would not have been possible.

References

Dong, Duong Duy and Man, Ngo Van. 1992. Possibility of native chicken husbandry in the Eastern South High Grey Land of Vietnam (in Vietnamese). Workshop of Farming System Network of Vietnam, pp. 58–69.

——1993. Compare some raising models on the Eastern South High Grey Land of Vietnam (in Vietnamese). Workshop of Farming System Network of Vietnam, pp. 186–195.

Hadiyanto, Pambudy, H.R., and Priatna, WB. 1994. The prospect of native chicken raising in poverty alleviation programmes in Indonesia. Animal Science Congress, Bali, Indonesia.

Priatna, W.B., Pambudy, H.R. and Hadiyanto. 1994. Extension bases and development of native chicken raising in rural areas. Animal Science Congress. Bali, Indonesia.

A Profile of a Cattle Rearing Domain in the Red River Delta

Vu Chi Cuong*, Le Viet Ly*, Vu Van Noi* and R.J. Petheram†

Abstract

Cattle rearing in Trang Viet commune, north of Hanoi, was studied, using rapid appraisal methods to provide a profile of the commune, and to identify constraints and opportunities in cattle rearing. One-third of the area was for communal grazing and cattle rearers operated less than half a hectare per household.

Family size and involvement with livestock rearing, which is second to cropping in importance, is reported. Most rearers kept cattle primarily for draught purposes. Average experience of rearing cattle was less than five years.

Usually, cattle were grazed during the day and handfed at night or when cattle had to work hard. Rearers stored rice straw (and grass) for feeding mainly in the dry season. Over 50% of rearers fed some rice bran to working animals and to cows with calves.

Controlled mating was practised. Cattle fertility was recorded, as well as breed types. The liveweight of crossbred animals was higher in each age class. The average value/kg liveweight fell with age.

Opportunities for enhancing cattle enterprises include attention to body conformation for beef and improved feeding methods along with forage supply. There is, however, a need for further studies on constraints and testing such ideas with farmers.

THE Red River Delta (RRD) is one of the seven agroecological zones in Vietnam. In 1993 the total rice production in this zone was 5.4 million t per year and comprised 49% of rice produced in the north of Vietnam (Statistical Year Book 1993). This study set out to provide information on the role of cattle in a selected farming system in the Delta and to outline methods of rearing and levels of productivity.

Objectives

The study took a farming systems research (FSR) approach, which aims to improve the welfare of target farmers, in this case cattle rearers in the RRD. The more specific objectives of this study were to:

- describe an overall picture of cattle rearing (production, feeding, breeding and draught) and its relation to crop production and other village activities; and
- seek possible constraints on, and opportunities for, improvement of cattle sub-systems.

Procedure and Methods

The first stage of the FSR procedure was the selection of a research site to represent the cattle rearing domain in the Red River Delta. The criteria used were:

- land use representative of the Delta, including both irrigated and dryland cropping;
- cattle population density 'average to high' and traditional rearing;
- land tenure representative of the situation in most of the Red River Delta;
- good access by farmers to markets for cattle and other agricultural products; and
- reasonably good access (within one hour's drive) from National Institute for Animal Husbandry (NIAH).

On the basis of the above criteria, the research site selected was Trang Viet Commune. Within the Commune, two villages which contained 82% of the cattle in the Commune were studied.

* National Institute for Animal Husbandry, Thuy Phuong, Thu Liem, Hanoi, Vietnam.

† Victorian College of Agriculture and Horticulture, Longerenong Campus, RMB 3000, Horsham, Victoria 3400, Australia.

Rapid rural appraisal (RRA) methods (Carruthers and Chambers 1981) were used to gather information of four main types/sources:

- data provided by the commune committee and other secondary sources;
- interviews with individual cattle rearers;
- measurement and recording of individual animals on farms; and
- information provided informally by farmers and committee members.

The results of interviews and measurements were recorded on field data sheets, and later transferred onto a computer spreadsheet using Minitab.

Results and Discussion

General description of the research site

Trang Viet is situated on the east bank of the Red River in Me Linh District, Vin Phu Province, 30 km north of Hanoi.

The commune comprises four villages, Dong Cao, Trang Viet, Diep and Thuy An. This latter is a specialised fishery community, living mainly on fish cage rafts. The Red River dyke running through the commune from the north to the south is a district road.

Climate

This part of the delta has a hot wet season (May–October) and a cooler dry season (November–April). Annual rainfall is 1680 mm. Monthly climatic changes are shown in Figure 1.

Land area and land use

Like most parts of the RRD, the land here is used mainly for crops. The total commune area is 746 ha of which 45% is used for crops, 15% gardens and 10% for housing and roads etc. The remaining 30% that is not cropped is used for grazing. It has some natural grasses and some trees belonging to the community. About 112 ha of land is irrigated and some of this can be cropped twice per year and the rest three times. Another 54 ha is dry land and is used for summer rice, other cereals, mainly maize, and some vegetable crops.

Population, households and labour resources.

The commune statistics showed a total population of 8080 people living in 1677 households, giving an average family size of 4.82 persons. The total labour force consisted of 4125 'main labourers' and 2410 other 'sub-labourers' (children and the elderly).

The number of people and main labourers per cattle rearing family averaged 6 and 3, respectively. These figures were slightly higher than the corresponding averages for all families in the whole commune (4.8 and 2.5 people respectively), suggesting that cattle rearing was carried out by families with more than average labour resources.

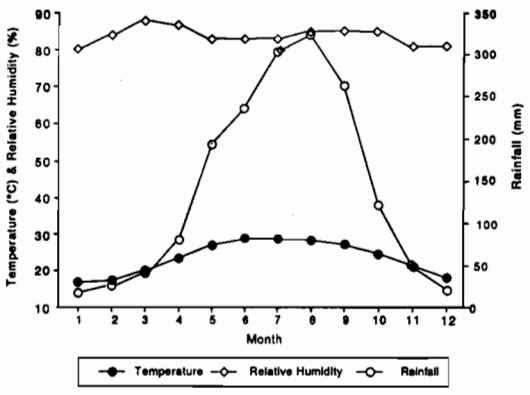


Figure 1. Average monthly rainfall, temperature and relative humidity in Trang Viet

The number of people (i.e. young and old) supported by families ranged between 2 and 3. These young and old people made up a 'sub-labour' force in the community which was important for cattle rearing.

Land types and areas operated by cattle rearing families

The agricultural land in Trang Viet commune is managed privately. Some other land (e.g grazing) is managed by the commune committee. The average area of land cultivated was 0.46 ha per family (or 960m^2 per capita). This was made up of 40–70% irrigated land, 20–40% of rainfed land and 15–20% gardens.

Crops and the cropping calendar

The main crops grown are listed in Table 1, which also shows the approximate time of year that each is grown.

The yields of main crops in this commune (Table 2) are typical of the yields of those in other parts of the RRD (Statistical Year Book 1993).

Rice produced per year/ha exceeded 10 t on some land types. The output of rice per capita in the commune grew from 200 kg in 1990 to 230 kg in 1994.

Livestock populations

The populations of the main animal species in Trang Viet Commune from 1990–94 are shown in Table 3.

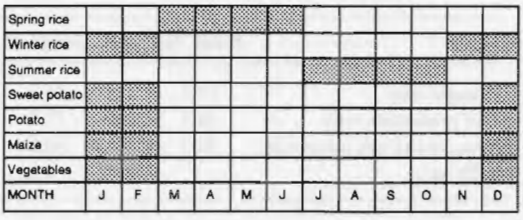
Pig numbers have risen steeply in the past four years, whereas cattle have declined. Recently a few farmers have started raising dairy cattle, but most cattle are reared for work or sale.

Market and marketing in animal production

Trading of animals and animal products follows traditional practices. The demand for animal products is increasing rapidly, especially from Hanoi. This has resulted in a recent increase in sale of animal products (Table 4).

There has also been a marked rise in the 'unusual species' reared and sold from these villages, such as frogs and tortoises. The prices of some animal products in Hanoi markets in 1994 are shown in Table 5.

Table 1. Crops and cropping calendar in Trang Viet Commune.



Source: Interviews with farmers and discussions with key farmers and Commune Committee.

Farmers' income earning activities on and off the farm

Apart from their cropping and livestock, many cattle rearers in Trang Viet Commune (20.3%) earned money for their families through extra activities or enterprises on or off their farms. As the market demands for handicrafts, flowers and services are increasing, it is likely that the opportunity cost of labour is rising, with the spread of industries and markets from Hanoi.

Livestock rearing in general

Cattle rearing families interviewed in Trang Viet Commune reared an average of 1.3 head of cattle. They also kept 2–4 pigs and about 15–32 chickens (Table 6).

In an effort to increase income, farmers operated various new kinds of livestock enterprises. Among the farmers who kept cattle, about 30% also reared other animals, such as silkworms, Muscovy ducks, fish, tortoises, eels and frogs.

Table 2. Crop yields in the Trang Viet Commune (t/ha) 1990–94.

	1990	1991	1992	1993	1994
Rice (on 3-rice-crop land)	4.1	4.1	3.9	4.0	4.4
Rice (On 2-rice-crop land)	4.5	4.5	4.2	4.6	5.1
Summer rice	2.2	2.3	2.1	2.1	2.5
Spring rice	3.0	3.1	3.1	3.1	3.0
Maize	2.3	2.0	1.9	2.4	2.5
Vegetable					16.7
Sweet potato					8.3
Potato					16.6

Source: Committee Statistics, Trang Viet Commune.

Table 3. Population of the main animal species in Trang Viet Commune.

	1990	1992	1993	1994
Pigs		2120	2561	2730
Cattle	890	840	870	720
Poultry		9891	14 700	10 500
Ducks				1000

Source: Trang Viet Commune Statistics.

Table 4. Estimated animal products sold from 1990–94 (kg liveweight).

Species	1990	1991	1992	1993
Commercial chicken	–	900	1800	2600
Local production	16 000	19 000	21 000	20 000
Pigs	17 000	21 000	23 000	122 000
Frog	300	400	500	2000
Tortoise	–	–	–	997
Buffalo	400	–	–	600
Cattle	2500	4000	5000	8000

Source: Trang Viet Commune Statistics.

Table 5. Prices of animals and animal products around Hanoi, 1994.

	Price per kg (VND)	Price per kg ($US)
Beef	15 000	1.36
Pork	11 000	1.00
Broiler chickens	11 000	1.00
Local chickens	14 000	1.27
Tortoise	260 000	23.64
Frog	20 000	1.82

Table 6. Average number of animals reared per cattle-rearer family.

	Trang Viet	Dong Cao	Whole commune
Cattle	1.33	1.32	0.43
Pig	3.45	2.70	1.62
Chicken	32.10	15.00	6.26

Table 7. Farmer opinion on purposes of cattle raising (%).

	Trang Viet	Dong Cao
Draught only	17.4	41.4
Calf production only	48.3	17.7
Draught and calf production	34.3	36.3
Milk only		4.5

Cattle rearing

All the 637 cattle in the two villages were fully owned by their rearers. There was no renting or sharing (except sometimes for work purposes). The origin of the animals on farms was 30% through purchase and 70% through birth on the farm.

The average ownership per household was 1.3 head in both villages studied (and 0.43 head in the commune as a whole). Over 70% of rearers had only one, 27% had two and only 3% had four cattle.

The farmers were asked to specify which of four 'purposes of rearing' (or combinations) best fitted their cattle enterprise. Their responses are summarised in Table 7.

The farmers' main purpose in cattle rearing differed between households and with location. Most households regarded their cattle as a multi-purpose enterprise. The percentage of households rearing cattle for milk was very low, but dairy enterprises may be increasing.

Village cattle herd composition and farmers' rearing experience.

The percentage of cows in Trang Viet (46.3% of whole sample) was higher than that in the Dong Cao cattle herd. The number of bulls above 24 months in Trang Viet was less than that in Dong Cao. This may be explained by the difference in demand for draught power in the two villages.

The age–sex structure of the total cattle herd is shown in Figure 2.

About 80% of rearers interviewed had kept cattle for less than 10 years and about half had less than five years of rearing experience. This apparently short experience of rearing their own cattle may be an important consideration in developing cattle rearing in the area.

Cattle feeding practices

The farmers were asked to categorise their cattle feeding into one of five main regimes, based on the proportion of time that they spent grazing (herding) and hand-feeding their animals. The main method of feeding cattle was 'combined' grazing and hand-feeding. Although most farmers relied on grazing, they cut grass and other forage to feed to cattle at night or when cattle had to work hard. Over 20% of cattle rearers fed cut grass only because of the labour/time required for grazing.

Feed supplies and storage

Farmers stated that most locally available feed such as natural grass and rice straw was fully exploited. The period of year when green grass was shortest was the time when rice straw and grass hay were traditionally stored and fed, usually January–April.

Over 50% of cattle owners (47–64%) used rice bran in small amounts, as a feed supplement for draught cattle or cows with calves. Rice bran was freely available from millers in the village, at a cost of 1000 VND/kg.

Cattle breeds, breeding and reproduction

Of the 497 cattle examined, there were:

363 females— 201 of the Laisind type: and
162 of a local type

134 males— 110 of the Laisind type: and
24 of a local type

Laisind is the term used for crosses between local and Red Sindhi cattle.

The mating system practised was controlled service. Most rearers have their cows mated with bulls of other rearers in the pen at home, not in the

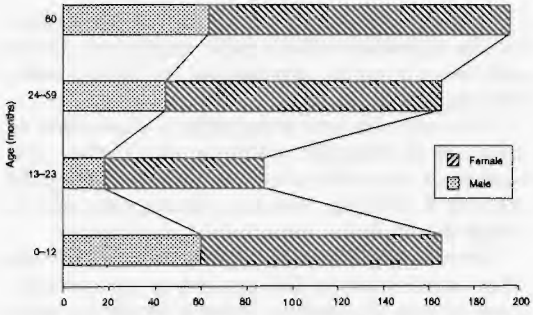


Figure 2. Age–sex structure of total cattle herd (n = 497).

field. Some farmers rented out bulls at $US2–4 per service. Farmer estimates of age at first calf and of calving interval shown in Table 8, while approximate, indicate a relatively high reproductive performance.

Daily care and management of cattle

School children (47%) and 'husbands with children' (24%) were the main combinations of family members responsible for daily care and management of cattle.

The enterprise (mixtures) producing most income for cattle rearers

Most rearers relied mainly on crop production and then on cattle for income. Pigs and other animals were also important. About 20% of rearers stated that off-farm enterprises produced most of their income.

Approximate estimates of family income from cattle and other sources

Estimates of per capita income of cattle rearers ranged from $US207–237. This value was higher than the estimate obtained from the Commune committee for the whole commune ($US194) and considerably higher than the $US135 estimated for farmers in the RRD (Tuan 1992).

The estimated percentage of income from livestock reproduction in Trang Viet (47%) was slightly higher than that in Dong Cao village (40%) and the average (43%) was very high compared to the percentage from animal production (30–32%) in Vietnam as a whole (Hassall et al. 1991).

Liveweight of cattle in different age and breed categories

Body weight of crossbred (Laisind) animals was generally much higher than local animals at the same age.

Table 8. Farmer estimates of cow reproductive performance (average).

	Trang Viet	Dong Cao	Both
Age at first calving (months)	22.3	29.4	28.6
Calving interval (months)	12.5	14.2	12.5

Bodyweights of crossbred (Laisind) cows and local animals in each age group are shown in Figure 3. Crossbred cows weighed 30 kg more at maturity than local cows.

Marketing and estimated prices (value) of cattle

Traditionally, cattle are sold for draught or breeding at an age of 6–10 months. Prices are negotiated between farmers and buyers in private and never recorded or publicised. Approximate prices were obtained by asking farmers to estimate the value of their animals. The main results were that cow values were higher than bulls, younger animals higher than older ones and crossbreds higher than local cattle of similar class.

This suggests that farmers achieve a price benefit in crossbreeding with larger framed (e.g Red Sindhi) cattle. The premium price for younger animals suggests an incentive for farmers to move towards rearing younger animals for sale.

Land area cultivated by animals, and training of draught cattle.

Most cattle used for land preparation were bulls and the average land area cultivated per year was 2505 m^2 per animal. However there was a ten-fold difference in the areas cultivated, (i.e. from 720 to 7200 m^2) because of differences in land ownership.

Training of cattle for work was usually at 24 months or when they reached an appropriate body size for work. They were trained by the rearers themselves, usually for 7–10 days.

Conclusions

The study has improved understanding of cattle rearing and revealed some important possibilities for improvement. There is a need for further studies to define particular constraints more clearly. For instance, a special study of constraints amongst ex-cattle rearers to identify reasons for moving to other enterprises. Another need is to define the forage opportunities that exist in the village in time and

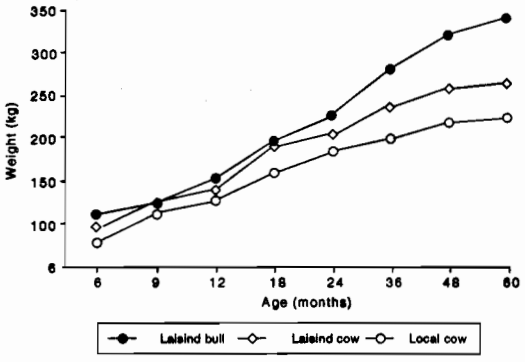


Figure 3. Liveweight and ages of cattle in Trang Viet commune (Nov. 1994)

space, and which species should be sought and tried on farms.

It appears that cattle rearing, especially for quality beef production, should have greater potential than is being realised by farmers with their present small-framed animals, given the high price markets for quality beef in Hanoi. However, meeting the market would require the development of crossbreeding programs and marketing arrangements. All these ideas and the results of the study should be presented to the farmers and Commune Committee for comment and ideas for further research.

No artificial insemination scheme has been used in the commune. The inability of farmers to purchase their own bulls for breeding means that an artificial (or other) breeding scheme may have appeal.

Farmers claim to lack capital and credit facilities for the expansion of their cattle enterprises. Credit may be an essential requirement for further cattle development programs.

They may also lack knowledge to allow them to capitalise on changing conditions and markets, and experience in modern concepts of cattle rearing. So training in feeding, breeding, health care, and in forage development appears to be a requirement.

There is scope for joint projects with ACIAR and other organisations to link research to new development projects and services, aimed at improving benefits of rearing cattle and cattle production.

Acknowledgments

The authors gratefully acknowledge the financial support provided by ACIAR, through the University of Melbourne, Australia, as well as the technical assistance of John Perkins. Thanks also go to all the farmers and the Committee in Trang Viet commune, and to colleagues at NIAH for assistance with data collection and preparation of the report.

References

Carruthers, I. and Chambers, R. 1981. Rapid rural appraisal for rural development (in Vietnamese) Agricultural Administration, 8, 407–42.

Hassall, H., Conway, A. and Lich, Le Ba. 1991. Policies and strategies for the development of cattle and buffalo production in Vietnam. UNDP/FAO Rome.

Statistical Year Book 1993. Statistical Publishing House, Hanoi, Vietnam.

Tuan, Dao The. 1994. Typology of peasant households (in Vietnamese). In: Vietnam. Research Highlights for 1993. Vietnam Agricultural Science Institute, Hanoi, Agricultural Publishing House.

Research Priorities for Improving Animal Production in the Mekong Delta of Vietnam

Chau Ba Loc, Vo Van Son and Truong Chi Son*

Abstract

The Mekong Delta, the southernmost part of Vietnam, is a highly productive agricultural and livestock area, supplying 80% of exported duck and pork. Per capita consumption for animal protein is a low 2–3 kg of meat per year.

Local breeds thrive but are lowly productive. Inbreeding is also noticeable in some areas of pig-raising and in poultry and cattle production. There is an absence of suitable information for cross-breeding programmes for farmers.

Animal feeding has been largely based on the feeding of crop by-products and residues but concentrates and pre-mixes are coming into use. Feeding is not based on the nutritional requirements at different stages of production. Animal nutrient requirements and feedstuff composition are insufficiently researched. Disease is a major constraint in poultry and pig production, diagnostic services are slow and the slaughtering system scattered. Poor sanitation and management contribute to low productivity.

Areas requiring research include, breeding and selection, feeds and feeding and disease prevention and control.

THE Mekong Delta (MD), the southernmost part of Vietnam, is considered one of the most important agricultural regions of the country. With an area of 39 551 km^2, a population of 15.5 million people and a coast length of 900 km, the MD supplies 50% of national food production, 80% of exported rice, 60% of fishery products and 80% of exported duck and pork.

Climate

The monsoonal climate regulates two seasons: dry, November–April, and rainy, May–October. The rainfall per annum of 1400–2000 mm combined with the high flow of the Mekong system, September–October (40 000 m^3/sec.), causes annual flooding of the entire Delta. Average temperatures are from 23–25°C during the cool months of December–January to 32–33°C during April.

* Faculty of Animal Husbandry and Veterinary Medicine, Can Tho University, Can Tho, Vietnam.

Land Resources

Most of the soil is young alluvium, about 40% of which is affected by problem soils, acid sulfate and saline soils.

Human Resources

The region is inhabited mainly by Vietnamese, Cambodians, Chinese and a small number of Cham people with a population density of 370 persons/km^2, compared with 195 persons/km^2 for the whole country. Population growth in 1990 was 2.7%. However, the population distribution is quite uneven with 25% in urban areas and 75% in rural areas.

The ratio of labour force to total population is 40% of which 16% are skilled labourers with the number holding university degrees nearly 1%.

In 1992 in the whole MD, there were only 86 vocational schools, five state-level technical schools and one university, namely Can Tho University.

Agriculture

Rice occupies 80% of the cultivated area while the remaining 20% is devoted to commercial plant crops and trees viz 10 000 ha of coconut, 60 000 ha of

sugarcane, 15 000 ha of pineapple and 80 000 ha of fruit trees. Various rice-based farming systems involving animals, agriculture, cash crops have been shown to be more profitable than rice alone.

Animal production accounts for about 30% of total value of agricultural production. The MD is particularly suitable for the production of duck, water buffalo and two indigenous breeds of pigs, the Ba Xuyen and the Thuoc Nhieu.

The MD is not only the main supplier of rice for the whole country but also of pig, duck, eggs and chicken to Ho-Chi-Minh City. Animal production depends for food largely on crop by-products and residues and mostly uses indigenous breeds available in the region while employing family labour.

The average per capita consumption of animal protein at about 2 kg of meat per year is low. Malnutrition among children is as high as 45% especially for those under five years of age.

Animal Production

Livestock and poultry numbers, for both MD and Vietnam as a whole, are shown in Table 1.

Table 1. Livestock and poultry population of the Mekong Delta and Vietnam 1993 (head).

Species	Mekong Delta	Vietnam
pigs	2 383 000	4 000 000
ducks	13 570 000	108 152 000
chickens	13 741 000	
buffalo	207 840	2 885 600
cattle	168 070	3 193 900
sheep and goats	15 630	400 000
horses	579	
rabbits	1466	

Swine production is considered to be the most important animal industry, followed by duck, buffalo, chicken and cattle. Ninety-five per cent of production is of the backyard type, and 1–5% are state run semi-industrial farms and medium size commercial farms.

About 42% of the pigs raised in the south of Vietnam are found in 11 provinces of the MD where large quantities of rice bran are available for pig feeding because of the considerable commercial rice production.

Three existing pig groups contribute to production:

- The advanced local group consisting of Ba Xuyen and Thuoc Nhieu breeds. They are raised on small scale family farms, the main feed supplies being rice bran and vegetables in the rural areas.
- The exotic group consisting of Yorkshire, Landrace and Duroc. They are raised in family and semi-industrial farms around the city and fed a total ration.
- The crossbred group resulting from crossing between local and the exotic groups.

Ducks

Ducks are raised in a scavenging system in combination with field rice production after the harvesting season and having access to ponds. Some families raise ducks professionally in their thousands by herding the birds from one rice field to another throughout the year. Ducks are the main exported animal product.

Chickens

Chicken production is carried out with small flocks of 5–20 birds which are raised on a free-range system in the village. However commercial farms of layers and broilers are beginning to be established around the city.

The MD is famous for its water buffalo, which have large body size and considerable strength. Buffalo and cattle are mainly used for draught purposes and meat production. Dairy production has not yet been developed.

Problems in Animal Production

Breeding and selection

- Local breeds are remarkably adaptable to local conditions and can thrive under basic management provided by rural families but they are of low growth rate and medium reproductive performance. Studies on local pigs in some provinces (Quac 1988; Thong 1985) revealed that the liveweights at ten months of age of Ba Xuyen and Thuoc Nhieu breeds are 80–85 kg whilst those of the Yorkshire are 105–110 kg.
- At farrowing Ba Xuyen and Thuoc Nhieu produce on average 8.5 piglets per litter weighing 0.7 kg per piglet at birth and 7.5 kg at 45 days whilst the figures for Yorkshire have been found to be 8–10 piglets per litter, 1.21 kg per piglet at birth and 10–12 kg at 45 days.

Thus there is a lack of reliable sources of good local breeding animals with the genetic potential to allow a sound selection and breeding program.

Which traits to include in a selection program is a problem in itself which many animal raisers do not realise.

- The effects of inbreeding are noticeable in some areas of pig raising and is a very common practice in poultry and cattle productions, due to a lack of new male breeding animals being introduced over a long period of time.
- Considerable efforts in improving local breeds were achieved in the past by cross breeding programs. These programs need to be continued to provide enough information to guide farmers. Generally cross breeding programs are very promising. For example, the average daily gain of the Ba Xuyen breed has been found to be 0.330 kg, whilst that of Ba Xuyen × Landrace is 0.370 kg and of Ba Xuyen × Yorkshire, 0.475 kg (Men and Van 1994).

Feeds and Feeding

While producers make use of available feeds such as crop by-products and residues and are now starting to add concentrates and premixes, feeding generally is not based on nutritional requirements at different stages of production.

- Nutritional requirements of different species especially those of local breeds have not been studied to provide a basis for nutritional and feeding programs.
- Analysis of nutrient compositions of feedstuffs particularly in the differing agroecological zones is incomplete whilst fluctuations of price of feed ingredients are major constraints to the development of livestock and poultry production.

Disease prevention and control

- Disease is a major constraint in poultry and pig production and threatens cattle production. About 30% of the pigs born in this region do not reach the market because of diseases such as colibacillosis, hog cholera, salmonellosis and respiratory diseases. The mortality of local chickens in some areas can be very high because of Newcastle disease and pasteurellosis. Duck plague exerts a very damaging effect on duck production.
- The vaccination rate is not high enough to provide constant immunity within herds, particularly in remote areas.
- Regional and provincial veterinary diagnostic labs have limited capabilities to give prompt results because of inadequate facilities.
- Slaughtering establishments are scattered and mostly managed by the private sector.

Management

- Poor sanitation and management are limiting factors affecting the productivity in most backyard production systems. Also, the keeping of production records is either insufficient or overlooked and thus hinders management in solving production problems.

Researchable Issues

The following are considered to be the areas where research is needed to improve animal production in the MD.

Breeding and selection

- Study and evaluation of genetic potential of local breeds and identifying traits of economic value using proper measurements.
- Conduct of selection programs to improve productivity of local breeds including the study of possibilities of genetic selection for resistance to stress and disease.
- Study of the adaptive ability of high yield exotic breeds under local conditions and in small scale production systems.
- Continuation of study of different crossbreeding formulae for meat and egg production.

Feeds and feeding

- The expansion of work on identifying the nutrient composition of local feedstuffs in different agroecological zones such as in fresh water, brackish water, acid sulfate soil and raised sandy zones.
- Establishment of the nutrient requirements of some important local breeds such as the Ba Xuyen pig and local duck breeds.
- Exploration of greater diversity in the use of crop by-products and residues for animal feeding. There is a particular need to try and reduce rice bran feeding especially at critical times of the year when the price of rice bran rises. Work should continue on testing newly introduced grasses and legumes for ruminant feeding.
- Rations need to be developed that use local feedstuffs in as highly productive a way as possible.

Disease prevention and control

- Vaccination programs for free-range local chickens.
- Programs to control duck plague and pasteurellosis.
- Control of swine enteric colibacillosis preferably by autogenous vaccine production.

- Control of pig reproductive problems especially abortion and infertility caused by parvovirus infection, leptospirosis and brucellosis.
- Development of eradication programs for foot-and-mouth disease.
- Study and control important parasitic diseases including fasciolosis in cattle and buffalo, metastrongylosis and gnathosthomosis in pigs, coccidiosis in chickens and filariasis in ducks.

Conclusion

A comprehensive research program covering the above issues will contribute not only to livestock and poultry development in the Mekong Delta but, importantly, also to national economic development.

References

Men, Le Thi and Van, Bui Hong. 1994. Evaluation of diets based on simulated sugar cane juice and water spinach for breeding sows and growing pigs (in Vietnamese). Can Tho University, Vietnam.

Quac, Vo Ai. 1988. Précis of studies on native and exotic pigs reared in Hau Giang region (in Vietnamese). Can Tho University, Vietnam.

Thong, Nguyen Minh, 1985. Survey on productivity of five types of Ba Xuyen breed of swine in Hau Giang province (in Vietnamese). Can Tho University, Vietnam.