Australian Government

Australian Centre for International Agricultural Research

Final report

project

Domestic and international market development for high-value cattle and beef in South-East Cambodia

project number	AH/2010/046
date published	1/6/19
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approved by	
final report number	FR2019-110
ISBN	978-1-925747-97-3
published by	ACIAR GPO Box 1571 Canberra ACT 2601 Australia

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1 Acknowledgments

Thanks are due to many other people who contributed to the success of this project in a dynamic and challenging environment. Farmers of the project villages and Kampong Cham and Pursat provincial DAHP staff who embraced project technology and worked together to improve cattle management and marketing. DAHP staff in Phnom Penh who co-ordinated many activites. The many students at Royal University of Agriculture who assisted with surveys, interventions and investigated aspects of cattle production and economics. Ian Jones of Agile Development Group gave valuable insights into business development and worked with project staff to get Mekong Meats up and running. Finally, Excellency Sen Sovann provided insights and guidance on government policy developments relevant to the project.

2 Executive summary

More than 85% of smallholders in SE Cambodia own cattle. Traditionally they have been used as a source of draught power and for savings, rather than a source of income. However, increasing mechanisation and labour costs, and new forage and weaning technologies, present an opportunity to reduce household labour in cattle. Returns per head can be doubled with the adoption of improved forage management systems. Achieving increased returns for Cambodian cattle smallholders will require improved regulatory support and whole of market chain development. Rapidly growing demand for beef in the region and high value markets in Ho Chi Minh City, Phnom Penh and Siem Reap present an opportunity to develop a market chain that rewards market chain stakeholders for improved production, animal health management and product value adding.

To work with smallholders, two provinces were chosen for the cattle populations and for the proximity to markets in HCM and PP. A survey of 278 households across 12 villages in 2 provinces indicated that most households had cattle, but that few improved managed techniques are practiced and that knowledge of disease and marketing opportunities is limited among farmers. Most keep animals as a cash reserve rather than for income generation. As a majority of sales were found to be farmer to farmer, cattle are used as a kind of community bank. Surveys of consumers in restaurants, supermarkets and wet markets in Phnom Penh and HCMC showed an interest and knowledge of important product attributes and food safety issues. The current market is largely undifferentiated with the majority of beef being sold at wet markets. Most consumers surveyed were willing to pay between significantly more (up to 30%) for a certified and quality product.

Interventions undertaken to improve farm management, biosecurity and marketing included implementation of village cattle vaccination programmes, training of farmers and VAHWs in biosecurity and cattle management, and trading of animals by weight. Product claims based on the interventions were made for a premium beef product introduced into the Phnom Penh market. An alliance was formed with an entrepreneur after initial attempts to form a working group with current stakeholders failed. A business strategy for the startup, Mekong Meats, was developed in collaboration with a social enterprise NGO (Agile Development Group). One major issue was that supermarkets and top end retailers only took a very small proportion of an animal, therefore several new markets needed to be developed to ensure profitability.

The strategy looked to the restaurant sector as a first entry into the market as this had several advantages over the supermarket sector, including being a larger market segment (especially local BBQ restaurants), having less administrative issues for entry, and lower margins. In addition to the premium beef quality claims, the strategy added value by cool chain direct delivery of vacuum packaged product, as well as developing quality management systems. These characteristics formed the basis for competition with imported beef. Other markets developed were roadside stalls outside factories, high end farmers markets and finally supermarkets.

At the completion of the project branded premium beef was being sold to restaurants, farmers markets, wet markets and supermarkets in Phnom Penh. However not all animals were sourced from project farmers due to supply side issues. The commencement of import of hundreds of thousands of Australian cattle into southern Vietnam caused a drop in prices in Cambodia, resulting in farmers being unwilling to sell after a sustained period of high prices.

The difficulties due to complexity of the post-slaughter value chain were affected by animal quality. The number of different breeds, ages and condition of cattle being grown by project farmers and available in Phnom Penh slaughterhouses introduced considerable added complexity. In particular, the advanced average age and poor condition of local animals was a problem. Australian cattle being finished to consistent target weight and condition in Cambodia, (in Vietnamese owned feedlots), became available in Phnom Penh towards the end of the project.

The change in mindset required for farmers fattening for market and producing a target animal will take some time. Mekong Meats intends to continue to build relationships with local famers to provide education, mitigate supply side risks, and take advantage of the market preference for local product.

3 Background

More than 85% of smallholders in SE Cambodia own cattle. Traditionally they have been used as a source of draught power rather than a source of income. However, because of increasing demand for quality beef products in Siem Reap (SR), Phnom Penh (PP) and Ho Chi Minh City (HCMC, Vietnam), increasing mechanisation, increasing labour costs and new forage and weaning technologies (defined through ACIAR projects such as AH/2003/008), smallholders now have the opportunity to reduce their household labour invested in cattle and manage their cattle for profit. The ACIAR project AH/2003/008 has indicated that returns per head can be doubled with the adoption of improved forage management systems. While cattle producers working with this project understand the potential benefits in income, they still see the most important benefits as saving of labour.

There are still a number of factors that are limiting cattle smallholders' ability to adopt new technologies and their capacity or desire to participate in these developing markets. These include:

1. Cattle in SE Cambodia are chronically challenged by nutritional shortfalls and endemic diseases. Consequently, the health status of smallholder cattle is often extremely poor, reducing the value of sale cattle.
2. Lack of information with regard to cattle prices, quality required and market structure diminishes a smallholder's desire to produce appropriate sale stock.
3. The current system of cattle production relies heavily on communal grazing and cutting of forage at distant locations during times of feed shortages. This production method is labour-intensive, time-consuming and conducive to spread of diseases.
4. Inability to meet international biosecurity standards required for export.

Previous ACIAR projects identified that achieving increased returns for SE Cambodian cattle smallholders will require, in addition to improved on-farm performance, improved regulatory support and whole of market chain development. The National Development Strategy for Livestock in Cambodia (Draft, 14 February 2011) echoed these findings and the current rectangular strategy has the specific objectives of improving 'the livelihoods of small producers in the interests of household income and food security' and 'the safe and efficient supply of livestock products to the urban consumer and potential export markets.' There is also the 'National Medium Term Priority Plan for Animal Health' which has linked the control and eradication of important cattle disease such as FMD, HS and anthrax as a necessary pre-requisite for improved trade in livestock and livestock products.

Movement of livestock and livestock products carries a risk of spreading disease. Disease risk is a major impediment to legitimate access of Cambodian livestock to international markets, which is particularly relevant to cattle farmers in SE Cambodia hoping to take advantage of higher livestock prices in Vietnam. Risk assessment of the market chains for Cambodian livestock is consequently of fundamental importance in identifying feasible risk reduction measures aimed at improving access to markets outside Cambodia.

At the farm level, Cambodian livestock owners regularly suffer significant production and financial losses as a result of disease outbreaks. Recent ACIAR research (AH/2006/025) has identified factors which contribute to the rapid spread of these diseases within and between villages. Until official disease control measures such as movement controls and widespread vaccination campaigns become a realistic possibility in Cambodia, farmers, traders and other market chain stakeholders can be assisted by ACIAR research to identify and adopt simple, practical biosecurity measures to protect their livestock and their income. Risk assessment of market chain segments and subsequent development of biosecurity interventions for different stakeholder groups are consequently fundamental to this project.

Other ACIAR projects such as AH/2006/169 attempted to develop clean market chains for poultry products in Indonesia. It is clear that consumers are increasingly concerned with food safety and knowing the origin of their food products. This project developed a market chain that provided consumers with surety that the product came from a 'biosecure farm'. Consumers were prepared to pay for this particular farm characteristic. Lessons learned from this project in Indonesia were applied to the present project.

Impetus for this project also came from the ACIAR/OIE/ABCRC Workshop (ACIAR, 2010) which

stressed the role of market chain development in improving animal health and production outcomes. Achieving projective objectives will also support regional disease control strategies managed by the OIE, FAO and ADB, especially the SEACFMD program. The project is also in-line with the AusAID/ACIAR workshop held in Phnom Penh in February 2008. This workshop highlighted the priorities in the ruminant livestock sector in Cambodia as:

- Reduction of negative impact of trans-boundary diseases, particularly FMD, by managing livestock movements
- Improvement in ruminant livestock health through integration of better nutrition. Identification of disease of importance to production, and treatments (including vaccination) for preventing and controlling key diseases
- Management of cattle and buffalo production through improvements in reproduction and year-round availability of feedstuffs in rice-based systems
- Development of market linkages for smallholder cattle and buffalo producers (ACIAR 2011, p.66)

There are 3.6 million cattle in Cambodia, an increase of 20% since 2000. It is estimated that the demand for beef in Cambodia will increase by a further 22% and will double in Vietnam by 2020. By integrating improved production, biosecurity and market structures, SE Cambodian smallholders will have the capacity and opportunity to access higher-value markets and hence, improve livelihoods, reduce disease risk, and establish a more sustainable market for Cambodian cattle and beef.

4 Objectives

The project had two objectives and 13 associated activities, presented below.

Objective 1: Describe and value the cattle market chain and identify the factors limiting smallholder participation in developing market opportunities

- Activity 1.1: Manage partner and market chain stakeholder relationships.
- Activity 1.2: Construct framework for diagnosing/analysing the cattle market chain, identify the knowledge gaps and stakeholder partners.
- Activity 1.3: Design and implement base level survey in Kampong Cham and Pursat provinces.
- Activity 1.4: Describe market/value chain for transit and Cambodian bred cattle.
- Activity 1.5: Design and implement demand and consumer analysis in Phnom Penh and Ho Chi Minh City.
- Activity 1.6: Design and implement risk assessment.
- Activity 1.7: Economic assessment of improved cattle management practices and on-farm costs of disease.
- Activity 1.8: List potential on- and off-farm interventions that may improve stakeholder participation in the market chain and assess and refine the market chain diagnosis framework.

Objective 2: Define and facilitate the adoption of market chain improvements and interventions that assist market participation and improve smallholder livelihoods

- Activity 2.1: Test the potential interventions with regard to their private and public economic and social benefits and costs.
- Activity 2.2: Facilitate the adoption of improved farm production and biosecurity activities.
- Activity 2.3: Facilitate the development of a clean market chain where all stakeholders receive an economic benefit from producing and trading cattle into the developing markets.
- Activity 2.4: Develop, with the assistance of other stakeholders, appropriate farmer, trader and livestock officer training packages and implement training programs in case-study locations.
- Activity 2.5: Monitor and evaluate market chain interventions.

5 Methodology

Two phases and five core methodologies were employed in this project. **Phase 1** included:

1. a workshop to synthesise previous value chain work and develop a better understanding of what extra work is required. The workshop also ensured that other project activities are consistent with the project objective of improving the market chain for cattle in SE Cambodia. An initial 4-day workshop brought all project stakeholders and other market chain experts together to develop this common understanding and agreed set of activities in all areas (animal production, animal health, governance and socio-economics). The workshop was facilitated by Lisa Adams who has experience in the region and technical areas.

2. *Framework analysis of market chains*. Based on Ostrom and Cox (2010) the project developed an appropriate framework for diagnosing the performance of particular cattle market chains and factors influencing that performance. A framework of this kind is crucial for avoiding the too-common trap of presuming that problems with cattle market chain performance are similar enough across different settings that they will respond similarly to one-size-fits-all solutions. This framework defined the internal characteristics (resources, products, governance system and participants) and external characteristics (social, economic and political settings and related market chains) affecting performance of particular cattle market chains, the interaction between these characteristics and the outcomes (level of welfare, cattle productivity, livestock disease movement) of these interactions. Aside from being a novel derivation of the Ostrom/Cox framework, the technique developed in this project is sufficiently generic to be transferable to future research concerned with livestock market chains in other rural development settings. The technique was used in the Project as a means of ensuring that data on all key factors affecting cattle market chain performance, including those influencing decisions by farmers and other stakeholders to participate in the cattle market chain, were collected and analysed appropriately.

3. *Definition and diagnosis of the cattle market chain*. Value chain analysis can help design projects and programs to provide support to a value chain, or set of value chains, in order to achieve a desired development outcome. The entry point and orientation of value chain analysis in this project was Making Value Chains Work Better for the Poor: A Toolbook for Practitioners (DFID 2008). Therefore, the tools used in the analysis are oriented toward analysing the value chain from the point of view of the poor – in this case smallholder cattle owners. One advantage of value chain analysis is that it forces the analyst to consider both the micro and macro aspects of production and exchange activities.

   The commodity-based analysis can provide better insights into the organisational structures and strategies of different actors and an understanding of economic processes which are often studied only at the global level (often ignoring local differentiation of processes) or at the national/local levels (often diminishing the larger forces that shape socio-economic change and policy making). First, the value-chain analysis systematically mapped the actors participating in the production, distribution, marketing, and sales of cattle and beef. Second, the value-chain analysis identified the distribution of benefits to actors in the chain. Third, value-chain analysis examined the role of upgrading within the chain. Finally, the value-chain analysis highlighted the role of governance, both internal and external. The project worked with stakeholders in two provinces; Kampong Cham (predominantly supplying cattle to HCMC) and Pursat (supplying to PP). Results from the literature review, risk assessments (stakeholder survey and key informant interviews), socio-economic analysis (300 farm-level surveys), and resource audits (secondary data, stakeholder surveys) were integrated to understand the value chain. Farm level data were collected based on the geographic area of traders, rather than the traditional approach of village level data collection. At a higher or macro level factors such as: government policy, demographic trends, market incentives, political and bureaucratic structure, large traders, consumer demand (Cambodia and Vietnam) trends, infrastructure trends etc that may also influence smallholder decision-making were analysed through a literature review and stakeholder workshops.

   a. *Literature review*. The institutional environment within which this market chain exists will be described. This will include a description of formal and informal social and cultural rules, government policy and non-government relationships. Information with regard to farmer's

understanding of this institutional environment will also be obtained through the smallholder survey and stakeholder workshops. This review will also include present knowledge with regard to the economics of livestock production and biosecurity, the cattle production systems and the social and environmental factors affecting present farming systems.

b. *Risk assessment*. Assessment of disease risk associated with several major trade routes in Cambodia was attempted by ACIAR Project AH/2006/025. Critical points for disease spread (and control) were identified along the livestock trade pathways, such as export depots located close to the Cambodia-Vietnam border. Other significant features of the risk pathways have also been identified, such as influential stakeholders who might be enlisted to attempt biosecurity interventions.

   A detailed risk assessment at a farm (300 cattle owners interviewed) and village level (12 villages were selected in 3 communes in two provinces). In order to identify feasible risk reduction interventions that benefit all stakeholders at the supply end of the market chain, the risk assessment work was underpinned by sociological research to better understand village traditions and farmer attitudes towards disease.

   The periodic occurrence of FMD outbreaks (approximately every three years) suggested an outbreak may occur during the life of the project. During the first year of the project the Biosecurity team created a specific questionnaire for use during FMD outbreaks to collect more KAP information from farmers and VAHWs about disease spread (see Appendix for questionnaire).

   Socheat Sieng investigated factors influencing vaccine effectiveness as part of his PhD. Storage conditions for livestock vaccines were investigated using a cold chain survey. Digital data loggers recorded temperatures inside refrigerators at both government (one cold store in each province) and commercial vaccine retailers (10 in Phnom Penh, 9 in Pursat and 8 in Kampong Cham) over a 30 day period to assess whether vaccines were held within the recommended 2-8°C temperature range.

   The effect of adverse storage conditions and under-dosing on the antibody response to FMD vaccine was investigated by administering vaccine subjected to six different treatments (storage temperature too high, too low, or correct, and half or full dose) to an individually identified animal in each household. Six households in three villages were treated (i.e. 6 cattle x 6 households x 3 villages = 108 cattle in total). The antibody responses were tested in blood samples taken from the vaccinated cattle three times over a 60 day period at NAVRI laboratories in Phnom Penh.

c. *Socio-economic analysis*. An initial smallholder survey collected detailed information regarding farming systems, household relationships, smallholder attitudes, sources of income etc. A detailed understanding was gained on areas of cattle management and marketing, including production, biosecurity and marketing knowledge and practices, as well as factors affecting smallholder decision-making. The farmer survey was developed and undertaken in collaboration with RUA. All technical project staff undertook a training course before field work started on 6-7 February 2013 at the Royal University of Agriculture in Phnom Penh. The field work commenced on 13th February 2013 in Pursat province, where 143 farmer households were interviewed in 8 villages, 3 communes and 2 districts followed by 144 farmer households interviewed in 4 villages, 3 communes and 1 district in Kampong Cham province on 19-23rd February 2013. The survey design was informed using the framework of Marshal 2015. *Resource audits*. Details regarding the physical environments (including, land quality, seasonal issues, infrastructure) were collected as part of the literature review, smallholder survey and stakeholder workshops. Secondary data were collected by Provincial DAH staff (Lorn Sophal and his counterpart in Pursat). Enrolled farmers also to recorded daily data on cattle management and household costs and revenues. These were used for an economic analysis.

d. *Analysis of market demand and consumer preference* was undertaken in PP and HCMC. As Vietnam is outside the project area, Dr Nam Hoang (UNE) was engaged for the specific

purpose of undertaking the work in Vietnam. He worked with counterparts in HCMC. In HCMC 1,000 consumers were surveyed at traditional markets and supermarkets to assess their willingness to pay and potentially change their shopping practices if a consistent supply of quality Cambodian beef was available in the supermarkets. A similar survey of 500 consumers was undertaken in PP. Initial surveys were completed by the end of Year 1. Due to rapid market developments including very large increase in imports of Australian cattle into Vietnam, Vietnam markets and demand for beef in Southern Vietnam were monitored throughout the project.

The analysis evaluated what affects both supply and demand and future market expectations, investigating a broad range of factors including exchange rate, production levels in different countries and demographic issues.

The conclusion of the Phase 1 market chain analysis (end of Year 2) produced a detailed description of market chains affecting Cambodian smallholder producers, an understanding of present and potential future market demand for beef in the developing urban markets and an analysis of the factors that affect the production and marketing of smallholder cattle producers in Kampong Cham and Pursat.

The rapid changes in cattle import and the nature of the value chain required extra research to be undertaken into an appropriate business model for supplying beef and further description of the post slaughter value chain. These were undertaken during phase 2 of the project.

The activities undertaken during **Phase 2** of the project were largely determined by the analyses and decisions made at the end of Year 2.

4. *Introduction and evaluation of interventions*. Analysis identified the potential interventions that may improve the efficiency and equity of the cattle market chain in Cambodia. After a call for proposed interventions each of the proposals were considered by the group and evaluated based on expected return, plausibility (Who, what, when, and how much), and whether sustainable and scalable. Proposed interventions are included in Appendix 2. Activities included:

   a. University research station and laboratory (RUA) experiments to test nutrition interventions that better match supply of cattle and feed with peak demand/price periods and deliver improved quality meat for the high-value market sector.
   b. On-farm demonstrations and testing of recommended feeding and reproductive management strategies (as developed at RUA). These sites (3 sites per province; 6 in total) also acted as pilot sites for field days, workshops and cross-visits from stakeholders.
   c. Based on the success of AH/2006/169 working with the poultry industry in Indonesia, the project initially envisioned Market Chain Development Groups (MCDG) based in geographical areas and managed by 4 medium-level traders. The development of such large scale coordination proved beyond the scope of the project, largely due the complexity of the post-slaughter value chain and the structure of the existing market chain within the project provinces. Therefore a business model was developed for a new wholesale business (see below), taking into account the characteristics of the market chain described in Phase 1. Further work was also undertaken on post-slaughter value chain to facilitate the development of the business model as this proved very important.
   d. Development of simple, low or no-cost biosecurity measures for each stakeholder group within the market chain. These measures will be the product of disease risk assessments undertaken for the various sectors of the market chain, and will be evaluated for feasibility with focus groups and stakeholder workshops.

      Post-slaughter value chain description and business development during Phase 2.

   e. Business model development. Initial work to direct product into supermarkets found difficulties in getting buy-in from an established supplier. The need for more detailed analysis of the various markets and a business model that would be appropriate resulted in research into business model options that would address complexities of the post slaughter value chain and issues with the current value chain.

f. Description of the post-slaughter value chain for beef. During business model development it became apparent that the various products, markets and prices for beef were critical to success, as was the product mix that came from various animal types. Detailed survey work of restaurants and on the post slaughter value chain was undertaken collaboratively by Mekong Meats and CSU students. This included detail on the value associated with various animal types and the market for various grade 2 cuts.

5. *Extension and training*. Various extension activities were used to educate stakeholders (e.g. posters, leaflets, booklets, workshops). Training and extension workshops were undertaken in the areas of biosecurity, production, marketing for farmers and VAHWs, and financial analysis training workshops conducted for DAHP and RUA staff and students. Cold chain analysis results and recommended best practice was presented to government officials and vaccine retailers. Extension materials for all farmers and VAHWs in the project area were made available and extra were printed for wider distribution. Project results were delivered to Cambodian policy-makers and regional organisations such as SEACFMD.

6. *Stakeholder ownership*. Project management structures ensured that the project was industry and community driven. Information emanating from the project was made available on a project website, and internally through monthly reports and annual planning and review meetings. A mid-project review (end of Year 2) assessed the recommendations emanating from Objective 1, and guided activities to be undertaken to achieve Objective 2.

   Intervention proposals were developed by project stakeholders and were assessed at the mid-project review. The selection criteria were discussed and agreed by the B4M team before use. For each proposal the following case was presented:

   1. Description of the issue and the proposed intervention. Where relevant, any other interventions that may contribute to addressing a particular problem were identified. Why the issue hadn't already been addressed.

   2. The importance of the issue to specific value chain participants was detailed, supported with objective (from household survey, consumer survey, market survey [not yet available], other research) and subjective (personal experience, reports, communication with experts) evidence.

   3. For each intervention, the activities within the project that it relates to were identified, ensuring all activities were addressed in the final selection (e.g. production, biosecurity and marketing)

   4. A brief budget and timeframe for the intervention.

   5. An estimate of the potential for capacity building that the intervention will provide, the potential for scale-up benefits to other stakeholders/areas, and the likelihood the intervention would be sustainable beyond the life of B4M. The aim of this was to begin to articulate the impediments to, and prospects for, adoption and scaling up/out of potential interventions. These final three criteria were used for feasibility assessment and ranking of criteria.

   After assessment the interventions that satisfied the criteria and were feasible within the project timeframe and budget were agreed upon and a program for implementation decided on. The interventions became the basis for product claims that could be used for the marketing of a branded product. The product idea was then taken to wholesalers who supplied the major supermarkets in Phnom Penh and who had been involved in discussions throughout the project.

   The project eventually worked with a start-up wholesaler who was part of the project team, closely connected to RUA. If the business is successful this structure will provide maximum chance of the ideas and procedures developed in the project being sustainably applied and expanded into new areas.

7. *Economic modelling.* Economic modelling of improved on farm management and biosecurity measures were undertaken in two aspects. Financial modelling performed gross margin analysis and benefit cost analysis comparing growing forage for cattle fattening with growing alternative crops such as long bean and traditional cattle keeping. Biosecurity modelling investigated the efficacy of vaccination for FMD under various scenarios and looked at the sensitivity to various

levels of vaccination coverage and efficacy. Both activities utilised data from project farmers for input values.

8. *Monitoring and evaluation.* At the end of the project a survey was undertaken of farmers to assess the knowledge attitudes and practices to production, biosecurity and marketing of cattle. The survey targeted three groups of farmers: those enrolled in the project and therefore had received full training in addition to assistance from DAHP staff in the form of free forage seed, cattle house construction, and hands on mentoring; those who had attended one of the training courses but were not enrolled in the project; and those with no contact with the project.

6 Achievements against activities and outputs/milestones

Objective 1: Describe and value the cattle market chain and identify the factors limiting smallholder participation in developing market opportunities

No.	Activity	Outputs/ milestones	Completion date	Comments
1.1	Manage partner and market chain stakeholder relationships	Opening workshop	Aug 2012	A project planning meeting was held for project partners to launch the project on May 28-29. Inception meeting held at DAPH on Aug 28. Market Chain planning workshop.
		Establish Project Liaison Group. 6 monthly meetings held, reports prepared	Feb 2012	After several meetings with existing traders and supermarket wholesalers, group formation was redirected. After a new business plan developed by Agile Development Group, a new alliance including a trader, slaughterhouse and wholesaler commenced operations in 2015 with B4M staff and farmers.
		Final workshop	Dec 2015	September 2016
1.2	Construct framework for diagnosing/ analysing the cattle market chain, identify the knowledge gaps and stakeholder partners	Literature review undertaken.	Sep 2012	Annotated bibliography completed. Draft diagnostic framework (checklist) constructed
		Series of activities (e.g. workshops, focus groups	May 2012 Aug 2012 Dec 2012 Apr 2013	Project partner workshop to discuss applicability of framework and appropriate headings Presentation at 'market chain' workshop and discussion with DAPH and RUA to validate the framework/checklist Use of checklist to influence the questions asked in the farm level survey Presentation of checklist with farm level survey example at Annual Review meeting
		Identification of specific project areas	Dec 2012 Apr 2013	Completed by DAPH and PDA Forage planting and farmer training begun
1.3	Design and implement base level survey. Provinces Kampong Cham, Pursat	Design of survey,	Dec 2012 Jan 2012	First draft completed Consultation and partner input into survey design Form completed
		Train enumerators	Oct 2012	With RUA and managed by Socheat
		Pre-test questionnaire	Feb 2013	
		conduct survey	Feb 2013	Pursat 143 HH, Kampong Cham 144.
		Enter the data .	mar 2013	
		Dataset available, analysed Student project Journal paper published	June 2013 Jan 2016	Data analysed - Summary report available 2 publications Clive O'Connor UNE honours project Hasnah et al - Livestock Research for Rural Development.

No.	Activity	Outputs/ milestones	Completion date	Comments
1.4	Describe market/value chain for transit and Cambodian bred cattle	Focus groups/key informant interviews to develop understanding of stakeholder relationships	Aug 2013 2015-16	Meetings Supermarkets, wholesalers, traders, farmers Cattle market underwent dramatic changes during project (including price fluctuations), due to increase in imports of Australian cattle.
		Description of market chain	Dec 2013 July 2016	Completed, however see above comments about the rapidly changing market landscape. Wholesale market chain described further
1.5	Design and implement demand and consumer analysis. PP, HCMC	Consumer survey designed and completed, report presented at workshop	Dec 2013 July 2016	Initial supermarket and wet market survey completed (reports available). Further work completed on tourist and local BBQ restaurants as a significant and important market segment. Robinson CSU honours
		Market demand data collection and modelling; present and future demand for Cambodian beef	Sept 2013	Completed and continued throughout the project due to rapidly changing market.
1.6	Design and implement risk assessment	Scope and design of risk assessment	Jan 2013	Networks established with farmers, traders, wholesalers, slaughterhouses and supermarkets
		Further assessment of the risk pathway	Oct 2013	village-level disease prevention likely to rely heavily on vaccination, therefore prompting research into vaccine cold chain effectiveness and vaccination practices.
		Recommendations for practical biosecurity measures.	Dec 2013	Biosecurity SOP for project staff developed and all staff trained. Biosecurity education identified as a practical intervention for market chain participants. Biosecurity education booklet for farmers trialled in Pursat. After farmer feedback, posters were developed for farmer training schools.
		Recommendations for practical biosecurity interventions post farm-gate.	Dec 2013	Trader biosecurity training booklets distributed through 3 trading companies controlling Cambodia's cross-border trade in cattle and buffalo. Visits to import/export livestock border depots. Biosecurity protocols discussed and training booklets distributed. Biosecurity interventions post farm-gate not pursued beyond initial meetings. Project focused on delivery of cattle into the Phnom Penh slaughter market. VAHWs questionnaire. FMD vaccine cold chain and practices research (Socheat Sieng PhD) generated recommendations delivered to policy makers in Cambodia and OIE for more effective use of donated FMD vaccine.

No.	Activity	Outputs/ milestones	Completion date	Comments
		Facilitation of biosecurity policy formulation	Oct 2014	Cold chain report completed and presentation workshop of results to Government officials undertaken. Policy advice and changes passed on to Project HE Sen Sovann. The biosecurity protocols developed for project staff have been recommended to the DAHP for wider application in Cambodia (i.e. by all projects and departmental staff).
		Workshop with policy makers	July 2013	RUA hosted policy workshop, April 2014. Cambodia Govt, FAO other industry stakeholders.
1.7	Assessment of economics of improved cattle management and on-farm costs of disease	Economic analysis of improved cattle management practices	Dec 2015	Scenarios for breeding or fattening with and without forage. Opportunity cost of vegetable growing calculated.
		Socio-economic cost of disease on-farm identified	Dec 2016	Socheat Sieng PhD study investigated CBA of whole village vaccination program and sensitivity analysis of critical factors such as reduced effectiveness, .
1.8	List potential on- and off-farm interventions that may improve stakeholder participation in the market chain and assess and refine the market chain diagnosis framework.	Mid-project review workshop, presentation of results from Activities 1.2 to 1.7 Diagnostic framework refined on basis of outputs from A1.3-A1.7.	May 2014	Presentations on activities to date and interventions developed at mid-term review. Practical farm and village level biosecurity interventions applied: • Biosecurity training for VAHWs • Biosecurity education for farmers • Vaccination of livestock

Objective 2: Define and facilitate the adoption of market chain improvements/ interventions that assist small-scale cattle producers participate in the developing cattle markets

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Test the potential interventions with regard to their private and public economic and social benefits and costs.	Summary of recommendations concerning benefits and costs of potential interventions	Apr 2014	completed
		Select highest priority/payoff implementable interventions	June 2014	Completed
2.2	Facilitate the adoption of selected on-farm interventions	Implement and evaluate cattle productivity interventions	July 2015	Many households growing forage and a proportion fattening cattle, some very successfully. Weight gain recording plagued with equipment breakdowns but success evident for several farmers. Financial analysis in several household types shows good returns.

No.	Activity	Outputs/ milestones	Completion date	Comments
		On-farm biosecurity improvements developed and tested	July 2015	Biosecurity education booklets created specifically for farmers. Biosecurity training delivered to study farmers at B4M training schools. FMD vaccination, HS vaccination, and parasite treatments provided in study villages by B4M project as protective and exemplary biosecurity interventions.
2.3	Facilitate the development of a clean market chain where all stakeholders receive an economic benefit from producing and trading cattle into the developing markets	Market Chain Development Groups. Meetings held, activities agreed	Dec 2015	After delays getting wholesaler buy in, agreement was reached with new wholesaler after new business plan developed by ADG. Wholesaler with very good relationships with DAHP, RUA and a slaughterhouse. Developed new market segments in PP, first in local restaurants, then tourist restaurants, and finally supermarkets and premium local farmers markets. Vertical chain alliance needs continued development for technical training of farmers and establish closed loop supply chain.
		Biosecurity interventions for post-farm sectors of the market chain developed and tested.	July 2014	Biosecurity protocols previously developed for VAHW and traders distributed. Post farm gate not pursued due to focus on PP market. Slaughterhouse beyond project scope, however wholesaler plans for refrigeration and vacuum packaging.
		'Consumer-focussed' beef produced by smallholder farmers in SE Cambodia	July 2015	Fattened cattle produced by project farmers but limited sales due to low cost beef availability from new feedlots and age and condition of cattle poor. Wholesaler planning ongoing technical improvements with smallholder farmers.
		'Consumer-focussed' beef receiving a premium price in urban markets of Cambodia	Aug 2016	*Mekong Meats* start-up supplying a variety of restaurants, supermarkets and farmers market in Phnom Penh - innovations in packaging and supply. Only purchasing limited number of project cattle, majority coming from feedlot finished. Consumers very interested in origin and food safety.
2.4	Develop, with the assistance of other stakeholders, appropriate farmer, trader and livestock officer training packages and implement training programs	Media, training and extension materials developed	Aug 2016	Training materials developed for farmers, VAHW, as well as DAHP staff on Production, biosecurity, and specialised areas such as vaccine cold storage.
		Qualified government and university staff capable of providing training	Aug 2016	Training workshops conducted in production, biosecurity and cold chain management, financial analysis, and training techniques for university and government staff.

No.	Activity	Outputs/ milestones	Completion date	Comments
	in case-study locations.	Training programs for farmers, village animal health workers, traders, retailers, project staff and university students developed. Stakeholders trained.	Dec 2015	Two farmer training courses delivered in each province in production, biosecurity and marketing. Trader and VAHW training material developed. Cold chain mgmt. training for DAHP and retailers conducted. Project staff and students trained in data collection, financial analysis.
2.5	Monitor and evaluate market chain interventions	Tested interventions and lessons learned completed	Dec 2015	Farmer data recording sheets had reliability issues. One M&E survey compared trained and untrained farmers. FMD vaccination rates still very low. Beef value chain complexity and a new business start-up main lessons.

PC = partner country, A = Australia

7 Key results and discussion

7.1 Cattle and beef market chain in SE Cambodia

7.1.1 Changing cattle markets and value chain in Cambodia

The market chain and stakeholders were described at the start of the project (full report available at http://www.une.edu.au/research/research-centres-institutes/irf/international-development-research/current-projects/market-cattle-south-east-cambodia). The main stakeholders are retailers (including restaurants and supermarkets), wholesalers, slaughterhouse, exporters to Vietnam, traders and farmer households. Cattle traders were further divided into four subcategories, each of which determine their trading capacities in terms of cattle number and access to different marketplaces and stakeholders throughout the chain. Cattle collectors/brokers are based in the villages and only trade 1 to 5 cattle per month due to limited capital. Small traders buy and sell between 15 to 20 heads per month, most of which are based at the commune level. Interprovincial traders, on the hand, trade between 60 to 100 cattle per month, and are licensed by the Provincial Department of Animal Health and Production to buy, sell and transport cattle across provincial borders. Similarly, large traders are also required to hold a quarterly license from the Ministry of Agriculture, Forestry and Fishery, that allows them to trade up to 1000 cattle per quarter between provinces and into the Phnom Penh market.

Slaughterhouses are important stakeholders, as they provide a service to traders for slaughtering their cattle on a fee per service basis, where 20,000 Riels are changed per head. Wholesalers only operated in the Phnom Penh market chain. They purchase carcasses from traders after slaughtering and process the meat based on cuts and grades for different types of consumers, e.g wet markets, restaurants or supermarket retailers. These retailers and restaurants in Phnom Penh further process the quality of cuts for the final consumer demands.

Export cattle are brought to border depots, which provide a service to exporters and charge 10,000 riels per head for holding the cattle prior to transferring them to Vietnam. The amount of time cattle are held by these depots depend on the negotiation of price between local and Vietnamese traders. Usually, cattle are only kept 1-2 days, but can sometimes be held shorter or longer depending on the ease in negotiation, or lack thereof. The three main depots are Trapang Thlong on the border of Kampong Cham province and Tai Ninh province of Vietnam, Phnom Den on the border of Takeo province and An Giang province of Vietnam, and Banteay Meas on the border of Kampot and Kieng Giang province of Vietnam. Despite the active movement of cattle from Cambodia to Vietnam, disease control and prevention at the depots is poor, therefore increases the risk of disease outbreaks.

Cattle movement through the market chain

The traditional beef market chain in Cambodia consists of actors and links that are involved in the provincial, Phnom Penh, and export (Vietnamese) markets (Figure 1). The three markets involve similar actors throughout the chains, however the Phnom Penh market consists of more actors and levels through which the product journeys from the production to the final consumer level. The Phnom Penh markets consist of 5 levels, where products produced by smallholder farmers pass through cattle collector/brokers to traders, slaughterhouses, wholesalers, and finally retailers at wet markets and super markets, before reaching the final consumers. The provincial market, in contrast, only consists of 3 levels, skipping the wholesaler stage as the beef goes directly to the provincial wet markets. The export market, similarly, involves collectors, traders, and exporters who transport live cattle to Vietnamese traders/wholesalers/retailers.

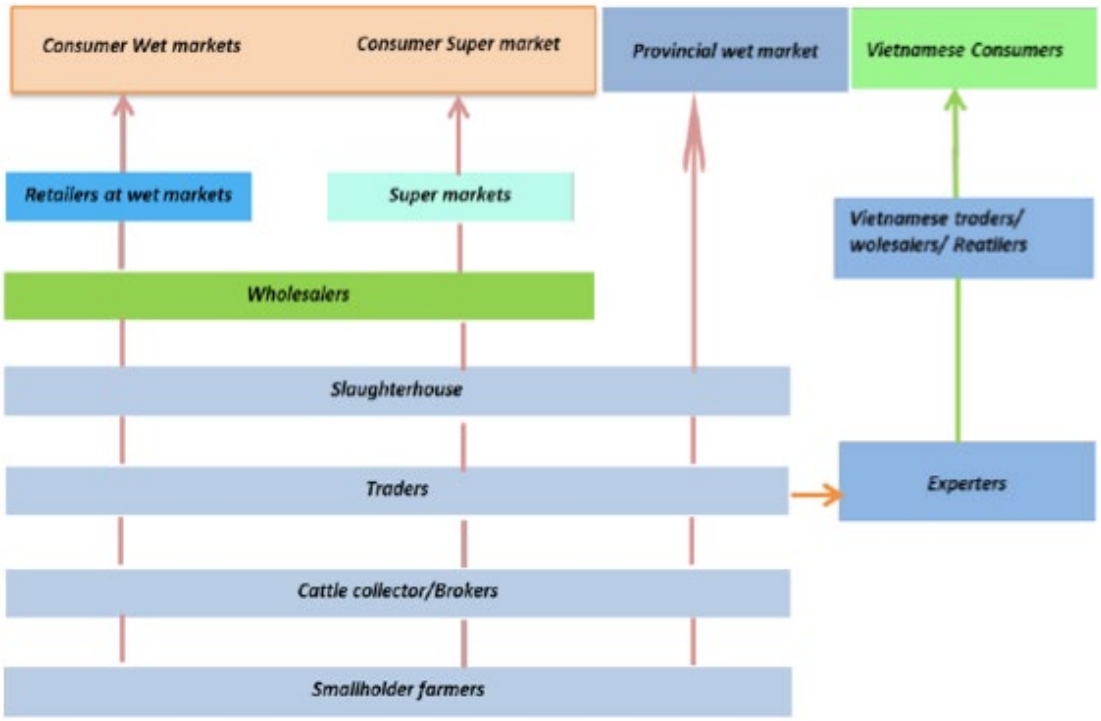

Figure 1. Traditional beef market chain in Cambodia

Kampong Cham and Pursat provinces

The number of cattle traded in Kampong Cham province in 2013 decreased from 119,000 heads to only 85,000 heads. Due to the decline in business, the number of large traders in the province has dropped from 30 to only 20 in the last five years. There are, however, between 70 to 80 small traders altogether. Over the last five years, collectors no longer require brokers, as they are now selling cattle directly to traders. Figure 2 shows the distribution of cattle traded in 2013 in Kampong Cham province. As evident, 15% of the cattle are slaughtered and consumed within the local provincial market, while 10% are sold to farmers for breeding. 30% are exported to Vietnam through Cambodian traders as mentioned in the previous section, 20% are sold directly to Vietnamese traders who operate under a local Cambodian company, and 25% to the Phnom Penh markets.

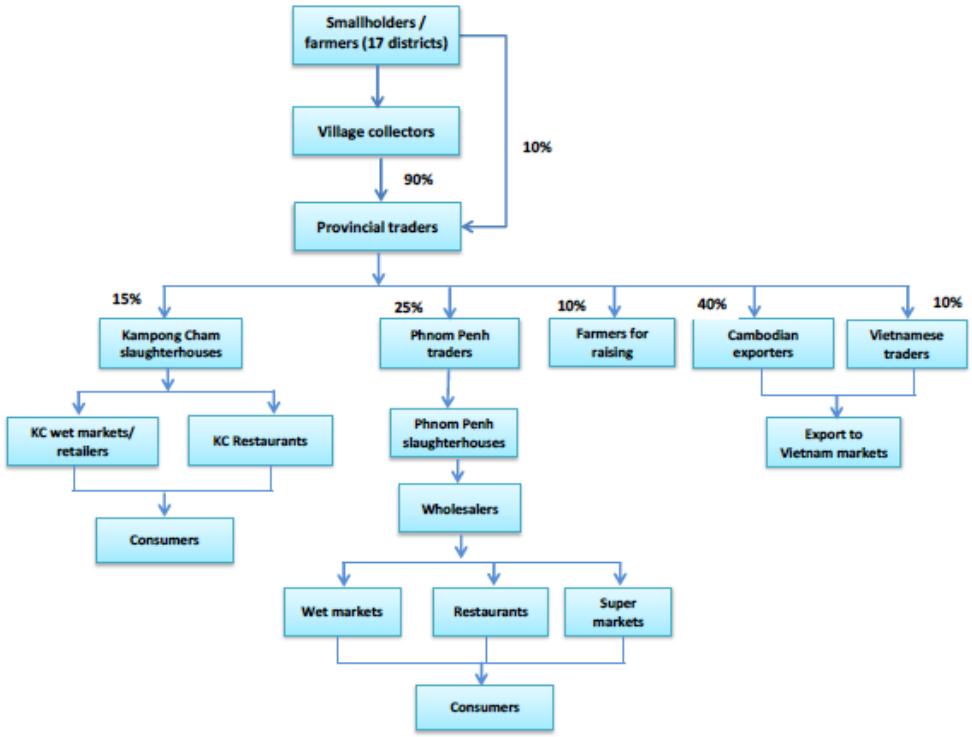

Figure 2. Cattle market chain in Kampong Cham Province in 2013

There are only 6 large cattle traders operating in Pursat province. It was estimated in that the number of cattle traded in the province decreased about 25%, from 13,260 to 10,200 heads yearly, in 2013 compared to the previous 3 years. The distribution of cattle in Pursat province is very similar to that in Kampong Cham province. 20% are slaughtered and consumed within the province, 30% are exported to Vietnam through Cambodian traders, and 20% are sold directly to Vietnamese traders operating in Pursat under a registered Cambodian company. 25% are sold to traders for the Phnom Penh markets, only 5% are sold to farmers for breeding.

Biosecurity along the market chain

The B4M project initially investigated all current market chain destinations for Cambodian cattle: local, provincial, Phnom Penh and Vietnam (Figure 1). As part of that research, the biosecurity team assessed biosecurity risks at critical points right along the market chain, building on work undertaken by ACIAR Project AH/2006/025. This eliminated local slaughter as a desired marketing option because it is generally not a market for 'high-value' cattle, serving instead as the destination for sick livestock and those in poor condition.

Also confirmed was that 'transit' cattle originating in Thailand and Myanmar travelled directly across Cambodia to export depots located adjacent the Vietnamese border. While these cattle do represent a biosecurity risk for introduction of disease into Cambodian livestock populations, that risk centres initially on Cambodian livestock located in the immediate vicinity of the export depots located adjacent to the Cambodia-Vietnam border which house the transit cattle prior to their final passage into Vietnam. While they may be considered a 'high-value' commodity, these transit cattle are not available for purchase and value-adding by Cambodian farmers, and therefore were consequently excluded from further consideration by the project.

Vietnam does offer a market for both slaughter-ready adult Cambodian cattle and unfinished young Cambodian cattle destined for Vietnamese feedlots. Consequently, the biosecurity team visited export depots along the Cambodia-Vietnam border to interview depot operators about their willingness for biosecurity education. Biosecurity options were also discussed at meetings in Phnom Penh with high

level traders and representatives of the powerful trading companies that control inter-provincial and international livestock movements in Cambodia. The company representatives were receptive to, and in some cases even enthusiastic about, having their agents trained in biosecurity protocols aimed at reducing the spread of livestock diseases. Similarly, export depot operators were receptive to biosecurity training because disease outbreaks in livestock consignments awaiting export movement into Vietnam are a considerable economic risk which result in price reduction and cancellation of sales.

After initial evaluation of market chain opportunities, the project decided to focus on marketing cattle into high value Phnom Penh markets. The biosecurity risks of this trade occur before the cattle leave the farm gate, as animals are generally transported directly to Phnom Penh for slaughter. Therefore the project restricted biosecurity interventions in post farm-gate market chain sectors to initial meetings with trading companies and depot operators early in 2013, and providing copies of the educational booklet '*Livestock biosecurity measures for traders of cattle and buffalo*' (product of ACIAR Project AH.2006.025. It was beyond the scope of the project to address the multiple biosecurity hazards that might affect product quality and food safety from the point of slaughter to the point of consumption, although some risks were addressed by the project partner wholesaler Mekong Meats using vacuum packaging and direct delivery to customers via a cool chain (see Section 7.2). Consequently, B4M biosecurity interventions focused on farm and village level activities aimed at ensuring that livestock disease didn't reduce the economic return that the farmers received from sale of their cattle into the Phnom Penh slaughter market.

Market volatility due to live Australian cattle imports into Vietnam

At the start of the project there were large numbers of cattle transiting Cambodia from Thailand to Vietnam as described in the previous section. In 2010 there were approximately 20 companies importing cattle at Banteay Meanchey, reducing to 3 in 2012. That trade resulted in declines in cattle numbers and consequent high prices in Thailand and Cambodia.

The cattle market chain in Cambodia was highly dynamic during the course of the project, and likely to continue as new large scale investments and trade policy changes take place. The international situation changed from large numbers of cattle transiting from Thailand, through Cambodia, into Vietnam, to a situation where large numbers of Australian cattle are being imported into Vietnam. Since 2012 a very large increase in the number of live cattle imported into Vietnam from Australia (Figure 3) resulted in a 15-25% reduction in prices, especially in Phnom Penh more so than regional markets, reversing previous cattle flows.

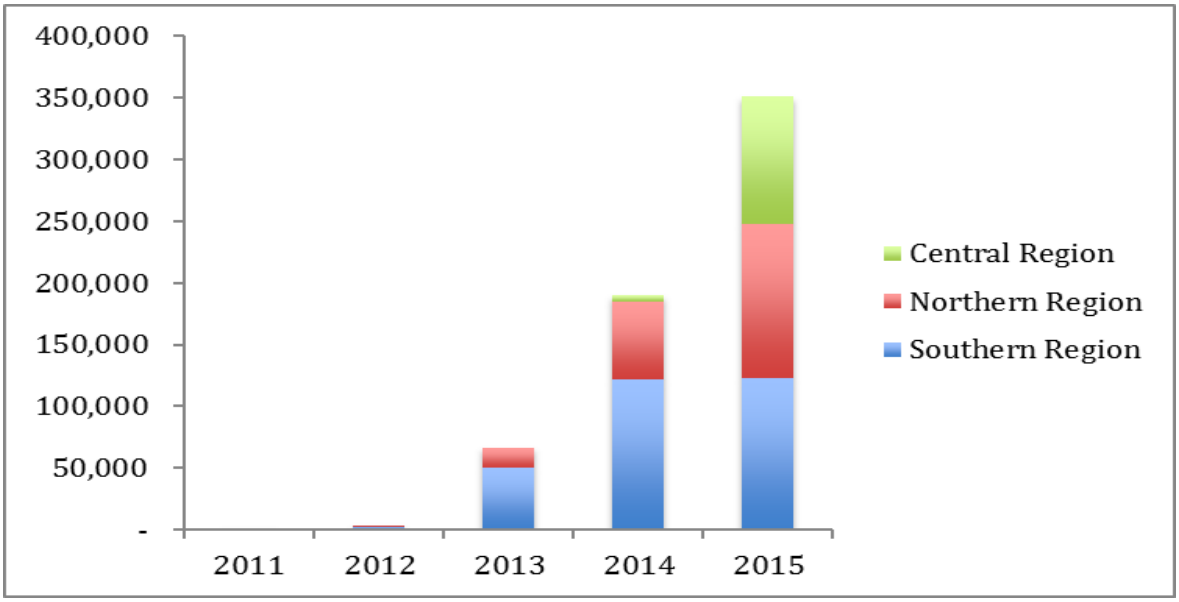

Figure 3. Australian Cattle imports into Vietnam

The market chain segments for cattle and beef are described in more detail below, from various consumer markets in Phnom Penh and Ho Chi Minh through the value chain back to farmers smallholder households. Reports on various sectors are available at http://www.une.edu.au/research/research-centres-institutes/irf/international-development-research/current-projects/market-cattle-south-east-cambodia.

7.1.2 Beef markets and consumers in Ho Chi Minh City and Phnom Penh

Beef demand

It is projected that consumption per capita for beef will increase at a rate of 33% from 2005–2020 (Jabbar, 2009). The demand for beef in Cambodia is believed to respond to the changes in consumers' income as well as price (Thun, 2005). Due to the improved living status of Cambodian consumers, the local demand for red meat is also increasing (Pen, 2014).

The demand for beef also changes seasonally. In Phnom Penh, 800 head are needed per day from June to November, increasing to 1,000 head per day in the high season (December to May). The demands in provincial markets, however, are still quite low. In Kampong Cham, for instance, only 4 head are needed per day, and 3 head in Pursat.

There is also demand for beef in Phnom Penh from major beef exporters such as Australia and the US. These meats are available in western restaurants and the price has generally been more than twice local beef, although prices have recently reduced - see below on the changing market situation. Recently, SLN Meat Supply commenced operating a large modern slaughterhouse near the sea port of Sihanoukville. The aim of this company is to supply Australian beef to the local market and also to export to Vietnam, China and other countries.

It was unofficially reported that Cambodia is importing beef products back from Vietnam to fulfill the demand in Phnom Penh city, however there are no data available from governmental statistics. Other regional import origins are Malaysia and Indonesia through Thailand to supply frozen beef stored in cool boxes during high season at provincial markets. During wedding or traditional ceremony seasons, the catering service use imported beef as the price is cheaper than local beef. The data on imported frozen beef into Vietnam are shown below (Table 1).

Table 1: Value of imported frozen beef in Vietnam 2008 - 2013 (USD)

	2008	2009	2010	2011	2012	2013	%
Australia	1,715,423	1,678,146	2,922,238	4,503,323	9,309,815	8,616,667	15
India	18,198,357	13,501,698	13,584,041	20,341,499	26,264,010	30,083,624	64
New Zealand	1,017,366	170,519	369,360	506,079	660,820	973,324	2
USA	2,251,068	1,158,088	2,586,853	4,353,015	7,427,296	12,971,750	16
Other	1,862,392	673,087	516,487	857,465	155,553	296,378	2
Total	**25,044,607**	**17,181,538**	**19,978,981**	**30,561,381**	**43,817,494**	**52,941,743**	**100**

Supermarket and wet market consumers

Any attempt to intervene in the beef market requires knowledge of consumer preferences and characteristics in the market segment being targeted. The project surveyed 1024 beef consumers in the two key markets of Phnom Penh and Ho Chi Minh City at both traditional wet markets and supermarkets (711 in HCMC, and 313 in PP, Table 2). The full report is available at http://www.une.edu.au/research/research-centres-institutes/irf/international-development-research/current-projects/market-cattle-south-east-cambodia.

The difference between traditional market and supermarket consumers was greater than the difference between Ho Chi Minh and Phnom Penh in both consumer characteristics and knowledge and preferences for beef products, although there were differences between the two cities. Importantly, although there are differences between the cities in aspects of knowledge of marketing and meat quality standards, consumers in both cities gave quality and service from sellers as the most important reasons behind their choices for buying beef, with advertising and price of much less importance. Similarly respondents in both cities identified animal health care, slaughterhouse and meat store hygiene, and meat freshness as the most important factors affecting beef quality.

Table 2: Number of survey participants in HCMC and PP

	Ho Chi Minh City		Phnom Penh		Total	
	Count	%	Count	%	Count	%
Supermarket	272	38	110	35	382	37
Open Market	439	62	203	65	642	63
Total	711	100	313	100	1024	100

Figure 4. Consumer being surveyed at traditional market.

In terms of price the two cities are only 200km apart and there is a porous border, so it would be expected that they are virtually one market. The difference between wet market and supermarket consumers was greater than the differences between the two cities. In both cities the majority of consumers were married women of average age approximately 40. Supermarket shoppers had higher education levels and incomes than those at wet markets. Phnom Penh consumers had lower incomes (including household income), were slightly younger, more were men and less were married. The majority in both cities consumed beef on average 1-4 times per week. Approximately 85% of beef purchased was domestic, although Phnom Penh consumers were less concerned about the origin of beef than HCMC. In Phnom Penh less imported beef was purchased (11% compared to 25% in HCM) and purchasing outlets were varied, including meat shops and street markets (virtually no respondents purchased at street markets in HCMC).

Although there were only minor differences in consumer characteristics and purchasing patterns, there were strong differences in knowledge of marketing awareness of beef. A great majority of consumers in HCMC knew of at least one beef brand, whereas the great majority in Phnom Penh couldn't recall any. Similarly, about half HCMC respondents knew of at least one meat quality standard, compared with less than 10% in PP. In response to food safety incidents, a greater number of respondents in PP said they would respond by stopping eating beef, whereas in HCMC most indicated they would try and understand the disease or incident to adjust consumption and that they would only buy beef if they can be sure it's safe. These differences may indicate better information channels in HCMC given the similar education levels and other profile characteristics of respondents.

When asked about willingness to pay for "Quality Certified Beef", 93% of HCMC respondents were willing to pay more compared to domestic beef. The average WTP price was 35% higher compared to that of domestic beef (lower than the price they pay for imported beef). Most of the HCMC respondents would pay 28% higher than the current price of domestic beef. In Phnom Penh, 66% of interviewed customers were willing to pay more for "Quality Certified Beef", and only 10% said that they would pay less for QCB. The price was 8% higher on average compared to the price of domestic beef they are buying (higher than the price they pay for imported beef).

Phnom Penh restaurant survey

Phnom Penh markets need approximately 800 head/day during the low season, and 1000 head/day during the high season. Tourists are the main driving force in the increase in beef consumption as well as the population's incomes. The early experience of Mekong Meats suggested that the restaurant sector was the most important and also the best strategically to gain a foothold in the market. This sector would be willing to pay for many characteristics of B4M products that can be marketed to consumers. Restaurants throughout the city generally only require high quality meat. However, very little information on the perception of beef is available to determine what constitutes quality in the minds of restaurant owners. Therefore, a survey of local BBQ, western style and tourist restaurants aimed to determine the definition of quality, as well as the factors that influence the decision to purchase beef produced by Cambodian farmers or imported beef. Finally, these factors will allow insights into restaurant owners' willingness to pay for local beef and their improved qualities.

Of 37 restaurants surveyed, the majority (>75%) of restaurants bought meat everyday, and also reported there was a trend of increasing demand. More than 80% of beef sourced was domestic and more than 60% were willing to pay more for an improved quality product and for the characteristics described in the B4M project interventions. The local BBQ restaurant sector is an important market segment for beef. On average, local BBQ restaurants purchased approximately 23kg of beef a day compared to approximately 5kg each for other meats, including chicken, pork and fish. In western style and traditional restaurants more poultry and fish were purchased than beef.

Restaurants rated beef quality as a more important characteristic than price when asked about different sources of beef. In describing characteristics that define quality, tender and fresh were the main offered. The idea of making claims about product characteristics that rely on trust is discussed in the section on brand development.

The full results from the survey can be found in Robinson (2016).

Mekong Meats customers survey

During latter parts of the project, after Mekong Meats commenced selling premium beef at several outlets in Phnom Penh they conducted market survey of customers and non-customers (see later sections for detail on Mekong Meats startup). The survey gave an indication of the importance of various value adding characteristics. Thirty telephone and personal interviews were conducted, 17 of whom were Mekong Meat consumers and the rest were not. A questionnaire of 11 questions in total, with generally closed questions and some opportunities for respondents' feedback and suggestions. The questions were designed to include six attributes of the marketing of Mekong Meat's products; packaging, origin, safety, consumer service, price, quality.

29 respondents knew of the company "Mekong Meats". This shows that most of the respondents have knowledge of the brand. 48% of those learnt about the brand from flyers distributed by the company's employees. 34% were personally approached, 20% saw advertisements on Facebook, and13% through word of mouth. Only 57% of the respondents had purchased from Mekong Meat. Of those, 53% made 1 – 2 purchases, while the remaining 47% had purchased 3 – 5 times.

The next important aspect dealt with what respondents thought about the attributes of products offered by the company. The three most common answers of five choices were; reasonable price (65%), product quality (55%), and product origin (51%). The other attributes of customer service and product safety were only 37% and 34%.

Factors that influenced buyers to make their first purchase: 33% for fresh beef products, 30% for cheap price, 26% for product safety, 23% for the product's packaging and to support local business. The remaining 20% purchase because of the beef's tenderness, 13% for the ease of free delivery service, 10% for the origin of the product, and 6% solely to try new branded products in the market.

When asked what improvements consumers would like for MM products and services; 35% want the company to increase its marketplace, 17% deliver products faster and broaden product lines, 11% want Mekong Meat to assure that products are always available, 5% want to see that expiration dates for the products are placed on the packaging, and also that the quality is always consistent and strictly

controlled from farm to the selling place. A small number of consumers wanted product sold in smaller portions fitted for individual consumption, and suggested that they be sold at supermarkets. To see these improvements, 76% were willing to pay more.

Mekong Meat's consumers appear quite satisfied with the products and services provided. Consumers chose to purchase from the business mainly for freshness and price. For non consumers and consumers alike, both groups agreed that Mekong Meat is known for the cheap price, which results from the company's initial penetration pricing strategy. As mentioned in the company's marketing mix, Mekong Meat is slowly implementing the market based pricing strategy, which results increases in products' prices to match that of the market's. Therefore, the products' prices will no longer be the point of attraction that appeals to consumers' price sensitivity. Based on Mekong Meat's consumer profile, the majority of final consumers are those who are of the lower middle and middle classes. Because of this, price is still a prevalent factor that affects their purchasing decision. Due to the economical strata and the limited number of Mekong Meat's existing consumers, this report's findings are solely based on the opinion of 30 respondents from a similar socio-economic group. Therefore, the answers are skewed and cannot be generalized for all types of potential consumers.

People who had heard of Mekong Meats were aware that price is good compared to that offered by competitors in the market. They also know of the product's quality in terms of freshness, taste, and texture. The factor that encouraged them to buy from Mekong Meat in the first place was the product's freshness. The product's price and safety were secondary.

Processors and Traders

The distribution of different cuts to the various market segments described above is the area where greatest value is added. For any premium product to be successful and for benefits to flow through the value chain, benefits must be realised from several sectors. The cuts suitable for supermarkets only represent a very small percentage of an animal and a very small market segment.

Sources and distribution of cattle into Phnom Penh markets

A study was conducted to observe characteristics of cattle arriving at Phnom Penh slaughterhouses. Most cattle (60%) supplied to Phnom Penh markets originated from northwestern provinces of the country: Pursat, Siem Reap, Bantey Meanchey, Battambang and Kampong Thom. 15% of cattle were supplied from Kandal and Kampong Chhnang provinces, 10% from Takeo and Kampong Speu provinces and 15% from Kampong Cham and others provinces. In Phnom Penh, there are three main retailer outlet types; wet market, restaurant and supermarket. The traditional wet market dominates beef supply of 65%, while restaurants account for about 34% and supermarkets for less than 1%.

The characteristics recorded include BCS, price, and meat yield. Data was collected on four occasions; September and December 2014 and March and June 2015, to describe seasonal pattern in cattle supply, price and BCS. The study was conducted in Chroy Chongva and Beung Salang slaughterhouses, the two main slaughterhouses in Phnom Penh city. The interview with traders took place at slaughterhouse or nearby the slaughterhouse where traders were keeping cattle before being slaughtered. The information was collected using semi-structured questionnaires from individual trader. It includes BSC, price and meat yield, bone and internal organ weight. The BSC was provided by interviewer on scale of 1-5 (1. very thin to 5.very fat). The remaining information was estimated with assistance of the trader.

Traders

Most of the year, the majority of traders (15 out of 22) buy cattle from collectors and only one-third of them buy cattle from farmers. In June however, (early rainy season) all traders (17) buy cattle directly from farmers.

There were between 4 and 11 traders from each period selling beef by themselves. 3-5 traders sold to distributors/wholesalers, and only 3 traders sold beef directly to retailers. Traders gave customer loyalty or friendship as a more important reason than price for selling to their customers.

The breeds of cattle observed in Chroy Chongva were colored-crossbred, white-crossbred, local and mountainous. In Beung Salang, cattle were mostly white-cross and Haryana. Overall, breeds are quite diversified although Beung Salang is more selective than in Chroy Chongva.

Between 80 and 90 percent of cattle at both slaughterhouses were male cattle and this was consistent across seasons. The age of cattle ranged from 1 to approximately 8 or older, however the mean was approximately 5.5 for all seasons except for December where the average age was approximately 4. This coincides with the onset of peak tourist season, indicating there is some market activity taking advantage of higher demand. However for efficient production and meat quality the average age of 5.5 is too old. Body condition score was on average 2.4 and didn't vary between seasons, ranging from 1 to 4. There was much potential for improved body condition.

On average, the meat yield of cattle at Phnom Penh slaughterhouse was 110.7 kg. The cattle at Beung Salang (131 kg) had higher meat yield than in Chroy Chongva (103 kg). Other parts of cattle such as bones, internal organ, head and skin are dependent on cattle size and also effect profitability. It is also correlated with meat yield and BCS. On average, cattle with meat yield of 110.7 kg had 20.2 kg of bones, 19.9 kg of internal organ, 10.8 kg of head and 21.9 kg of skin. So in total the weight of live cattle could be on average 183.5 kg, excluding faeces that could be 5-10% of the cattle weight. So the cattle with liveweight of around 200 kg and meat yield of 110 kg should be the target for farmers for their fattening program.

Table : Meat yield and portion of cattle at slaughterhouse in Phnom Penh (all kg).

Location		Meat	Bone	Offal	Head	Skin
Chroy Chongva	Mean	103.2	17.7	19.1	9.7	21.4
	N	657	656	657	657	657
	SD	45.2	6.1	6.9	4.0	9.2
Beung Salang	Mean	131.1	27.1	22.3	13.8	23.3
	N	243	243	243	243	243
	SD	54.7	6.1	6.4	4.9	6.8
Total	Mean	110.7	20.2	19.9	10.8	21.9

Overall, on average the purchased price of cattle was 3,700,000 riels (925 USD, Table 3). The price of cattle in Chroy Chongva slaughterhouse was between 3,000,000 and 3,500,000 riels (750-875 USD). In comparison, the cattle in Beung Salang worth higher value around 5,000,000 riels (1,250 USD), which was higher than in Chroy Chongva. The average price of cattle did not differ markedly during different period of the month in both slaughterhouses. The different between minimum and maximum price was too high showing huge variation of the mean. The weakness of this data could be the small number of sample size, giving that time and budget for the study is limited.

Table 3: Price of cattle observed at slaughterhouse in Phnom Penh.

	Mean price - Real	N	SD
Sept	4,137,838	136	1,514,850
Dec	3,602,566	235	1,712,645
Mar	3,591,739	184	1,684,254
Jun	3,730,142	555	1,670,094

There is a significant correlation of meat yield and price of cattle (Figure 5). BCS was not significantly correlated with price because it was consistently low and other factors such breed, were quite variable. The current market system of visual inspection of cattle and price based on meat yield therefore appears to be efficient.

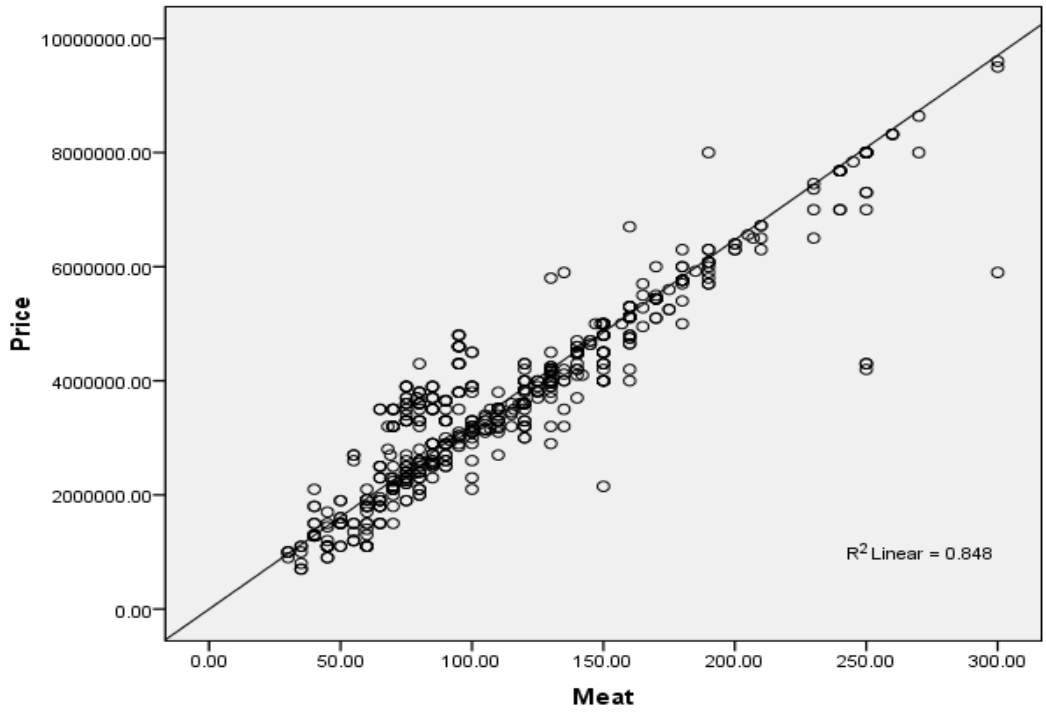

Figure 5: Correlation of meat yield and price of cattle

T-test was performed to find the difference of age, BCS, meat yield and price by sex of cattle. Male cattle were fatter than female cattle, meat yield was higher and therefore price was significantly higher. The BCS, meat yield and price are different significantly by breed of cattle. Brahman had the highest BCS (2.9), followed by mountainous cattle (2.6) and Haryana (2.4). Other breeds have an average BCS of 2.3 or below.

Brahman and Haryana yielded the highest meat (150 kg or more). White-cross and mountainous breed cattle yield over 110 kg of meat per animal. The meat yield of colored-cross and local cattle is below 100 kg.

7.1.3 Smallholder farmer households.

Any attempt to influence farmer behaviour requires knowledge of decision making and existing systems of household management. Farmers were surveyed in Kampong Cham and Pursat provinces, selected for the high cattle populations and proximity to the Phnom Penh market. In addition, Kampong Cham is close to the Vietnam border. 287 households were surveyed from 12 villages, 8 in Kampong Cham and 4 in Pursat. The household survey provided basic information on all aspects of household livelihoods including assets, income and activities, labour, social capital and cattle management and marketing. Data gave insight for analysis of farmer decision making and design of interventions later in the project, and will provide a baseline for any later impact assessment (Hasnah et al 2016; O'Connor, 2015; full summary report is available at http://www.une.edu.au/research/research-centres-institutes/irf/international-development-research/current-projects/market-cattle-south-east-cambodia).

The average household size was 5-6 with 1-2 adult men and women and 1 young (<18) male or female in each household. Highest education levels were greater for household members than survey respondents (generally main decision makers). About 15% of farmers had no formal education, two thirds had primary/secondary, and very few high school or university. In contrast virtually no other household members had no formal education, a third of had primary, a quarter had high school and 10% were university qualified.

The great majority of respondents were farmers (95%). Less than 5% of household individuals had paid employment other than farming. Of the average 5.4 household members, on average 2.2 were engaged full time on farming activities and 1.9 worked with cattle. The great majority owned or rented paddy fields which was 1.25ha in Kampong Cham and 2.96ha in Pursat. One third of households in KC and a half in PS had land other than rice paddy that could be cropped (1.1 ha in KC and 1.64 ha in PS). Almost all households owned cattle, with an average of 6 head of cattle. Other assets owned by the majority of households in both regions include: chickens, buffalo, bicycles, motorbikes, and TVs. Assets that only a small proportion of households own include; goats, pigs, ducks, fish, hand tractors, and generators. Only a few households own a car or a truck. A majority of households used a mobile phone, whereas none used email.

In Kampong Cham, the majority of farmers sell rice and receive income through off-farm activities and remittances. Other important income sources for Kampong Cham farmers are selling chickens, and pigs. In Pursat province, the majority of farmers sell rice and chickens. Other important income sources are off-farm activities, fruit trees, remittances and other vegetables. Importantly, very few used cattle production for income generation, showing that cattle are still regarded as draught animals and as assets to be sold when needed (Table 4). As most cattle sales are farmer to farmer, cattle act as a kind of community bank.

Table 4: Reason for keeping and raising cattle.

	First Reason (%)		Second Reason (%)	
	Kampong Cham	Pursat	Kampong Cham	Pursat
Draught	47	45	18	7
Keep for breeding	7	15	39	48
Keep for fattening	4	3	10	8
Be sold for cultural social reason	40	38	29	31
Others	2	-	4	7

Despite making no regular income from cattle, a significant amount of household labour goes to tending cattle. Most labour went to off-farm work and remittances (approx. 33-50 days per month), rice and annual crops (25 days per month), followed by cattle(15 days per month of which two thirds is youth labour). Between a quarter to half of farmers experience a labour shortage from May to December.

Cattle management varied between provinces but was an integrated part of household farming activites. In pursat most cattle were kept in a pen or fenced area, whereas in KC most were kept under the house. A minority of households in KC had a feed trough, whereas a majority didn't. The great majority either tethered, free grazed or herded the cattle in the field during the day, as well as feeding with rice straw and native grass. A majority in both provinces used wells as the primary water source for cattle, with only a quarter having dams. Virtually all farmers used manure to fertilise crops.

With regard to animal health, for each of three years prior to the survey, about a quarter of respondents said they had not experienced an FMD outbreak, one half had experienced one outbreak, 5-10% had experienced more than one and 20% said they didn't know. The results were similar for HS. In response to livestock disease, in Pursat most farmers contacted a VAHW when animals were sick, whereas in KC only about half did, with many treating the animal themselves first.

Only about half the farmers gave vaccination as the best method for preventing FMD, although a majority in both provinces had vaccinated animals in the previous three years. Many had little knowledge of disease transmission processes and appropriate management of sick animals (e.g. isolation), and misunderstandings about human susceptibility to FMD for example. Similarly, only 30 – 50% had dewormed animals in the last year.

In terms of cattle marketing, the majority of cattle purchases are from other farmers and most farmers contact neighbours when they want to buy. Only a third contact a broker/collector. Only two thirds of farmers had sold cattle in the last 3 years, and the great majority sell due to a need for cash. A third of farmers sell without finding out any information about price, a third contact brokers, and the rest

contact neighbours and relatives. On average each farmer knew 3 traders who bought cattle in their area.

Production and biosecurity on farm

DAHP project staff enrolled farmers and worked with them to increase productivity, improve biosecurity practices and work towards producing premium animals with a view to the Phnom Penh market. Major improvements made were the introduction of high quality forage species (supply of seed and technical assistance), technical assistance in the building of cattle sheds, and training to increase biosecurity and production knowledge.

3 villages in each of Kampong Cham and Pursat provinces were selected for farmer enrollments. The first year of forage establishment and production resulted in 45 households in 3 villages in Kampong Cham partnering with the project. These households own a total of 203 head with approximately 43 being fattened for market and 29 sold during 2013. Within Pursat there were 232 head of cattle owned by households partnered with the project, with 38 being fattened and 28 sold during 2013. There were significant losses of forage due to flooding during the wet season resulting in a loss of 30% of forage plots in Kampong Cham and 40% in Pursat. These were replanted in the wet season and new farmers were enrolled. An additional 58 farmers expressed interest in participating in the project, potentially an extra 6.7 ha of land allocated to growing forage. An excessively long dry season led to several forage crop failures as farmers ran out of water. Solutions to the feed gap that were later considered by the project were reconditioning of dams or wells to facilitate irrigation of forage and silage production. Climatic variation continued to be an issue for farmers throughout the project. In the final year experienced farmers lost forage plots due to excessive wet weather. Forage seed availability for replanting is also an issue as it must be purchased through a company in Thailand.

After the first two years where flooding and extended dry seasons resulted in considerable losses, the fattening of cattle specifically for market and new enrolments were the main focus of extension to farmers during the second year. 28 households were fattening cattle and 25 new households began growing forage plots during 2014 including 17 in three new villages in Prey Chor district and one village in Kampong Siem district. The main project intervention of whole village vaccination and deworming commenced implementation. The number of animals being fattened for market increased steadily during the 2014 and several farmers were buying young animals specifically for fattening. In 2015 9 new households growing 2.1 ha were enrolled in the project. At the end of the dry season only 14 cattle were being fattened, although numbers would increase as the rainy season began. When farmers began fattening and selling cattle project staff requested information about where cattle were being sold and information on sale price, however many farmers were reluctant to give the information. The steady increase in numbers of farmers building cattle houses, taking up forage growing, attending training and expressing interest shows the success of interventions. A survey of farmers late in the project showed good uptake of forage and other technology within project villages (Table 5), despite a tendency for enrolled farmers to have larger farms and forage plots, other factors were highly variable and not different between groups.

Table 5. Summary of forage survey results for enrolled and non-enrolled farmers.

		Enrolled	Non-enrolled	p-value
Mean forage plot (m^2)		1230.22	514.71	0.07
Mean farmland (ha)		2.36	1.33	0.08
Time cutting forage (mins/day)		20.82	9.25	0.19
Number of cattle fattening		2.4	2.3	0.15
Number cattle not fattening	**Males**	2.29	3.00	0.36
	Females	2.80	2.67	0.50
	Calves	1.70	2.00	0.88
Cattle sold in 2015		2.14	2.11	0.38

An important management intervention that remains difficult with low uptake is vaccination against FMD. Due to the multiple and complex issues surrounding vaccination and the cold chain, this was the topic of PHD studies of Socheat Sieng (see below).

Results of interviews and questionnaires with farmers and VAHWs indicated the following important points:

- Farmers and VAHWs had a poor understanding of how contagious diseases like Foot-and-Mouth Disease (FMD) and Haemorraghic Septicaemia (HS) spread between animals.
- Understanding and application of biosecurity measures by farmers ***and VAHWs*** is poor.
- There are numerous customary practices which carry a high risk of spreading FMD during an outbreak. These practices include:
    - allowing neighbours and friends with infected cattle to visit and examine livestock in an uninfected household
    - helping to treat sick animals without subsequent disinfection of hands and equipment before handling livestock in an uninfected household
    - communal grazing and roadside tethering of cattle
    - slaughter and butchery of FMD-affected animals without any hygienic precautions between handling infected meat and uninfected livestock.
- A surprisingly high proportion of the study farmers (74% in KC, 69% in Pursat) had had their cattle vaccinated in the preceding 3 years (2010-12), mainly against FMD (55% in KC, 70% in Pursat). However, widespread vaccination against FMD (some of it government or donor subsidised) in late 2010 and early 2011 in response to a nationwide FMD outbreak doubtless elevated those figures. This supposition is supported by the fact that quite a few of the interviewed farmers (32% in KC and 17% in Pursat) were uncertain what their animals had been vaccinated against. It should also be noted that where vaccinations had been administered to cattle, it was rarely undertaken more than once per year (inadequate for sustained protection against either FMD or HS).
- Many farmers contact their VAHW for assistance if their livestock get sick (44% in Kampong Cham, 72% in Pursat).
- VAHWs are viewed by farmers as the preferred person to administer vaccinations to livestock (76% in KC, 82% in Pursat).
- The most common reason for not vaccinating their cattle was **not** *cost* (< 10% of farmers in both provinces), but *difficulty in finding somebody to do the vaccination* (36% in KC, 29% in Pursat).

In the absence of regulatory disease control measures (see policy assessment, above), the project trialled farm- and village-level biosecurity interventions targeting:

- Biosecurity training for project staff
- Biosecurity training for VAHWs
- Biosecurity education for farmers
- Vaccination of livestock.

The farmers in our study villages advised us that some of the customary behaviours which carry a high risk of spreading livestock disease (listed above) would be difficult to change in the short term due to fear of causing offence to friends and neighbours. The farmers were nevertheless enthusiastic to receive biosecurity education which would allow them to understand how to prevent disease spread by modifying their practices over time.

Figure 6 Biosecurity training booklet for Cambodian farmers

Farmer training

Two farmer field schools were conducted in project villages in Kampong Cham and Pursat. The training was carried out in two different stages. Firstly, the project team provided training to provincial counterparts and their staff (training of trainers) on how to delivery all important messages in three different fields to farmers by using the same training materials (posters) and interact with farmers during the training session (questions and answers). Secondly, the project team provided training to enrolled and non-enrolled farmers, village chiefs, commune council members and VAHWs on livestock production (growth forage to fatten cattle), animal health and biosecurity and cattle market chain.

Train the trainer training took place at Prey Chhor District office of Department of Agriculture of Kampong Cham province. The integrated farmer training took place in 3 study villages per province. One day farmer training was carried out in each study village (Table 6). Provincial counterparts (new trainers) took part as trainers during some sessions with supervision from the project team. Training materials developed were posters with simple text and photos, white board and flip chart paper for explanation. Training took place at an exemplary farmer household and a participatory approach was used throughout the training, with hands on examples of forage planting being undertaken. Training sessions also provided excellent recruitment opportunities. Many new farmers enrolled after seeing the benefits from improved management first hand. The first training was whole day training and this was difficult for some farmers. Therefore the second training reduced the duration to a half day.

Figure 7 B4M Farmer training, Prey Chhor District, Kampong Cham – May 2nd , 2014

Table 6: Attendance for 1st integrated farmer training.

Province	*Village*	*Farmer*	*VAHW*	*Vil. chief*	*Com. council*	*District vet*	*Total*
Kampong Cham	*Koh Svay*	*24 (10 F)*	*6 (2 F)*	*1*	*0*	*1*	*32 (12 F)*
	Dei Kraham	*26 (6 F)*	*1*	*1*	*0*	*1*	*29 (6 F)*
	Teuk Nem	*26 (12 F)*	*6 (1 F)*	*1*	*0*	*1*	*34 (13 F)*
Pursat	*Roleap*	*23 (8 F)*	*10 (1 F)*	*0*	*2*	*1*	*36 (9 F)*
	Toul Krous	*22 (12 F)*	*2*	*2 (1 F)*	*0*	*1*	*27 (13 F)*
	Kralanh	*6 (1 F)*	*9*	*2 (1 F)*	*2 (1 F)*	*1*	*20 (3 F)*
Total		***120 (49 F)***	***33 (4 F)***	***7 (2 F)***	***4 (1 F)***	***6***	***171 (56 F)***

Economic modelling of forage production

An economic analysis of smallholder forage production systems was undertaken to evaluate whether or not investing labour and capital in these interventions would improve smallholder livelihoods and income.

Methods and Study Area

This study was undertaken in two provinces as Kampong Cham and Pursat, and included 122 households (75 in Kampong Cham and 47 in Pursat).

Data was collected by household survey and on-farm production data collected through the keeping of farm record sheets assisted by trained B4M project staff. In Kampong Cham and Pursat provinces, the average breeding herd size was 7 head (including calves) per household and 4 head for fattening enterprises.

Inputs for breeding, fattening cattle including costs

Forage and non-forage producing farmers use different inputs, the differences include:

1. Feed is the most important input used in both breeding and fattening systems and has a direct impact on production costs productivity. If farmers provided low quality feeds this resulted in low quality product (meat), low productivity and low output of cattle (low income). The study revealed that the average cost of cattle feed was US$111/breeding cow without forage. With forage planting the feed costs rose to US$193/breeding cow in the same 2 year period. The fattening feed cost without forage was about US$40/hd and US$78/hd with forage planting over a 3 month period.
2. Labour for breeding and fattening cattle without forage is generally double that required for forage production as non-forage farmers needed go far from their house to cut and carry the feed. Usually, the farmers use their own family labour for this task. Cattle breeders with 7 head without forage need approximately 5-6 hours per day to take care the cattle. This includes cut and carry and communal grazing in rice fields. They require about 228 person days per year compared to 114 days per year for cattle breeders with forage. For cattle fatteners during a 3 month fattening period without forage farmers would require about 56 person days compared to 22 days for forage producers (4 head per household).
3. Pharmaceutical products for de-worming and vaccination are other inputs used in both breeding and fattening systems Effective use can prevent disease and improve weight gain. On average the farmer would have to invest about US$5/hd.
4. Weight gain in cattle fattening is dependent on the quality of feed and nutrition management. If the farmer provides good quality feed then the cattle will gain more weight compared to those cattle who receive low quality feed. Based on the farmer record sheets, the an average cattle weight gain was about 0.46kg/day for farmers who provided good quality forage (purchase weight 196kg after 90 days weight was increased to 237kg) compared to without forage weight gain of about 0.21kg/day (purchase weight 196kg after 90days weight increase only 215kg).
5. Breeding cattle supported by good quality forage have higher productivity than breeding cattle without forage. On average, breeding cattle without forage have calving rates of about 70% while cattle with forage had calving rates up to about 84%.

Gross margins

Cattle breeding

Cattle breeding is a significant income source for smallholder households. The GMsfor cattle breeding with and without forage production were compared. Direct costs included cost of cattle, labour, feeding and vaccination services.

Calving rate represents one of the most important factors for breeding profitability. Calving rate varied between cattle breeding with and without forage due to nutriitive value of forage. Farmer interviews showed the calving rate without forage was about 70% compared to 84% with forage.

Table 7 presents the GM for cattle breeding without forage production. The variable costs for the 2 year breeding period were US$2,541. These costs were includes health care (vaccination), replacement stock, labour and feed costs. The sale income was US$3,817 which included sale of culls, and calves. In this example heifer calves are kept as replacement, it is a self-replacing herd.

Table 7. Cattle breeding without forage production

Variable Costs					
			head	$/head	
1	Transport and marketing		5.2	20	105
2	Vet costs		17.9	5	89
3	Other		17.9	10	179
4	Replacements	Bull	0.4	1,000	420

5	Feed cost			7.0	111	779
			of value of sale			
6	Commission	1.50%	cattle	5.2	726	57.03
7	Casual labour		228	Day/US$	4.00	912
8	Forage maintenance					0
	TOTAL ANNUAL COSTS					**2,541**
Income					US$	
			cull			
1	Sale of Stock		cows	0.8	785	599
			cull bull	0.4	1,071	450
			heifer calves	1.6	457	746
			steer calves	2.4	589	1,429
2	Animal draught power		40days	1.5adults	5/day	308
3	Sale (or value of) manure			1,360kg	0.03/kg	286
	TOTAL ANNUAL INCOME					**3,817**
	GROSS MARGIN					**1,276**
	GROSS MARGIN/COW					**182**

The gross margin for smallholder farmers with a herd size of 7 head without forage production were about US$1,276, therefore US$182'hd/yr. In comparison the smallholder farmer with 7 head and grows forage has higher variable costs than non-forage producer but also higher GMs of US$2,774 and US$396 per head (Table 8). Therefore, the smallholder cattle breeder with forage production will receive a GM about 58% higher than farmer who breeds cattle without forage.

Table 8: Cattle breeding with forage production

Variable Costs						
				head	$/head	
1	Transport and marketing			6.2	20	124
2	Vet costs			19.8	5	99
3	Other			19.8	10	198
4	Replacements	Bull		0.4	1,000	171
5	Feed cost			7.0	193	1,354
			of value of sale			
6	Commission	2%	cattle	6.2	913	85
7	Casual labor		114	Day/US$	4.00	456
8	Forage maintenance					14
	TOTAL ANNUAL COSTS					**2,502**
Income					US$	
1	Sale of Stock		cull cows	0.8	1,004	767
			cull bull	0.4	1,339	562
			heifer calves	2.1	571	1,210
			steer calves	2.9	736	2,143
2	Animal draught power		40days	1.5adults	5/day	308
3	Sale (or value of) manure			1,360kg	0.03/kg	286
	TOTAL ANNUAL INCOME					**5,276**
	GROSS MARGIN					**2,774**
	GROSS MARGIN/COW					**396**

Cattle fattening

The feed costs for cattle fattening with forage production was US$78, about double the costs incurred in a fattening activity without non-forage (US$40 per head), The animal health costs are the same

between cattle fattening with and without forage production. Fattening without forage has lower feed costs as cattle are generally free grazed or fed using the cut and carry system. Despite the lower feed costs there is a much larger labour cost associated with grazing and collecting forage. Farmers without forage spent about 56 days in a 90 day period accessing feed. Compared to 22 days for farmers who grow forage. Variable costs for fattening with forage were US$2,464 (4 head) with non-forage costs of US$2,377. On average cattle fattening without forage returned a GM of US$286 per head compared to a with forage production GM of US$345 per head, about 20% lower (Table 9, Table 10). Differences between the GMs were related to the weight gain and fattening costs, mainly labour. Fattening with forage resulted in average weight gain of 0.46kg per day per head, compared to 0.21kg without. Over 3 months this converted to increased gains of $81 per head when fattening with forage.

Table 9. Cattle fattening without forage production

Variable Costs						
				head	$/head	
1	Transport and marketing			4.0	20	80
2	Vet costs			4.0	5	20
3	Other			4.0	10	40
4	Steers			4.0	437	1,748
5	Feed cost			4.0	40	158
6	Commission	2%	of value of sale cattle			26
				days		
7	Casual labour		56	@US$	4.00	224
8	Forage maintenance					0
	TOTAL ANNUAL COSTS					**2,377**
Income					US$	
1	Sale of Stock			4.0	806	3,225
2	Animal draught power		12days	0.2adults	5/day	12
3	Sale (or value of) manure			1,360kg	0.03/kg	286
	TOTAL ANNUAL INCOME					**3,523**
	GROSS MARGIN					**1,145**
	GROSS MARGIN/STEER					**286**

Table 10. Cattle fattening with forage production

Variable Costs						
				head	$/head	
1	Transport and marketing			4.0	20	80
2	Vet costs			4.0	5	20
3	Other			4.0	10	40
4	Steers			4.0	437	1,748
5	Feed cost			4.0	78	311
6	Commission	2%	of value of sale cattle			26
				days		
7	Casual labour		22	@US$	4.00	88
8	Forage maintenance					71
	TOTAL ANNUAL COSTS					**2,464**
Income					US$	
1	Sale of Stock			4.0	887	3,548
2	Animal draught power		12days	0.2adults	5/day	12
3	Sale (or value of) manure			1,360kg	0.03/kg	286
	TOTAL ANNUAL INCOME					**3,845**
	GROSS MARGIN					**1,381**
	GROSS MARGIN/STEER					**345**

Opportunity cost of growing vegetables - long bean and cucumber

Before changing to grow forage it was assumed farmers grew other commodities such as vegetables (long bean and cucumber). It is necessary, therefore, to understand the opportunity cost of changing to an alternative production system. If they now grow forage it implies they forego growing the vegetables.

The average plot size was 40m by 50m (2,000m^2). If growing long beans on this area the smallholder would have earnt about US$407 per season. If he/she grew cucumbers they would have earnt US$420 (Table 5 & 6).

Table 5: Gross Margin of Long Bean production

Enterprise:	**Long Bean (40m@50m)**					
Income						
Sale to trader	2,500	kg	@	0.62	$/kg	1,550
Sale to other	250	kg	@	0.60	$/kg	150
Total income						**1,700**
Variable costs						
Seed	2	kg	@	9.00	$/kg	18
Fertilizer - manure (kg)	7	kg	@	5.00	$/kg	35
Fertilizer-Urea	100	kg	@	0.60	$/kg	60
Fertilizer - NPK	300	kg	@	0.80	$/kg	240
Herbicide (bottles)	0	bottle	@	0.00	$/bottle	0
Pesticide (bottles)	12	bottle	@	8.00	$/bottle	96
Plastic cover	2.5	piece	@	31.00	$/piece	78
String	20	kg	@	1.20	$/kg	24
Bamboo trellis	350	stick	@	0.25	$/stick	88
Fuel (L)	75	L/ha	@	0.95	$/L	71
Irrigation pumping	24	times	@	5.00	$/time	120
Crop transport to market	3,000	kg/ha	@	0.00	$/kg	0
Land preparation	7	days/ha	@	7.00	$/day	49
Planting	3	days/ha	@	5.00	$/day	15
Watering	40	days/ha	@	5.00	$/day	200
Weeding	15	days/ha	@	5.00	$/day	75
Harvest/cutting	25	days/ha	@	5.00	$/day	125
Total expenses						**1,293**
Gross Margin/2,000m^2						**407**

Table 6: Gross Margin of Cucumber production

Enterprise:	**Cucumber (40m@50m)**					
Income						
Sale to trader	5,600	kg	@	0.23	$/kg	1,288
Sale to other	900	kg	@	0.23	$/kg	207
Total income						**1,495**
Variable costs						
Seed	1	can	@	26.00	$/can	26
Fertilizer - manure	5	cart	@	5.00	$/cart	25
Fertilizer-Urea	100	kg	@	0.60	$/kg	60
Fertilizer - NPK	250	kg	@	0.80	$/kg	200
Herbicide (bottles)	0	bottle	@	0.00	$/bottle	0

Pesticide (bottles)	9	bottle	@	8.00	$/bottle	72
Plastic cover	2.5	piece	@	31.00	piece	78
String	20	kg	@	1.20	$/kg	24
Bamboo trellis	350	stick	@	0.25	$/stick	88
Fuel (L)	75	L	@	0.95	$/L	71
Irrigation pumping	0	times	@	5.00	$/time	0
Crop transport to market	6100	kg	@	0.00	$/kg	0
Land preparation	6	day	@	7.00	$/day	42
Planting	3	day	@	5.00	$/day	15
Watering	35	day	@	5.00	$/day	175
Weeding	10	day	@	5.00	$/day	50
Harvest/cutting	30	day	@	5.00	$/day	150
Total expenses						**1,075**
Gross Margin/2,000m^2						**420**

The farmers indicated that the reason for changing from vegetable planting to forage production was mainly due to the understanding that vegetables can only planted one time per year (seasonal cropping), and farmers often struggle to find markets as other farmer in the village are also growing the same seasonal vegetables, leading to low prices. Farmer sometimes lose money by growing seasonal vegetables as there may be no market during harvest time.

Even when the GM for vegetables looks attractive farmers in the B4M project areas regarded these returns as risky and variable. When forage production was promoted starting in early 2012 and farmers realised there was an increasing demand for good quality cattle in both local and export (Vietnam) markets, many farmers were keen to switch from vegetables to cattle as they regarded it as a less risky and potentially growing market.

Issues and lessons learnt

The speed of enrolments, the sale of fattened project animals to other buyers, and setbacks that occurred with forage growing due to weather extremes were a precursor to the issues of volume and reliability of supply that arose during business planning (see below). Another aspect that created problems in supply was that only a proportion of farmers trained in forage production and biosecurity began fattening. Some became breeders, some didn't have enough forage area or labour to increase production, or capital to buy young animals specifically for fattening. This further reduced the number of animals available, as well as the seasonality due to rainfall. As an example, an extended household at one village consisted of grandparents looking after grandchildren, with several of the young adult members away working. The grandparents said they didn't have capacity (labour) to increase production nor to buy cattle (capital) for fattening and would just continue with cow and calf. However by the end of the project they had changed perspective and had begun fattening a number of animals.

Limitations with seasonality of feed availability need to be addressed. Farmers supplying restaurant sectors need to have reliable water supplies to irrigate forage, and not all project farmers did. The number of households needed given the size of forage plots is also an issue. The average forage plot size was approximately 2500m^2, only sufficient for fattening a few animals. Many scale and logistic issues are addressed in the startup business plan (see later section).

Several issues arose around the marketing of cattle. The large increase in Australian cattle arriving in Vietnam resulted in a decrease in prices of some 20-30% from the high levels during the early part of the project. Given the previously sustained high prices, it is not surprising that many farmers were reluctant to sell, perhaps expecting cattle prices to regain earlier levels. A related issue in terms of marketing and the time for change to take place was that even though farmers had started growing forage and improved management, many farmers still kept animals mainly as a convertible asset, and so weren't necessarily turning animals over or even selling at the best time. Training farmers in

marketing cattle did anecdotally improve farmer interactions with traders, however further training would be needed by many to aquire business skills. Several project farmers had built considerable herds during the project and were making a good living from cattle. The result was an insufficient number of available cattle, and owners not necessarily willing to sell at the right time. A closer relationship between the wholesaler and the farmers is needed to build trust. The farmers can become aware of the specific needs of the wholesaler and the transactions can be simplified and therefore negotiation becomes easier.

To some extent many of the issues faced were a result of the project being unable to form the market chain groups that were envisaged with existing traders and wholesalers in the provinces. The resulting delay was only compounded by a separate process to setup a new business. The time required to develop networks and trust with individual landholders was too great for the last year of the project. The business plan developed specifically addresses issues of supply and marketing in terms of a start-up strategy and is presented in a separate section below.

7.2 Market chain interventions

After the first 2 years of the project a process was undertaken to develop possible market chain interventions that would facilitate improved cattle production and market access for smallholders. The interventions were assessed based on three criteria; 1. Capacity building, 2. Scale-up benefits 3. Sustainability beyond the life of the project. The final interventions were then decided on in light of available budget.

The proposed interventions and the main pros and cons raised in discussion are listed below (Figure 6). Several proposed activities were rejected based on the criteria, mainly feasibility within the project scope, including the use of microfinance for feed gap solutions and the use of mobile phone systems for dissemination of market information and disease outbreak information. Figure 6. Proposed beef value chain interventions and entry points.

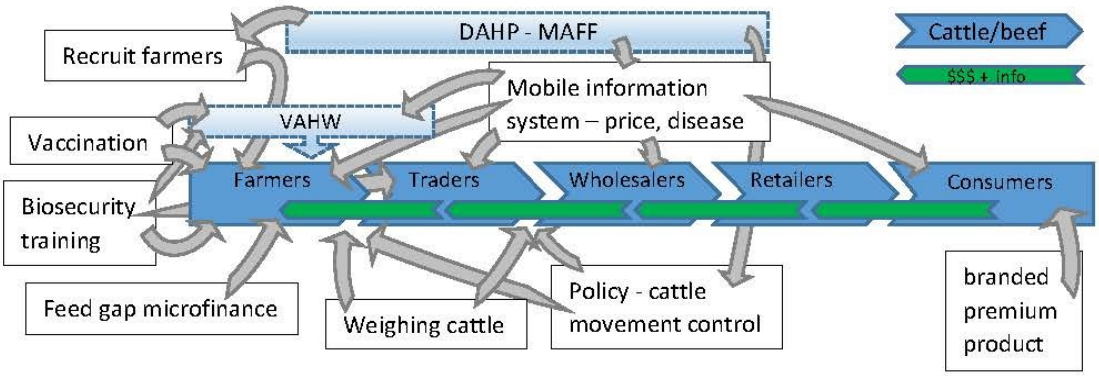

Figure 8. Proposed beef value chain interventions and entry points.

Most of the interventions are aimed at farmers and to a lesser extent village animals health workers and traders. Weighing cattle and movement policy is aimed mainly at the transfer of cattle between farmers and traders and traders and wholesalers. A branded premium product is aimed at consumers and therefore influencing the whole value chain. A mobile information system would allow entry at multiple points to most stakeholders, but would require a quality data system and would be difficult to establish.

7.2.1 Adopted proposals:

1. Recruit increased number of farmers. It was proposed to recruit more farmers into the project. These could be: 1. re-engaging farmers who dropped out (due to failed forage, etc), 2. farmers in new villages, 3. new provinces. Re-engaging farmers was agreed to be a good idea, with the caveat that site selection needed to be reassessed for situations such as flooding of forage plots. Recruiting new villages was thought not possible at this stage due to time constraints on staff, however may be best attempted in the last year as part of a scaling-up of proven project results. It was suggested that unit costings need to be developed for the cost of recruiting a farmer in existing and new villages. This would be useful information for future activities if and when a value chain developed that required training and enrolling of farmers by other stakeholders. Later the limited number of cattle available proved to be a major limitation in the development of markets for a branded product and so scaling up will be necessary. It also became apparent that many farmers not enrolled in the project had begun adopting improved management techniques trough contact with the project and enrolled farmers. So the benefits of project management techniques appear clear. Enrolling extra farmers would expedite this process, but could be more strategic by spreading effort out to maximise uptake for project effort.

2. Liveweight of cattle. This proposal required distribution and training in the use of portable scales. This would be a significant advance in the marketing of cattle, providing certainty and confidence for buyer and seller, although probably more for the buyer who is likely more experienced in visual assessment, and has more knowledge of market conditions. All project cattle will be weighed, extra scales purchased and training undertaken to try and increase the sale of cattle by live-weight. This would also facilitate the collection and distribution of objective market information (see mobile phone suggestion below). For example, the introduction of a system of market information would require objective ways of identifying different types of animals. The current system of visual inspection of animals is a source of ambiguity, and is heavily biased towards a more experienced party in a transaction (i.e. not farmers).

3. Biosecurity.

- Cold chain management, survey work and vaccine storage were agreed to be necessary, and had already commenced as part of Socheat Sieng's PhD. It was suggested that assessing the effectiveness of vaccine due to half doses being administered was a regulatory issue and it could be assumed that it would be ineffective and that it doesn't need confirmation experimentally (this would replicate work done by vaccine developers).

- The effectiveness of different forms of training and communication was discussed. E.g. given low levels of literacy it was suggested digital stories or video may be a good supplement to written material. An example of a video on youtube using a Smartphone was demonstrated. These technologies would be just as appropriate for production extension. Costing on video production was needed.

- Whole village vaccination/deworming vs just project cattle. At the meeting conclusion it remained unclear whether the project should proceed with vaccination of project cattle, whole villages or just concentrate on issues surrounding the administration of vaccine. This is because if decisions are taken to vaccinate it would need to be every 6 months and may be ineffective if insufficient proportions of populations are vaccinated. Even though whole village vaccination was quite expensive, a decision was that it was needed to be able to make claims for a premium product.

4. Premium Product clean market chain – The introduction of a premium product to market that used improved management techniques as market claims of premium product characteristics. The perception of what was good about project cattle that would appeal to consumers needed to be established. Discussion of what characteristics could be used to sell project beef centered on the problem that there is no audit of trained project farmers so quality cannot be guaranteed. Characteristics agreed on were 1. forage fed, 2. farmers trained in biosecurity, animal health management and production, 3. grown in Pursat and Kampong Cham.

There was considerable detail needed to plan and cost this intervention. Animals need to be weighed on farm after sale and before transport, price and destination information passed to project staff, animals identified with ear or neck tags, marketing material designed and produced, number of project cattle estimated, incentives for farmers, traders and wholesaler to partake in product developed (e.g.

transport subsidies), formation of a market chain working group, and launch of a product into supermarket and wet market.

5. Market Study - Price monitoring HCM city. Continued monitoring of price and cattle imports into HCM from Australia was proposed at minimal cost. It is important to investigate the impacts of the ongoing supply change on market beef price in HCMC/Phnom Penh region. This was agreed to be useful given the current market volatility and the possible effect on the project activities. Currently all NW project cattle go to Vietnam with very specific requirements (6-8 month Haryana castrated males). However, the utility of some aspects of the proposal were questioned – e.g. studying facilities in Vietnam processing Australian cattle. Determining the destination of Cambodian cattle would be useful, although perhaps more difficult.

6. *RUA nutrition and marketing student projects*. Nutrition experiments continue with in- vitro and in-vivo assessment of available feed sources such as first, second and third grade rice bran.

Interventions not undertaken

7. Microfinance for feed-gap and cattle purchase proposal. The consensus was this is a difficult area for the project to ask farmers to take risk on unproven technologies/proposals made by the project. It was also clear that expertise in microfinance doesn't exist within the project. An example was quoted of World Bank subsidised finance in Vietnam– it is not available in Cambodia - why? Also interest rates are currently prohibitively high at 36% annum. There are also problems with financial management and literacy, e.g. some farmers go to several banks and borrow too much. Other points raised included the need for yearly interest not monthly to avoid cash flow issues as raising cattle needs a longer time frame. Farmers can't service a monthly interest bill.

Conversely, it was suggested that farmers need to have some stake in proposals to maximize ownership and uptake. Several microcredit groups exist for other purposes and some farmers have used finance – e.g. for the bio-digester project. It was suggested these existing examples be investigated further and could be introduced later in the project for activities that have been identified as needed and demonstrated to be effective such as pond and well building and repair for irrigation.

There are many technical solutions to the feed-gap available (e.g. irrigation of forage, silage production methods developed in NW project, use of feed supplements for low quality residues such as rice straw, cassava chip, leguminous tree crops). However, these also present technical barriers as well as financial – the implementation for many of these was discussed however how the project could facilitate this was inconclusive. It was proposed that the provincial staff be charged with overseeing measures aiming to provide a regular supply of project cattle for sale as premium branded beef product at traditional market and supermarket.

8. Seed bank for forage. Setup of a seed bank for forage was suggested to overcome seed supply issues. This would require considerable work in the research and development of seed production, storage and distribution. It perhaps represents a business opportunity for a University. It was thought to be beyond the scope of the project and would yield no benefits during the life of the project.

9. Mobile phones for distributing market data (or disease outbreak) information was a difficult area as there are issues with availability and reliability of market data. It was tried in a previous project although the aim was much more ambitious – predicting cattle movement and therefore disease outbreak. Although DAHP collect market data (this has been happening for some time on standard format) it may not be comparable – e.g. cattle are sold by visual assessment of meat yield, rather than live weight and many different factors effect animal price (breed, sex, age, condition – see cattle price section). There are also technical challenges and the capacity of farmers to use SMS may be limiting. However this is a rapidly evolving technology and it was suggested it should be reviewed later. It could be as simple as price information from project sales distributed via recorded message. Another step towards market data was RUA student Theng Couch PhD which collected seasonal data on animal breed, weight, BCS and price from two provincial and the Phnom Penh markets. Such data will give some insight into current pricing mechanisms operating in the main markets.

10. *Renovation of wells*. Several farms have functioning wells and ponds, however it was suggested that renovation of enrolled farmers wells could alleviate some feed gap issues. Details of which farms weren't given and farms were initially selected to have ponds and wells. The costing of well

renovation was very low and needed revision, probably on a case by case basis. This may be a case where farmers could borrow money as there is a clear benefit and little risk, however the cost benefit would need to be analysed for each farmer, and this was beyond the capability of the project at this stage. A desktop analysis on the economics of growing forage scheduled for later in the project would be a necessary first step. Another point raised was if water was available would farmers choose to grow forage or other crops? This represented a significant risk for the project.

7.2.2 Branded product development

Based on the project interventions, a workshop with all project partners considered appropriate claims that could be made about a premium product based on the improved management of B4M cattle. The four characteristics that made the cut were 1. Forage fed, 2. vaccinated (HS and FMD) and dewormed, and 3. farmers trained in biosecurity. 4. grown in Pursat and Kampong Cham. The chosen characteristics were designed so as to not make claims which were not justifiable or verifiable, such as cattle being disease free.

The original project strategy was to work with existing wholesaler supermarket suppliers to get a premium product into supermarkets as a proof of concept. The differentiated branded product would make certain claims about the product origin and characteristics, and therefore attract a higher price. The original intention was to achieve this through existing stakeholders. However, after unsuccessful negotiations with three wholesalers that were currently both supplying supermarkets in Phnom Penh and had contacts with traders in Kampong Cham and Pursat, the project began work with an entrepreneur who was involved with the project, and also with developing a dairy cooperative,

A new business, Mekong Meats, was started with the aim of introducing a branded product into the market in Phnom Penh. However, it was necessary to take a broader view than the current value chain. Several new areas of market and value chain research were undertaken to support business development. Market research in the important restaurant sector looked at the requirements in both tourist/western and local BBQ restaurants. Post slaughter value chain description was undertaken as it became apparent the supermarket represents a very small, albeit high value, part of wholesale turnover. Also, aspects of packaging and distribution are important parts of the perceived quality of products, and so product packaging, and distribution were also key to adding value in identified developing markets.

It became apparent that there may be supply issues if project animals were to be available consistently to ensure a consistent supply. Seasonality effected the supply of sufficient animals throughout the year. Although many farmers had been enrolled and given technical assistance, for various reasons only a proportion of enrolled farmers took the final step and began fattening animals for sale. Some began breeding, while others didn't have the capital to buy young animals or the labour to tend larger numbers and so continued while enjoying the added benefits of forage feeding and improved management.

Also, as no existing traders and wholesalers were involved and no relationships had been developed within the B4m chain, there was no obligation for farmers to sell to a new buyer. Most animals that were recorded as fattened were side sold. The household survey showed that the great majority of sales are farmer to farmer. This shows that more than a cash reserve for individual farmers, cattle are used as a kind of community bank.

There were also issues with gaining access to supermarkets. There were virtually no undifferentiated and branded beef products available. Beef available in supermarkets was packaged and cooled at the supermarket, but otherwise similar to that sold in wet markets. Although the supermarket were keen to diversify product lines, there were administrative barriers to establish new product lines, the product would only be taken on consignment, and only small quantities of the best cuts were needed.

To address start-up issues, the project and entrepreneur worked with social enterprise NGO Agile Development Group to develop a business model and start-up strategy (the full report is available at http://www.une.edu.au/research/research-centres-institutes/irf/international-development-research/current-projects/market-cattle-south-east-cambodia). Agile Development Group were running their own small project on buying cattle for landholders as well as have expertise in business

development and were therefore a good fit. There was also a mutual benefit for ADG in terms of the technical expertise in production and biosecurity within the project relevant to their efforts in livestock management training. The strategy developed recommended several new approaches to address the issues encountered (see Appendix for full report).

These included;

A train and trade model. Motivated smallholders can become local coordinators, recruit and train other farmers in forage and vaccination, and earn commission by sourcing animals locally for purchase. This utilises the social capital of farmers and farmers can produce target animals regularly that can be sold by weight, providing regular income. Local co-ordinators could eventually replace traders, the model becoming a closed supply loop.

Selecting the market. Based upon earlier surveys and research undertaken in the Consumer Survey report, the preliminary targeting for the premium beef will be focused on customers in Phnom Penh. In recent years Phnom Penh has experienced double-digit economic growth; the emergence of a new Khmer middle class; and an increase in tourists that have stimulated a growing market of new hotels, restaurants, and bars. In additional to this, residential buildings including low rise, high rises and gated communities are being rapidly built and sold around the city in a population eager to show off its success. These factors contribute to a higher density and level of target customers to base the premium product sales on. Phnom Penh is also the main market for domestic beef in Cambodia, which will also allow non-premium product to be cleared and sold off efficiently.

Consideration was also given to initially piloting the brand in Kampong Cham, and Vietnam city markets based on proximity to the cattle supply (KC) and market size (HCMC). However, the Phnom Penh market is a much more secure option to build a solid brand and base, expand across Cambodia, and tweak any marketing required to enter the Vietnamese market. Once proof of concept, profitability levels and logistics are determined and if any refinements to the product or brand are required, it will be much easier to access the Vietnamese market with a strong track record. Testing and growing in the Phnom Penh market also provides a much stronger value proposition when interviewing Vietnamese wholesalers to competitively select the most suitable that can provide the most reach, sales and support into a new territory.

The Phnom Penh market was further broken down into potential sales channels and their potential for order quantities and sales/product throughput. Initial meetings with Lucky Supermarket showed that volume per store would be incredibly low, with all risk borne by B4M for initial placement into store on a consignment basis. In addition to the 30% margin required by Lucky, there is a pre-product registration fee and a line fee for placement in the store. Advertising within the store would incur additional costs, affecting profitability. After discussion with the key buyers at Lucky indicating that each of the 9 stores could potentially only sell 5 kilograms of Grade 1 beef per week, and with final end consumers/customers having the option to choose between multiple vendors and their ranges, the supermarket channel in Phnom Penh is a riskier launch pad than other options.

It was recommended to begin the supply of the Mekong Meats product directly to the hotel and restaurant market, and this is explored further in the report in terms of value proposition and the key target customers that eat and stay at these venues. More importantly, it is the actual purchaser of the beef that holds considerable power here in terms of building the brand. Hotels and standalone restaurants are more concerned with the end product than a supermarket as there is a much larger vested interest in terms of repeat customers and recommendations for new customers that far outweigh the interest of supermarkets whose primary concerns is the availability of lines and margins.

More importantly, key restaurant customers are dependent on quality and taste for their business offering to their customers, and more often than not the purchasing person will be the person who is also cooking the beef. This provides a significantly better opportunity to build a loyal customer base that will pay a premium rate for the Grade 1 beef. Additionally it provides better leverage to build brand association with quality and taste in contrast to a supermarket. If hotels and restaurants are prepared to market product as part of their commitment to quality and taste it provides an opportunity for recognition and a platform for key consumers - who are eating at these establishments – to then make secondary purchases of B4M product once the business is sustainable and moving into the supermarket area with a much stronger offering.

Whilst restaurant and hoteliers were not covered in the initial Consumer Survey, a key positive of attracting this market is the instant feedback and decision making for purchases. Placing new lines and tempting consumers away from their existing purchases has a much longer lead time than having direct meetings with chefs to attain a customer base of approximately 10 restaurants to sustain the new business initially.

So while restaurants are the key market, there are many other people and organisations for which Mekong meats will be creating value and who will pay for it. The product has a number of key customer segments from which they can earn revenue through the sales of a carcass and its associated by-products. Each segment has its own value proposition and this depends on the grading of the beef and the parts of the carcass such as skin and bones, with key customers including:

1. Grade 1 beef
    a. Western focussed restaurants with a focus on beef sales, such as Lone Pine, Taqueria Corona, Che Culo, Malis
    b. Western focussed hotels with a focus on quality food or social impact, such as The Pavillion, Kabiki, Mad Monkey Hostels, House Boutique Hotel.
    c. Local focussed barbeque restaurants that currently sell a premium 'Australian' plate
    d. Local wholesalers such as AusKhmer, Dan's Meats and Smokey de Boer

2. Grade 2 beef
    a. Smaller local restaurant and hotels
    b. Local wet markets

3. Grade 3 and 4
    a. Local wet markets

4. Skin and Bones
    a. Local wet markets

At the completion of the project branded premium beef was being sold to restaurants, farmers markets, wet markets and supermarkets in Phnom Penh. However not all animals were sourced from project farmers due to supply side issues. The import of large numbers of Australian cattle into southern Vietnam caused a drop in prices in Cambodia, resulting in farmers being unwilling to sell after a sustained period of high prices.

The complexity of the post-slaughter value chain described above was affected by animal quality. The number of different breeds, ages and condition of cattle being grown by project farmers and also available in Phnom Penh slaughterhouses introduced considerable complexity. In particular, the advanced average age and poor condition of local animals was a problem. Australian cattle, imported through Vietnam, finished in Cambodia in Vietnamese owned feedlots were available in Phnom Penh towards the end of the project.

The change in mindset required for farmers fattening for market and producing a target animal will take some time. Mekong Meats intends to continue to build relationships with local famers to provide education and mitigate supply side risks. At the end of the project Mekong Meats premium branded beef was being sold in Supermarkets, western, tourist and local BBQ restaurants, farmers markets and other stalls. RUA was continuing work on utilisation of locally available feed types, trained DAHP staff were continuing to increase the number of farmers utilising improved management techniques and awareness of improved marketing possibilities.

8 Impacts

The major impact of the project will come from creating an awareness and market presence of a branded product makes claims about product characteristics. The product sources vaccinated Cambodian cattle from farmers trained in biosecurity and uses a cool chain and vacuum packaging to improve food safety. The product makes claims about product origin characteristics including farmer biosecurity training and forage feeding for what was a previously undifferentiated product in the marketplace. As the wholesaler gains market share they can use the closed market chain to impose quality and animal specification constraints on producers, creating demand driven improvements in biosecurity. This also provides a mechanism for project interventions and for other incremental improvements in the value chain to be sustainable.

This simple idea has great power. Traditionally, the only avenue for consumers was to visually inspect meat and make judgements about freshness and safety in open air wet markets. The product now makes claims that increase consumer awareness, expectations and confidence. Mekong Meats beef products are now on sale in supermarket, tourist restaurants and premium farmers markets in Phnom Penh where they receive a price premium (Figure 7). Lower grade cuts are on sale in local BBQ restaurants and mobile carts outside factories for the sale of cheaper cuts. If the business is successful, other suppliers will copy the idea of product claims, and potentially the market force for superior management of the market chain, through to farmers.

Figure 9. Mekong Meat products for sale at a farmers market.

The Mekong Meats business model has introduced some other innovations that improve marketability and efficiency in the value chain. Product is delivered to outlets and private consumers daily, avoiding several steps in the chain and sending meat via a cool chain. This introduces efficiency for the consumer and wholesaler. Hotel and restaurant owners appreciated not having to go to the wet market as an advantage for their business, as well as vacuum packaging improving presentation and hygiene, with the caveat that cool chain is still required.

8.1 Scientific impacts – now and in 5 years

Scientific impacts are slow to be realised but can be judged by the publication of results in scientific journals and at conferences. These publications will then form part of future knowledge that may impact thinking. The project has produced several journal articles and student theses. Publications were produced on policy, household knowledge, financial analysis, and landholder attitudes to major diseases and cattle management. These mainly socioeconomic topics are important as the industry transitions from traditional uses to market focused production of beef. In particular the focus has been on the use of market signals to improve management and disease control. The project provided valuable knowledge on the market chain for cattle and the transit of cattle through Cambodia in a time of great change in the industry. The full impact of the major industry changes is yet to be seen. An understanding was also gained of farmer knowledge attitudes and practices to some major livestock disease issues, particularly foot and mouth disease and HS.

Journal articles:

Patrick I.W., Sovann S. and S. Socheat (2017), Working towards consensus – the need for coordinating policies on emerging disease threats in South-East Asia. *OIE Scientific and Technical Review*, Vol. 36 (1)

Hasnah, Patrick, I. and Smith, R.G.B. (2016) Household-level farming and marketing practices determining body condition score and economic value of cattle in Cambodia. *Livestock Research for Rural Development*. Volume 28, Article #116. http://www.lrrd.org/lrrd28/6/hans28116.html

Marshall G. R. (2015) A social-ecological systems framework for food systems research: accommodating transformation systems and their products. *International Journal of the Commons*, Vol. 9, no 2: 881–908.

Patrick, I., Muniroth, S. and Smith, G. (2014) 'The Changing Beef Industry in South-Eastern Cambodia', in L. Robins (ed.) A Policy Dialogue on Rice Futures: Rice-Based Farming Systems Research in the Mekong Region, Proceedings of a dialogue held in Phnom Penh, Cambodia, 7-9 May 2014, ACIAR Proceedings No. 142, Australian Centre for International Agricultural Research, Canberra, pp. 84-87.

S.Sieng, S.W. Walkden-Brown and J. Kerr (Accepted). Variation in storage temperatures for foot and mouth disease vaccine in Cambodia. *International Society of Environmental and Rural Development*. Accepted.

S.Sieng, S.W. Walkden-Brown and J. Kerr (under review). Effect of vaccine storage temperatures and dose rate on antibody responses to foot and mouth disease vaccination in Cambodia. *Veterinary Medicine and Science*. Under review.

Student Theses:

Sieng Socheat. 2017. An investigation into the efficacy of foot-and-mouth disease control programs in cattle in Cambodia. PhD Thesis, University of New England

Maddi Robinson 2016 Cattle management practices of smallholder farmers in kampong Cham province and opportunities for direct beef marketing in Phnom Penh, Cambodia. Bachelor of Animal Science Honours thesis Charles Sturt University

O'Connor, Clive. 2015 Determinants of Income in Smallholder Farming Households in Southeast Cambodia. Bachelor of Economics Honours thesis, University of New England.

Tok Sokunthea 2014 Economic effects of introducing forage into crop-livestock production systems in Pursat Province. Masters in Natural Resource Management thesis. Royal University of Agricultural, Cambodia

Theng Couch 2017 Market fluctuations in cattle pricing and condition PhD thesis. Royal University of Agriculture.

8.2 Capacity impacts – now and in 5 years

A diverse range of capacity impacts are evident and should continue into the future: Activities included: many student projects completed in both Australia and Cambodia (post graduates are listed above in scientific impacts, undergaduate projects at RUA are listed below); DAHP staff attended training sessions on train the trainer for on farm management and marketing of cattle, and then delivered two courses to farmers during the project; DAHP and RUA students attended a workshop on financial analysis of farm management scenarios; DAHP staff and industry stakeholders also attended training on cold chain management for vaccines. RUA students were trained as enumerators to conduct surveys, and also assisted in field sampling and vaccination of animals.

Perhaps the greatest impact has been in farmer training and uptake of improved management. Uptake was ongoing thoughout the project and at each stage of the project new farmers were establishing forage, building sheds and improving the management of their cattle. The increasing numbers of farmers adopting the technology that were not part of the project demonstrates the effectiveness of the farmer training and subsequent communication from farmer to farmer.

Farmer training had two components; (1) training of trainer and (2) integrated farmer training. Training of trainer was provided to provincial and district staff (extension officers) of both study provinces. After the training, the provincial and district staffs will be able to run and deliver the same message to farmers by using the same training materials. More than 170 farmers attended each of the farmer training schools that included training sessions in each of 6 project villages. Farmer training was available to anyone who wanted to attend, not just project enrolled farmers. Project enrolled farmers received extra on farm assistance as resources allowed.

The introduction of local branded beef in Phnom Penh markets has the power to continue this capacity building. The business model of Mekong Meats is to “Train and Trade”. Mekong Meats’ proprietor also has strong connections to RUA and DAHP through the project, providing a channel for new technical knowledge to become available to farmers. As Mekong Meats continues to grow, farmer capacity will grow with it, and has the potential to expand a long way beyond the project area in 5 years. This model also has the potential to make vaccination feasible.

Economic analysis of forage production and fattening cattle was the subject of a workshop conducted at RUA in Phnom Penh in November 2014. There were 25 attendees from DAHP and RUA including project staff and students and data used was collated from project sources and literature. After the workshop, planning took place for the economic analysis of forage production and fattening using the data and experience of project farmers. A training workshop was undertaken on correct protocols for cold storage of vaccines with DAHP and industry stakeholders.

Farmer training in Prey Chor district, Kampong Cham province.

8.3 Community impacts – now and in 5 years

The main community impacts from the project are in livelihood activities possible from the labour saving and income benefits from improved cattle management and marketing. The time saved and extra income available from marketing cattle allows households to undertake a variety of other community, economic and educational activities. Households utilising improved management techniques and realising improved income from better marketing of cattle have a 50% reduction in labour requirements, and potentially a 40% increase in income from cattle. Children that were previously involved with cattle tending can spend the time on schooling. Where older household members and women are able to tend cattle housed close by, adult household members can undertake off farm work.

Within five years the industry will look quite different. It is likely large numbers of cattle will continue to be imported and local markets will be forced to compete. The ASEAN free trade agreement will have begun with consequences for cattle trade and movement. Smallholders will need to keep adapting. There are examples from the project of farmers who have purchased neighbouring properties, or have increased herd size from several cattle to 10-20 during the course of the project. Such larger farmers get the majority of income from cattle production. For example, one farmer indicated as a result of expanding his cattle, he had given his rice land to his children to farm. Those farmers who are able to adapt and run cattle raising as a business will further develop markets, be they niche markets locally or in Phnom Penh. In other households grandparents were increasing cattle numbers despite family members working off farm for remittances.

In order to encourage community support for project activities and to avoid resentment towards project farmers within their villages, the project provided education and biosecurity interventions for all livestock farmers in the study villages. All cattle and buffalo in the study villages received six monthly vaccinations against FMD and Haemorrhagic Sepicaemia (HS) during 2014 and 2015. Additionally, the cattle belonging to our study farmers were regularly treated for internal and external parasites. These biosecurity initiatives were designed to protect the investment made by our study farmers in the commercial production of cattle. The FMD vaccination program was expected to generate an adequate level of herd immunity to protect those communities from the worst effects of the FMD epidemics that periodically sweep through Cambodia.

The benefit to the study villages of this project's vaccination initiative is likely to extend beyond temporary protection against FMD during 2014-2016. Because past FMD vaccination initiatives in some villages have been ad hoc, poorly-planned and too limited in scale to create herd immunity, they have not been effective in stopping FMD spread within villages or even protecting vaccinated animals. If our study villages had been challenged by an FMD outbreak during the life of the project, demonstrable protection of the village livestock (and the investment made by our study farmers) was expected to restore farmer confidence in the effectiveness of FMD vaccination, prompting adoption of vaccination as a trusted, cost-effective biosecurity measure.

8.3.1 Economic impacts

One of the major outcomes from the project was a new company startup (Mekong Meats) that utilised research knowledge outputs from the project to market a quality product that benefits consumers, creates jobs and improves livelihoods for producers. This company pioneered several concepts from the project that aim to make biosecurity and quality enhancements at the farm level sustainable through a market mechanism. By the completion of the project Mekong Meats had similar turnover to the wholesaler first approached by the project of 12 cattle per day.

The main potential mechanism of economic impact is the procurement policy of beef wholesalers. Having made certain claims about the beef products it sells, consumers will expect quality and claims

to be consistent and verifiable, and the business will require certain standards of suppliers. Assuming that several wholesalers introduce similar premium product lines and therefore competition remains healthy for product, then prices achieved should increase as well as increases in productivity, and reduced food safety and disease risk from improved management practice.

Economic modelling showed gross margins utilising forage increased 20- 58%. If 85% of households own cattle and they gain 2 hours of labour per day (conservatively), and use this time to earn other income, this equates to up to a 20% increase in income. It may allow one family member to earn income off farm as was the case with several project farmers. For some project households, grandparents or women were able to manage cattle while other family members were off farm working. Given that many households outside of project villages were taking up forage and management technologies, and the high proportion of households owning cattle, the impact will keep growing.

The economic impact of biosecurity improvements are more difficult to estimate and there are no vaccination campaigns currently running. Modelling looked at various factors that can impact the effectiveness of vaccination campaigns, showing that if issues such as the cold chain and ineffective administering of vaccine are not addressed, a campaign will not be effective. The modelling also offered some insight into the behaviour of farmers. Some farmers routinely deworm and vaccinate against HS, however they don't consider FMD a significant risk and don't vaccinate. Modelling showed that cost effectiveness of vaccination was sensitive to morbidity and frequency of an outbreak. With an outbreak only every 5 years and morbidity rates of 50 and 75% vaccination was not cost effective. It is also possible that farmers can reduce the morbidity with stall feeding once they understand disease transmission.

8.3.2 Social impacts

The change in labour and family members' participation in cattle raising was the driver of social impacts. Examples encountered in the project were women running cattle breeding enterprises, grandparents fattening cattle while parents were working off farm. Children able to attend school and not having to spend large amounts of time tending cattle in the field. These changes affect the dynamic within households and increases household income. Changes will be evident in ways such as higher education levels of other household members measured in household survey. These changes increase the diversity of opportunities available for household income generation.

Longer term changes may effect land ownership and village structure. For example, the most successful farmer specialised in cattle production and was fattening 10 animals per year, resulting in income of approximately US$10000. This was possible because he had purchased two adjacent farms.

RUA Policy roundtable highlighted issues where project activities are relevant for policy. The project branded product could dovetail with the policy initiative to create an FMD free zone. The initial claims for product from Kampong Cham and Pursat could be adapted to the FMD zone.

8.3.3 Environmental impacts

Nil.

8.4 Communication and dissemination activities

The project utilised a broad communication strategy.

Journal articles are listed below in the publications section.

Conference presentation and attendance

Several project staff attended the Regional Livestock Production Conference in Jakarta, 2014.

Patrick, I., Muniroth, S. and Smith, G. (2014) 'The Changing Beef Industry in South-Eastern Cambodia', in L. Robins (ed.) A Policy Dialogue on Rice Futures: Rice-Based Farming Systems Research in the Mekong Region, Proceedings of a dialogue held in Phnom Penh, Cambodia, 7-9 May 2014, ACIAR Proceedings No. 142, Australian Centre for International Agricultural Research, Canberra, pp. 84-87.

S.Sieng, S.W. Walkden-Brown and J. Kerr (2015). Variation in storage temperatures for foot and mouth disease vaccine in Cambodia. Presented at: 7st International Conference on Environmental and Rural Development, and the 3rd IDRC-SEARCA Annual Fellowship plus Conference-Workshop held on 16-17th January 2016, Royal University of Agriculture, Phnom Penh, Cambodia.

RUA students presented the results from numerous at national and regional conferences held in Phnom Penh during the project.

Sambo Channy	*In Sacco* Degradability of Different Grades of Rice Bran of Cross-breed Cattle Fed Rice Straw and Mulato II as Basal Diet	7th ISERD
Nget Vibol	Acceptability to the Services of Hemorrhagic Septicemia Vaccination Program in Pursat Province	7th ISERD
Keat Song	Nutrient intake and digestibility of Cross-Bred Cattle fed Rice Straw-Mulato II Supplemented with Rice Bran, Gliricidia and Rumen cake	7th ISERD
Heng Sreychou	Nitrogen Utilization of Cross-bred Cattle fed Rice Straw+Mulato II Supplemented with Rumen Cake, Gliricidia or Rice Bran	2nd NCARD
Yin Karona	Effect of different ratio of different rice bran grades on rumen fermentation using in vitro gas production technique	2nd NCARD
Khe Dalin	Effect of Different Replacement Ratio of Wheat distiller grain by-product and Rice Distiller grain by-product of Rumen Fermentation using IN VITRO technique	2nd NCARD
Ven Samnang	In-Sacco Degradability of Wheat distiller grain and Rice distiller grain by-product of cross-bred cattle fed rice straw and Mulato II	2nd NCARD
Nob Hakley	Knowledge, Attitude and Practice of Smallholder Cattle-Raising Farmers on Biosecurity of Hemorrhagic Septicemia and Food and Mouth Diseases	3rd NCARD
Bona Chum	Impact of Forage Fodder Bank on Cattle Production and Market System of Smallholder Households in Prey Chhor District, Kampong Cham Province	2nd NCARD

Extension material

A biosecurity education booklet was created specifically for Cambodian farmers (livestock owners) to add to the Khmer-language ACIAR series already featuring biosecurity booklets for Village Animal Health Workers (VAHWs) and livestock traders.

Additionally, biosecurity protocols were developed for project staff to apply themselves when visiting farms and households where livestock are kept. These protocols were recommended to

DAHP/POAHP for general application by their staff, and we further recommend them to ACIAR for adoption by their project teams working on farms in countries where transmissible livestock diseases are endemic.

“Better cow, better price” extension leaflet produced to give marketing information to farmers.

Videos on Youtube:

Two videos were produced on forage production, one in Khmer and one in English:

Video on growing forage featuring project forage expert Lorn Sophal and a B4M farm: https://www.youtube.com/watch?v=sfRjTHycGbs

ACIAR video in English on forage growing:

https://www.youtube.com/watch?v=s75bzq5UWEE

Other media.

UNE Research+ magazine article. September 2016. Beef4market: changing the lives of Cambodian farmers.

9 Conclusions and recommendations

9.1 Conclusions

Many current practices of farmers are inefficient and lead to low animal productivity and health, and therefore high disease risk. Partly this is due to lack of knowledge, but also attitudes due to farmers differential perception of risk (and benefits from vaccination) around major diseases. Forage and deworming were readily taken up, especially by fattening farmers due to immediately observable benefits in production. HS vaccination rates are reasonable due to cheap, subsidised government programs, and the high risk of mortality. FMD vaccination is still low due to perceived infrequent risk of infection, low risk of mortality and therefore low perceived benefit from vaccination by individual farmers. Economic analysis shows this is not the case, however there are many infrastructure and capacity barriers preventing an effective vaccination program.

A vaccine cold chain is an important component of any disease control program and there were serious shortfalls found both in vaccine vendors and some government locations. The efficacy of FMD vaccine (in producing antibodies) was shown to be seriously compromised by temperature variations outside the recommended storage range and due to delivery of only half doses.

The project implemented improvements in production and biosecurity practices at the farm level. At the completion, large numbers of farmers both within and outside the project (and in neighbouring villages) were growing forage, building cattle sheds and improving management practice. Improvements in biosecurity understanding for farmers, VAHWs, traders, and government officials were also evident. There were improvements in supply chains where Mekong Meats wholesalers had introduced a branded product to major markets in Phnom Penh making claims about quality and origin.

The use of branding and product claims has great potential to modify traditional markets for livestock in Cambodia. Differentiation in the market based on product quality claims will result in greater drivers of productivity and efficiency, including disease control.

At the conclusion of the project there were:

- DAHP trained farmers using improved production and biosecurity technologies to fatten increasing numbers of animals for the Phnom Penh and local markets.
- A wholesaler in Phnom Penh, with direct access to the trained farmers, selling premium branded product into supermarkets, premium farmers markets, tourist restaurants and local BBQ restaurants. There were insufficient project animals available to supply the business.
- A university training graduates and postgrads and conducting trials into the nutritive value of various locally available feed types, and the economic returns from various production systems.

These constitute the basis for an innovation platform where enhancements in production and value adding can rapidly be deployed and where proceeds from efficiencies can be distributed throughout the market chain. However to achieve this, over time increased trust and relationships need to be developed between stakeholders along the market chain, particularly the wholesaler and farmer groups.

9.2 Recommendations

Knowledge of farmers, VAHW and traders of disease signs, symptoms and issues and prevention strategies was poor. Farmers readily uptake technology and practices that have a short term and obvious benefit such as forage production, housing cattle and deworming.

There are currently virtually no vaccinations for FMD, only those infrequently provided by government. Given the technical issues with the vaccine cold chain, the lack of farmer knowledge and many farmer cultural practices identified as difficult to change, and that any wider government driven control campaign would be very difficult to implement and unlikely in the short term, an alternative is for a purchaser to require certain practices. Project delays and time limitations meant that there wasn't time to develop relationships between villages and with Mekong Meats, however a closed loop supply chain has potential to change behaviour. If Mekong Meats (or a similar company) were to establish relationships within villages to source cattle, they could undertake vaccination or assist with logistics, training and require certain standards of farmers. This is a significant cost for a company, however, there are several NGOs undertaking such activities in Cambodia. Two examples are Agile Development Group, and Cows for Cambodia. There would be reciprocal benefits if local NGO programs had access to training expertise and the endpoint of cattle sales, they could be much more viable and could mobilise the social capital necessary to build relationships at the village level. Future research into marketing of premium products should take advantage of the many communities that have already been trained in improved management practices, and those where NGOs are currently operating. This would provide a good platform for further research into the best methods to get farmers to join with a project.

10 References

10.1 References cited in report

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Pen M, Savage DB, Lorn S and W (2014) Beef Market Chain and Opportunities for Farmers in Kampong Cham Province, Cambodia. IJERD–International Journal of Environmental and Rural Development, (2014), 5-1.

Pham, L., Smith, D., Sotheun, S., & Vitau, S., December, 2015.Cambodia beef cattle industry in "Regional Workshop on Beef markets and trade in Southeast Asian and China", Ben Tre, Vietnam

Sieng S, Hawkins C, Madin B and Kerr J (2012). Charactersitics of livestock traders and trading in Cambodia. In: Animal Biosecurity in the Mekong: Future Directions for Research and Development. L.B. Adams, G.D. Gray and G. Murray (eds). ACIAR Proceedings No. 137, 45-58. Australian Center for International Agricultural Research: Canberra.

Thun V and Takeya H (2005). "Analysis of household attitudes towards the consumption of beef in Cambodia." Journal of Agricultural Development Studies (Japan) (2005).

Shankar et al. 2012. Animal disease and livestock-keeper livelihoods in Southern Cambodia. International Development Planning Review 34(1):39-63 · DOI: 10.3828/idpr.2012.3

10.2 List of publications produced by project

Journal articles:

Patrick I.W., Sovann S. and S. Socheat (2017), Working towards consensus – the need for coordinating policies on emerging disease threats in South-East Asia. *OIE Scientific and Technical Review*, Vol. 36 (1)

Hasnah, Patrick, I. and Smith, R.G.B. (2016) Household-level farming and marketing practices determining body condition score and economic value of cattle in Cambodia. *Livestock Research for Rural Development*. Volume 28, Article #116. http://www.lrrd.org/lrrd28/6/hans28116.html

Marshall G. R. (2015) A social-ecological systems framework for food systems research: accommodating transformation systems and their products. *International Journal of the Commons*, Vol. 9, no 2: 881–908.

Patrick, I., Muniroth, S. and Smith, G. (2014) 'The Changing Beef Industry in South-Eastern Cambodia', in L. Robins (ed.) A Policy Dialogue on Rice Futures: Rice-Based Farming Systems Research in the Mekong Region, Proceedings of a dialogue held in Phnom Penh, Cambodia, 7-9 May 2014, ACIAR Proceedings No. 142, Australian Centre for International Agricultural Research, Canberra, pp. 84-87.

S.Sieng, S.W. Walkden-Brown and J. Kerr (Accepted). Variation in storage temperatures for foot and mouth disease vaccine in Cambodia. International Society of Environmental and Rural Development. Accepted.

S.Sieng, S.W. Walkden-Brown and J. Kerr (under review). Effect of vaccine storage temperatures and dose rate on antibody responses to foot and mouth disease vaccination in Cambodia. Veterinary Medicine and Science. Under review.

Technical reports:

Nam Hoang, Sok Muniroth, Ian Patrick, Geoff Smith 2013. ACIAR Project No. AH/2010/046 Working Paper No.1 Consumer Survey Summary Results Phnom Penh and Ho Chi Minh City. Available at: http://www.une.edu.au/__data/assets/pdf_file/0006/88827/b4m-consumer-survey-report.pdf

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Miriam East Ian Patrick Socheat Sieng Theng Kouch Sok Muniroth 2013 ACIAR Project No. AH/2010/046 Working Paper No.2 Household Survey Summary Results Kampong Cham and Pursat. Available at: http://www.une.edu.au/__data/assets/pdf_file/0007/88828/b4m-household-survey-report.pdf.

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Sieng S. and Kerr., J. 2014. Attitudes and practices toward on animal health and vaccination of Village Animal Health Workers in two study provinces. Project report.

Sieng S. and Kerr., J. 2014. Attitudes and practices toward on animal health and vaccination of smallholder cattle farmers in two study provinces in Cambodia. Project report.

Pen Miranda, Seng Mom, Theng Kouch, Nget Vibol, Seng Tongheng. 2015. Knowledge, Attitudes and Practices towards Public Vaccination Program in Pursat Province. RUA Working paper no 1.

Agile Development Group: From Supply Chain to Business Model. Report on business model for a branded premium beef product. ACIAR Project No. AH/2010/046. (Appendix 2).

Extension material.

UNE Research+ magazine article. September 2016. Beef4market: changing the lives of Cambodian farmers.

Biosecurity measures for farmers (booklet in Khmer) http://www.une.edu.au/__data/assets/pdf_file/0005/88826/farmer-biosecurity-booklet.pdf. Accessed 2/2/17.

Forage grasses making a difference in Cambodia (Video in English) https://www.youtube.com/watch?v=s75bzq5UWEE. Accessed 9/6/16

Raising Cow and Grass Production (Video – in Khmer). https://www.youtube.com/watch?v=sfRjTHycGbs. Accessed 9/6/16

Student Theses: (abstracts in Appendix)

Sieng Socheat. 2017. An investigation into the efficacy of foot-and-mouth disease control programs in cattle in Cambodia. PhD Thesis, University of New England

Maddi Robinson 2016 Cattle management practices of smallholder farmers in kampong Cham province and opportunities for direct beef marketing in Phnom Penh, Cambodia. Bachelor of Animal Science Honours thesis Charles Sturt University

O'Connor, Clive. 2015 Determinants of Income in Smallholder Farming Households in Southeast Cambodia. Bachelor of Economics Honours thesis, University of New England.

Tok Sokunthea 2014 Economic effects of introducing forage into crop-livestock production systems in Pursat Province. Masters in Natural Resource Management thesis. Royal University of Agricultural, Cambodia

Theng Couch 2017 Market fluctuations in cattle pricing and condition PhD thesis. Royal University of Agriculture.

Appendix 1: Workshop agenda and list of participants

Agenda

Inception Workshop of ACIAR Projects No. AH/2010/046

"Domestic and International Market Development for High-Value Cattle and Beef in South-East Cambodia (Beef for Market)"

28th August 2012

Department of Animal Production and Health (DAPH), Phnom Penh, Cambodia

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Time	Topics/Activities	Facilitator
8:00-8:20	Registration	Ms. Uk Pao Mr. Bou Theoun
8:20-8:30	Arrival of Distinguished Guests	Ms. Uk Pao (Master Ceremony) Mr. Bou Theoun
8:30-8:45	Remarks by UNE	Dr. Ian Patrick Director, IRF University of New England
8:45-9:00	Opening Remarks by DAPH	HE Kao Phal Director of DAPH
9:00-9:15	Tea Break	
09:15-9:30	– Current livestock Situation in Cambodia – Strategy Livestock Development	Dr. Sar Chetra Deputy of DAPH
9:30-9:45	– Introduction to Project – Arrangements and Implementation for "Beef for Market" Project	Dr. Ian Patrick Director, IRF

9:45-10:00	Objectives of Animal Health Component	Dr. Jim Kerr/Mr. Sieng Socheat/ Mr. Pich Peda
10:00-10:15	Objectives of Animal Production	Dr. Darryl Savage/ Mr. Khy Yukheng/Mr. Lun Sophal
10:15-10:30	Objectives of Market Chain	Dr. Nam Hoang Mr. Sok Moniroth
10:30-11:00	The 'Health' of the Market chain	Dr. Graham Marshall
11:00-11:15	Work Plan for research component	Dr. Seng Mom
11:15-12:00	Discussion	All
12:00-12:10	Wrap up and Closing	Dr. Sar Chetra
12:10-	Lunch Break	**Regent Restaurant**

List of Participants

Inception Workshop of ACIAR Projects No. AH/2010/046

"Domestic and International Market Development for High-Value Cattle and Beef in South-East Cambodia

(Beef for Market)"

28th August 2012

Department of Animal Production and Health (DAPH), Phnom Penh, Cambodia

****

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Appendix 2 Student theses abstracts.

Socheat Sieng. PhD. University of New England (2017)

An investigation into the efficacy of foot and mouth disease control programs in cattle in Cambodia.

Abstract

Foot and mouth disease (FMD) is a highly contagious viral disease which has a significant impact on the economy and livestock productivity of smallholder farmers as well as livestock exports. The aim of this thesis is to investigate the efficacy of foot-and-mouth disease control programs in cattle in Cambodia. The research reported in this thesis involved survey of smallholder farmers (livestock producers), village animal health workers (local animal health service providers) and vaccine retailers (vaccine suppliers); investigation of the cold storage temperature variation; FMD vaccination experiment to identify the effect of vaccine storage temperatures and dose rate on antibody responses to FMD vaccination and on-farm economic analysis (benefits and costs) of the FMD vaccination program. Due to the scarce human and financial resources and low enforcement of strict animal, people and product movement regulation, it makes Cambodia almost impossible to control FMD. The current FMD control program in Cambodia is relied on the limited government-subsidised FMD vaccination program and supports of FMD vaccine from the OIE.

In this study, gross margins, benefit cost and sensitivity analysis of farmers with and without biannual FMD vaccination scenarios were undertaken to identify the most effective on-farm FMD control practices. The results suggested that the FMD vaccination including farmer training and deworming programs can be justified if properly planned and implemented. The economic benefit from the FMD vaccination program for farmers who vaccinate compared to who didn't depend on the success rate of vaccination, the success rate of treatment and nursing program and the proportion of sick animals treated. However, the economic losses to affected farmers were also depended on the severity of the FMD outbreaks. This result is potentially useful for the veterinary authorities to use in the farmer training and vaccination campaign from a disease control perspective.

The results from this study revealed that the majority of farmers were familiar with FMD but they still had little ideas on biosecurity. Infected animals were separated by a small number of farmers and this was during the day, animals tend to reunite during the night. Farmers always offered their assistance to their neighbours to restraint and treat FMD infected animals, they generally unaware that this is a major mean of disease spread around their communities, and consequently their animals were infected either before (58%) and after (42%) they went to help the neighbours.

Although the vaccination is important for the control program, only a very low percentage of the animal population in the study areas were received a single annual government-subsidised FMD vaccination while the majority of farmers and village animal health workers have not vaccinated their animals at all during the study period. Booster has never been given to animals. The FMD vaccination programs were performed based on the unreliable and limited annual government budget. Private FMD vaccination services did not exist in the study areas. This work showed that current level of vaccination coverage cannot be expected to gain herd immunity.

Vaccine handling and cold storage management were not appropriately performed by vaccine retailers and provincial veterinarians. There was no system to check or monitor the cold storage temperatures. The maximum and minimum thermometer was not utilised by the majority of veterinary drugstores and provincial office of animal health and production. Vaccines were kept with foodstuffs, on the bottom of the storage unit and door shelves in the majority of cold storages. The majority of vaccine retailers have experienced consistent electricity blackouts. The cold storage temperature recordings were obtained by using electronic data loggers, programmed to record temperatures at 30

minute intervals for 30 days. These data indicated that most of vaccines in many cold storages were exposed to unacceptable freeze or below recommended temperature and ambient temperatures for more than a week (168 hours) and longer of the temperature recordings. A vaccine cold chain is an important element of current disease control program. The results indicated that vaccine handling and cold storage management were serious shortfalls in both veterinary drugstores and provincial office of animal health and production. The experimental study on the effect of vaccine storage temperatures and dose rate on antibody responses to FMD vaccination found that freezing vaccines for a week did have a deleterious effect on the antibody response, while ambient temperature well above recommended temperature range did not effect on antibody response to vaccination. Halving the dose significantly reduced the antibody response to vaccination. The outcomes of this experiment clearly demonstrated that a significant deviation from recommended temperature range for up to a week had significant immediate effects on antibody titre. This issue requires improved practices and ongoing monitoring. The results also highlight the need for improvement and solutions to avoid ongoing future exposure of vaccines to freezing and ambient temperatures.

Based on the results of this study, it could be concluded that FMD vaccination program is ineffective in the study areas. The complex issues along the whole livestock production chain and the endemic nature of the disease pose real challenges for its efficacy of disease control program. It is unlikely that FMD control programs in Cambodia will reach their potential until all issues are brought under control. Therefore, the results of this study call for improvements in the future vaccination practices and awareness of vaccination campaigns. In order to improve the efficacy of the FMD control programs, DAHP requires significant amount of government financial support and would be more effective if targeted on FMD high (highest) risk areas. It is recommended that an incentive FMD vaccination program is developed and implemented to reduce susceptible animals in the country. To achieve this the department and provincial office of animal health and production need to ensure that farmers and VAHWs understand their involvements and contributions in the FMD government-subsidised and private FMD vaccination programs are great importance of future FMD control program in Cambodia.

Tok Sokunthea. Master Natural Resource Managemernt Royal University of Agriculture, Cambodia

Effects of introducing forage into crop-livestock production system in Pursat province.

Abstract

Growing population causes the high demand of food and meat consumption, yet large ruminants rearing in Cambodia is dominated by small-scale producers. This type of production faces monumental challenges particularly on market competition as the productivity of cattle depends mainly on traditional approach, especially feeding methods. According to these challenges, this study was conducted to describe crop-livestock system, and to analyze economic of cattle production with forage plantation. To meet the objectives of this research, two main research methodologies were employed such as agrarian system analysis method, and cost and benefit analysis method. The results indicate that the majority of farmers depended on rice and livestock production. On average farmers owned 7 cattle per household, and they spent about 29 person-day per cattle per year. The majority of farmers raised their cattle in the purpose of draught and sold. Most respondents sold their cattle at aged 2-3 years. Forages were introduced to farmers in five different types of species, and farmers were trained how to plant, harvest and maintenance. Forage did not lead to any significant different of labor use between forage-planted farmer and none-planted farmer. However, it contributed to the positive effect of economic analysis. Forage could provide net income 891 US dollars per hectare per year if it was sold. In addition to this, in the case of farmers utilized forage for feeding their livestock, it indicates that farmers could earn net return around 542 US dollars per

year from selling calves of 5 cows. In contrast, at the same numbers of cows rearing by feeding rice straw as the main diet, farmers could get the net return about 154 US dollars per year. Interestingly, producers could earn 4,412 US dollars from ten fattening bulls by using forage as main feed. In conclusion, although there are some positive findings of planting forages, certain conditions should be taken into account including land availability for forage plot, sufficient water for irrigating during dry season, and the purpose of cattle production.

Clive Oconnor. B Econ Honours, UNE 2015

Determinants of Income in Smallholder Farming Households in Southeast Cambodia

Abstract

Using farm level data from households in two regions in Southeast Cambodia, this study examines the determinants of household income, with a view to plot the path to high value farm production. Modelling of household income as a function of labour allocation, human capital and household characteristics allows an estimation of how smallholder households derive their income from a mix of farm, off-farm and remittance labour. Regression-based analyses revealed that off-farm labour allocation helped to improve total on-farm income. Education was directly influential on improved farm incomes. Cattle were shown to have a moderately positive relationship with income, with cattle primarily used for draught and held as a liquid asset. Credit had a strong and significant impact on both on farm and off-farm incomes. The household stock of labour was not deterministic in off-farm or farm income. Therefore, the path to high value farm output is strongly influenced by access to credit, improved human capital formation and the interaction of the off-farm labour market and farm output.

Maddinson Robinson, B Animal Science Honours Charles Sturt University 2016

Cattle management practices of smallholder farmers in kampong Cham province and opportunities for direct beef marketing in Phnom Penh, Cambodia.

Abstract

Over the last 20 years, there has been a considerable change in the diets of people throughout south-east Asia (Bush and Henry, 2013). Most notable was the annual 5% increase in the consumption of beef and buffalo between 1990 and 2000 (FAO, 2005). The change in consumption has been linked to expanding urbanisation and increasing household income. As a consequence of the growing demand for meat, a ‘livestock revolution’ is being seen in many of the developing countries throughout south-east Asia. Current estimates indicate, from 1997 to 2020, the annual growth of meat consumption will be approximately 3.4% in south-east Asia alone. This consumption growth has been correlated with an estimated population growth of approximately 22% by 2050 (Lorn et al., 2014). The increasing demand for animal products has not only seen a change in the consumption of meats such as chicken and pork but also a change in the consumption of red meat, particularly beef (Bush et al., 2013a). The shift in the demand for red meat throughout the Greater Mekong Sub-region (GMS) could give farmers a unique opportunity to provide better quality animals to meet the currently expanding regional markets (Bush et al., 2014).

This study determined the opportunity of provincial smallholder producers to market their cattle directly to the high-end restaurant market in Phnom Penh through (1) the evaluation of cattle management practices and the knowledge of farmers about the movement of their cattle through the market chain once sold and (2) measuring the demand for domestic beef in the high-end restaurant market in Phnom Penh. The criteria to determine beef quality used by restaurant owners were also explored. Semi-structured face to face interviews with 30 farmers in Kampong Cham and 37 restaurant owners in Phnom Penh

were used. In addition, a slaughterhouse survey to determine carcass composition of cattle from different origin and with different nutritional management (feedlot, forage fed for weight gain, and traditional cut and carry feeding); a forage survey to assess size and management of forage plots of smallholder producers in Kampong Cham province and a restaurant menu survey in Phnom Penh to assess beef sources (domestic versus imported) were conducted. Data collected was analysed using basic descriptive statistics.

Overall, there have been a few changes in livestock production that largely coincide with the extension activities that have targeted farmer training as a part of the Beef for Market (B4M) research project (Smith, 2010). Despite these changes, many farmers still see cattle as an “asset bank” and only sell when money is needed. The majority of farmers did not know where cattle were slaughtered and processed nor opportunities for marketing cattle directly to the high-end restaurants in Phnom Penh. The majority of barbeque (BBQ) style and western and traditional (W&T) styles restaurants surveyed within Phnom Penh purchased domestic beef products (100% and 68%, respectively) and were willing to pay more for quality branded beef creating a unique opportunity for smallholder producers to meet this demand. In future, training should equip farmers and restaurant owners with the knowledge of how to access the market chain. This will require companies that market high quality local beef products, to create a direct marketing link.

Appendix 3 FMD outbreak questionaire