Australian Government

Australian Centre for International Agricultural Research

Project final report

project

Improving smallholder crop-livestock systems in eastern Indonesia

project number LPS/2004/005

date published August 2008

prepared by

Shaun Lisson

Farming Systems Scientist, CSIRO Sustainable Ecosystems

co-authors/ contributors/ collaborators

Neil MacLeod[a], Cam McDonald[a], Jeff Corfield[a], Lalu Wirajaswadi[b], Rahmat Rahman[c], Syamsu Bahar[c], Nasruddin Razak[b], Ketut Puspadi[b], Dahlanuddin[d], Yusuf Sutaryono[d], Rusnadi Padjung[e], Sania Saenong[c], Lia Hadiawati[b], Sahardi[c], Mashur[b], Dwi Proptomo[b]

[a] *CSIRO Sustainable Ecosystems,*
[b] *Balai Pengkajian Teknologi Pertanian (BPTP), Mataram, Lombok*
[c] *Balai Pengkajian Teknologi Pertanian (BPTP), Makassar, South Sulawesi*
[d] *Fakultas Peternakan, Universitas Mataram, Lombok*
[e] *Hasanuddin University, Tamalanrea, Makassar, South Sulawesi*

approved by Dr Debbie Templeton

report number FR 2008-40

ISBN 978 1 921531 11 8

published by
ACIAR
GPO Box 1571
Canberra ACT 2601
Australia

Contents

1 Acknowledgments

The authors would like to acknowledge the contribution of Dr Bill Winter (retired Program Manager ACIAR) in developing and supporting this project. The support and involvement of staff from Dinas Peternakan is also appreciated.

2 Executive summary

The demand for beef cattle has been increasing strongly in Indonesia. This provides a potential opportunity for smallholder farmers who are the main producers of Bali cattle in Indonesia to improve their economic welfare. However, figures indicate that Bali cattle numbers have actually been declining across most regions of Indonesia over the past decade, leading to a supply deficit that is largely being serviced by imports of beef and live cattle from Australia. There is an opportunity to develop and implement strategies at the smallholder level to increase the number and quality of Bali cattle.

This project has identified a range of factors that are constraining livestock production in the smallholder farming systems of eastern Indonesia including: availability and quality of forages, especially during the dry season; poor knowledge and/or capacity to implement optimum feed management practices; limited supplies of readily accessible stock water; bull availability; inadequate cattle housing; labour availability; extended and sub-optimal breeding cycles; diseases; marketing constraints and limited access of smallholders to the formal credit sector for acquiring cattle and livestock handling materials. Most of the technologies needed to address these constraints have already been developed in Indonesia or elsewhere, but have yet to be adopted by local farmers.

This project explores the merits of an approach for improving livestock production that combines the principles and tools of farming systems analysis and farmer participation. The process begins with an extensive benchmarking process to understand and quantify how the current system functions and the constraints to livestock production. Potential strategies for addressing these constraints are identified and their economic, social and environmental viability is assessed using a customised whole farm model. These simulated results are then ‘workshopped’ with farmers to come up with a shortlist of feasible, best-bet strategies for subsequent on-farm trialling. The on-farm trials then become an important extension platform for subsequent extension and communication to other farmers within and beyond the target village.

The feedback from farmers and the results from monitoring the on-farm trials indicate that the participatory, farming systems approach was successful. There is a range of evidence to support this including: quantifiable gains in forage and livestock production, labour savings and gains in household income; the intention of most farmers to continue successful strategies; and evidence of significant adoption/adaption of the livestock improvement technologies by other (non-project) farmers.

The pathways to adoption of livestock improvement strategies varied with the region and the technology concerned. Strategies requiring more skill and knowledge to implement, and for which the implications are more complex and less predictable (e.g. changing feed availability or breeding cycle) required greater input from the project team and benefitted most from the modelling analysis. The involvement of village ‘champions’ was instrumental in fostering uptake in two of the focus sites. Typically, an incremental approach was taken to the rollout of best-bet strategies. The initial focus was to address forage supply and quality constraints through modest plantings of selected forages. The confidence and trust arising from successful adoption of these comparatively simple technologies was then used as an entry point for more complex animal management strategies which require long-term planning and investment.

The Integrated Analysis Tool (IAT) was found to be exceptionally useful in a number of ways: a) as a communication tool to inform/underpin the dialogue between the project team and the farmers; b) enabling rapid analysis of the financial, resource and production impacts of livestock improvement strategies and their sensitivity to key climate, soil, management and farm design variables; c) screening out less desirable strategies and identifying a shortlist of best-bet options for subsequent on-farm testing, thus ensuring a more efficient and targeted use of limited project resources; d) providing a degree of

confidence to both project staff and farmers that the strategies to be tested on-farm are likely to have a beneficial effect, and; e) for some farmers providing motivation about the potential impacts of proposed livestock improvement strategies.

The apparent success of the approaches developed and tested in this project provides support for wider adoption in other regions of Indonesia.

3 Background

Bali cattle (Bos javanicus) account for ~ 25% of the total cattle population in Indonesia and are particularly important in the smallholder farming enterprises of the eastern islands where they make up ~ 80% of the cattle population (Talib et al. 2003). The demand in Indonesia for beef cattle, both for meat (increasing at 6-8% per annum, Talib et al. 2003) and live cattle for resettlement areas currently exceeds the local capacity to supply these animals, with the deficit largely met by imports of beef and live cattle from Australia (189,000 head in 2005-6, MLA 2006). As a consequence, Bali cattle numbers have declined in most areas of eastern Indonesia over the past decade although the extent of the decline is highly variable across provinces. The increased demand is also reported to be encouraging farmers to sell bulls at a younger age and is leading to village-level shortages of mature bulls. The decline is further exacerbated by increasing slaughter rates for pregnant cows (Talib et al. 2003).

In recognition of the declining cattle population and the potential threat this poses to the economic wellbeing of many Indonesian smallholders, some Government of Indonesia initiatives have been developed to arrest the decline. For example, the Provincial government of East Nusa Tenggara (NTT) has banned the export of the some categories of bulls and heifers. Females that are still capable of breeding are also being purchased from slaughterhouses for redistribution to selected smallholders (Talib et al. 2003).

While actions such as these may help to stem the decline in the Bali cattle population, additional strategies are required to significantly increase the number and quality of Bali cattle to meet the expanding demand. These strategies need to address the key constraints to cattle production that have been identified by this and other studies (Talib et al. 2003, Wirdahayati 1994, Mastika et al. 2003). These include: availability and quality of forages, especially during the dry season; poor knowledge and/or capacity to implement optimum feeding management practices; extended and sub-optimal breeding cycles; diseases; marketing constraints and limited access of smallholders to the formal credit sector for acquiring cattle and livestock handling materials. Issues relating to capital access and the livestock market are largely beyond the control of farmers. The focus in this research is on constraints that the farmer can have a direct influence on, namely feed availability, feed quality and animal management.

As with most developing countries, the adoption of improved grass and legume forages into mixed crop-livestock farming systems has been slow in Indonesia. This is not due to a lack of available and adapted forage species. A plethora of local and international work has identified cultivars for the majority of tropical environmental niches, but their adoption has been poor (Ivory 1986, Schultze-Kraft 1986, Horne and Stur 1999). Farmers have either not been sufficiently exposed to forage options, or are not convinced that improved forages provide significant benefits to their livestock enterprises. However, there are examples in southeast Asia where smallholder farmers have successfully introduced forages into the cropping systems (Horne and Stür 2003, Shelton et al 2005, Paris 2002) and these successes, despite being rare, demonstrate the potential benefits from adoption of improved forage technology in mixed smallholder farming systems.

Benefits of a whole-of-system, participatory approach

Norman and Collinson (1985) define the farming systems research (FSR) process as having four distinct stages. The first stage involves determining constraints that farmers face and the potential flexibility within the farming system to adopt change. The second step advances potential strategies to address these constraints. Historically this step has involved researcher managed and implemented trials on research farms, subsequently evaluated for technical feasibility, economic viability and social acceptability. In the third stage, the most promising strategies are evaluated on-farm in farmer-implemented trials.

The fourth and final stage involves the broader implementation and dissemination of successful strategies.

The key to the successful approach adopted by Horne and Stür (2003) was the strong emphasis on farmer participation. At the start of the process, farmers in selected villages were engaged to diagnose and prioritise issues of interest. Potential solutions were identified and discussed with farmer focus groups and a shortlist made of appropriate technology options for on-farm testing. Their approach recognises the vast amount of pre-existing knowledge relating to the most appropriate forage species for different environments in southeast Asia. This essentially negates the need for extensive trials on experimental farms as proposed by Norman and Collinson (1985). Preliminary on-farm trials are typically small in extent. Results from the monitoring and evaluation of these trials are then reported back to the rest of the village. Promising technology is likely to be expanded and integrated permanently into the activities of farms. Other farmers within the village and neighbouring villages are then influenced through a variety of extension techniques including supporting 'local champions', working with farmer groups, conducting field days etc

Benefits of whole-farm simulation tools

A key feature of the smallholder farming systems of eastern Indonesia is the tight integration between various biophysical elements (i.e. livestock, crops and forage), resource endowments (i.e. land area and quality, feed supply, labour resources, cash availability) and social context (i.e. religion, cultural practice, risk attitudes) of smallholder households. Additional complexity arises from the impact of temporal climate variability and fluctuations in commodity prices and input costs. It is, therefore, important when evaluating any of the potential options for improving cattle production that consideration be given to the impact of such component changes on the overall farming system and the sensitivity of these system responses to fluctuations in climate and other factors. Simulation models that capture the key system processes and their interactions and response to change offer a good means for exploring these complex interactions.

Whole-farm simulation models have developed to such an extent that they can reliably simulate the key processes and interactions within smallholder, crop-livestock farming systems. As such, they can be used to help explore the technical feasibility, economic viability and social acceptability of various welfare improvement strategies for smallholder farmers and the associated tradeoffs between different system components. For example, Castelan-Ortega et al (2003a and b) describe a decision support system comprised of integrated biophysical models for maize and cattle production and a socio-economic model, developed for the purpose of identifying the optimum allocation of resources that maximise farmers' income. Herrero et al (2002) describe a platform that integrates a variety of databases and component biophysical modelling tools to enable comprehensive systems analysis of crop-livestock systems in developing countries.

However, examples of successful application of simulation models actually leading to demonstrable impacts on smallholder farmer practice are rare. The impact has more often been on research direction or in the training of local researchers (Carberry et al 2004, Matthews and Stephens 2002, Matthews et al. 2002). Carberry et al. (2004) states:

"In the past, modelling applications (in smallholder farms) have generally meant abstract analyses whereby researcher-designed management scenarios are tested under hypothetical situations, and recommended actions are suggested on what managers should do, generally without any reference to real world testing".

The approach adopted in this project combines the principles of FSR analysis (Norman and Collinson 1985, Horne and Stür 2003) and whole-farm modelling in considering the social, economic and biophysical impacts of change, with strong farmer participation in all steps from benchmarking, identification of cattle/forage improvement options and the on-farm testing and communication of findings.

Building on previous work

The present research strategy is built on the considerable advances that were made in projects AS2/2000/124 and 125 working in mixed crop-livestock smallholder farming systems in rainfed lowland and upland areas of eastern Indonesia. The objectives of these earlier projects were: to build relationships with the key stakeholders; to develop an understanding of the crop-livestock production systems through various benchmarking, surveying, monitoring and general observation and; to develop the tools necessary to assess the production, economic, environmental and social benefits and risks at the smallholder farm level that would flow from a greater emphasis on beef production by increasing forage quantity and quality.

Both AS2/2000/124 and 125 took a systems approach to study crop-livestock farming in smallholder systems. AS2/2000/124 was based in South Sulawesi (Sulsel) where the main objective was to explore whether forages could be introduced into higher rainfall rice-based farming systems where land availability for forages was a constraint. AS2/2000/125 was based in the semi-arid area of eastern Indonesia (Sumbawa) where land for forages was not as much of a constraint as the long-dry season where forage quantity and quality severely limits animal productivity.

The two projects worked closely in model development, with the AS2/2000/124 team concentrating on the crop and forage models, and the AS2/2000/125 team focussing on developing a household socio-economic model and a simple livestock model for Bali cattle and an integration tool (Integrated Analysis Tool, IAT) that linked crops, forages, animals and household economics in a way that various scenarios could be tested.

The IAT is now fully functional and operational and gives the operator the ability to choose a number of cropping, forage and livestock options. The model is sufficiently detailed to represent the effects of important drivers (e.g. precipitation, soil fertility, interest rates, market prices, economic consequences), yet is sufficiently simple that it can be used by local staff with relatively little training.

These two projects were reviewed, along with three other AS2 projects, in mid-2003. The following excerpt from that review has guided the development of this project.

“Farmers are keen to increase cattle production, particularly as the relative prices of cattle and grains have changed so rapidly, but they face a constant problem of balancing the crop and livestock components of their systems. The feed supply per se and the quality of that feed becomes a real problem during the dry season. However, production of forages on-farm to meet that demand has trade-offs against crop production. Conducting conventional field research to explore the variety of options has serious limitations because of the significant year-to year differences in rainfall and its pattern, which constrain the ability to extrapolate results to other times.

Experience in Northern Australia has demonstrated the value of generating simulation models that accommodate these constraints and can link the components of the system. This capacity enables the development and evaluation of numerous production options, taking account of price differentials and individual farmers’ circumstances. The CSIRO Sustainable Ecosystems team (CSE), and their collaborators, have such systems in place and have considerable experience in the humid and semi-arid tropics. This project used that experience to address this problem, with livestock added to that system.

There have been substantial increases in capacity in the modelling of crop-livestock systems in both Australia and Indonesia and significant progress towards a functional model based on data collected at the sites in both Sumbawa and South Sulawesi. This is the first time that such an integrated model has been developed. Sustaining the research effort and its application as an extension training tool will require commitment within Indonesia to retain capacity and with providers of model support.”

While these two earlier projects were successful in developing the models and building capacity in systems approaches within the partner agencies in Indonesia, they did not reach the stage of directly testing these tools with farmers or testing the best-bet scenarios on the ground via on-farm trials.

4 Objectives

1. To develop, test and apply tools, information and knowledge-sharing techniques appropriate for use at both farmer and extension levels to evaluate the impacts of management interventions into tropical rainfed crop-livestock systems.

- Undertake desktop studies to develop and test crop-forage-livestock options in partnership with groups of local farmers in a range of case study settings (Sulawesi, Lombok, Sumbawa) to identify `best-bet' options to profitably increase livestock production on smallholder farms;
- Undertake on-farm trials of the `best-bet' options over a range of regional sites to test their technical efficacy under realistic field conditions and to monitor their impact in terms of improving household welfare, the natural resource base and their social acceptance viz a viz, existing smallholder practices.
- To refine the existing simulation models to more closely mimic (1) the growth and yield performance of rainfed crops, multi-purpose fodder trees, forages and livestock production; and (2) the consequences for household welfare for a wide range of smallholder settings in eastern Indonesia.

2. To communicate the outputs of the project to smallholder farmers, both in the immediate vicinity of the case study sites and more broadly across eastern Indonesia; and also to other providers of research and extension services.

- Use the on-farm trial sites as ongoing extension platforms, plus other more conventional extension methods to demonstrate, raise awareness and promote acceptance of the farming systems approach to management and of the risks and benefits of the best-bet options identified in partnership with the collaborating farmers.
- Promote the expansion of local capacity to undertake farming systems research and extension activities by supporting the establishment of the 'Centre for Simulation and Modelling in Agricultural Systems' within the Faculty of Agriculture and Forestry at Hassanuddin University.

5 Methodology

Project site selection

Project activity was conducted at four sites: 1) SPA village in Sumbawa; 2) Lompo Tenggah, Pattappa and Harapan villages near Barru in Sulsel; 3) Mertak village in southern Lombok and; 4) Lemoa and Manyampa villages in the Parangloe subdistrict of the Gowa Regency in Sulsel. The original intention was for the principle, co-ordinated project activity to take place at the Barru and Mertak sites. Activity at the Lemoa, Manyampa and SPA sites was to be conducted by, and be the responsibility of, the Indonesian contingent with minimal input from the Australians.

Activity in the earlier AS2/2000/124 and 125 projects was focused on the villages at Barru in Sulsel and at SPA. Over the course of these projects we developed strong relationships with the local farmers and Dinas staff and there was a strong level of expectation that we would return and complete the work that we started in these earlier projects. The large amount of data already gathered from these sites enabled us to launch directly into the workshopping and testing of various options with farmers. Furthermore, preliminary workshops had already been conducted at the Barru site.

Mertak is just a two hour drive from Mataram, Lombok where some of the Indonesian project staff are based. Mertak was visited during the course of a project development trip to Lombok in July 2004. We met with a group of farmers to discuss the nature of their farming activity, to gauge the nature and extent of constraints to livestock production, and their level of interest in exploring options to overcome those constraints. Mertak has a total population of 7400 (2100 households), half of whom are illiterate and many of the remainder have very low levels of formal education. The village covers an area of 2700ha comprised of rainfed lowland (280ha), upland (750ha), grazing land (360ha) and forest. In the lowland areas, farmers typically grow rice during the wet season and soybean as a first dry season crop, although many crops fail or give very poor yields due to the unreliable rainfall in the region. It has the largest cattle population in its sub-district, with each household having about two cattle fed on a combination of crop residues, pasture and cut and carry. Feed typically runs out in September/October and rice straw has to be trucked in from neighbouring areas. The farmers we spoke to want to increase cattle numbers and identified access to capital and feed availability as the primary constraints to livestock production. They expressed interest in exploring the incorporation of high quality forage species into the system, and the improvement in feed quality via rice fermentation.

At the specific request of the Vice Governor of Sulawesi, two villages were chosen in the Parangloe subdistrict of the Gowa Regency, as the preferred second site in Sulsel. This subdistrict is about 35km from Makassar and has the highest cattle population in the Gowa Regency. This subdistrict is one of the major suppliers of fresh vegetable produce for the city of Makassar and also supplies Makassar with drinking water from the Bili-Bili dam on the Jeneberang River. High rainfall combined with a steep undulating landscape and poor land management practices has resulted in extensive soil erosion and a major landslide event in early 2004 with substantial loss of life. These events have led to declines in agricultural productivity and the contamination of dam water, incurring substantial expenses for water purification. Siltation of the Makassar Harbour downstream of the dam has created a navigational hazard to local shipping. There is a growing awareness that farming and soil conservation practices in this subdistrict will need to be modified to make them more sustainable and that research needs to be conducted in order to help farmers come up with the best solutions.

Key steps in the process

Step 1. Quantify and understand the farming system

The first step involved developing a clear understanding of how the farming systems in these sites function, and quantifying the associated resource flows and farm productivity. The information/data is used in a number of ways:

- To identify appropriate / representative case study villages, sub-villages and farmers by alignment with defined selection criteria. Participation is based on whether Bali cattle are already part of the farming system; there is both on-farm capacity (e.g. feed / land resource availability) and willingness by farmers to improve cattle production; there is support from village leaders and district extension agency staff; the sites are accessible and representative of activity at a broader scale.
- To develop and parameterise the farming system model so that alternative management options can be explored and compared.
- As a baseline against which the performance of alternative practices can be compared and evaluated.

The social and economic information for this study was sourced from a combination of historical village records (i.e. secondary sources), semi-structured interviews with farmer groups and individual farmers, and the 'expert knowledge' of staff from the collaborating research, development and extension agencies. These socio-economic data were complemented by the collection of primary biophysical data relating to forage availability, feed management, cattle breeding cycles, cattle performance, soil characteristics and climate.

All interviews were conducted by local project staff who were familiar with village custom and language, and who had a history of activity in the target villages. Interviews were conducted at a convenient time for the interviewee, often in the evening so as not to disrupt the daily on-farm work schedule. Best results were achieved when interviews were conducted by a team of two with one of the team having a 'guided' discussion with the interviewee/group while the other took notes and ensured that the required information was collected. The Australian members of the project team participated in many of these interview sessions.

Step 2. Develop and parameterise desktop simulation tools

The second step involved the refinement and parameterisation of the Integrated Analysis Tool (IAT), developed in projects AS2/2000/124 & 125. The IAT is a smallholder household simulation model that integrates three separate models: the farming system model (APSIM, Keating et al 2003), a model for Bali cattle growth and a smallholder enterprise economic model. Key attributes of the IAT include:

- Incorporates key socio-economic and biophysical processes and their interactions in smallholder farming systems
- Capable of accommodating the diversity of current and potential farming systems (i.e. management, soil and climate) as well as variation in commodity prices and seasonal climate
- Transparent in terms of the model assumptions and caveats of use
- Easy to operate by development or extension professionals in an interactive way with farmers (not directly by, or in isolation from farmers)
- Enables rapid assessment of the potential production and socio-economic impacts of changes in the system state (i.e. management, climate, soil, prices, costs)
- Able to be readily updated to accommodate the specifics of new regions, changes in farming practice etc.

A full description of the IAT is given in Appendix A. In this project, model development work involved:

- The creation of new APSIM datasets for each of the four villages
- The calibration of a new APSIM model for Elephant Grass
- Improvements to the IAT interface
- The addition of new capacity to the cattle and economic models.

Step 3. Identify strategies for Bali cattle improvement

Once the benchmarking was completed, farmer group meetings were held in each focus village. At these meetings, the benchmark results were presented and discussed to ensure their validity. Small group discussions followed in which farmers were asked to identify constraints to livestock production and to nominate potential options to address those constraints. These constraints fell into three broad categories: (i) those beyond the control of the individual farmer (e.g. access to finance); (ii) those for which the solutions are obvious and do not require detailed analysis (e.g. disease, stock water supply); and (iii) those for which the solutions and the implications are more complex (e.g. feed availability, breeding cycle). Potential solutions to this third group of constraints were analysed with the IAT, using a single, representative farm configuration (for each village) and by comparing current practice with practice based on the potential solutions that arose from the farmer workshop.

The results were presented to the farmers for discussion and refinement at a second workshop (one day later), so as to identify a shortlist of feasible and viable best-bet options for improving Bali cattle production in the region.

Approximately five of the farmers that participated in the original benchmarking activity were then chosen from each village to participate in on-farm trials of selected best-bet strategies. The selection of these farmers was based on the following criteria:

- Currently own/manage cattle
- Have capacity/desire to improve/expand cattle production
- Willing to adopt/trial agreed best-bet strategies
- Willing to establish and manage trial activity with guidance and necessary consumables provided by the project
- Willing to allow other farmers to view activity (field days etc)
- Willing to provide seed and cuttings to other farmers
- Acceptance of signage describing activity and key results
- Willing to participate in monitoring activities (interviews etc).

Given that the IAT analysis was based on a representative, generic farm, not all of these options were appropriate for every farmer. The strategies had to be customised or adapted to fit the specific physical, cultural and social circumstances of each farm and farmer. With this in mind, separate discussions were held with each of the selected best-bet farmers to identify farm-specific livestock improvement strategies that were then trialled on-farm.

These interviews were conducted at the farmers' house and were followed by a walk around the farm in order to help 'visualise' the management practices, constraints and opportunities that arose during the interview. A key part of the process involved the completion of a 'typical' annual activity calendar with the farmer. This calendar summarised the timing (e.g. sow and harvest time), area and location (e.g. cropland, upland, backyard) of food crop, grazing and cut and carry activities; the timing of cattle breeding activity (i.e. mating, calving and weaning); the source and composition of off-

farm feed sources (i.e. crop residue or cut and carry); the composition and period of use of on-farm conserved crop residue; and the timing and nature of peak labour periods. Other baseline information was collected relating to herd size and age profile, historical crop yields, perceived constraints to livestock production, maximum manageable herd size, family details (size, age distribution, education level) and so on. The activity calendar enabled the project team to rapidly identify farm-specific livestock production constraints and potentially feasible options for addressing these constraints (from the list of strategies arising from the earlier workshop and incorporating the farmers' own suggestions). The calendar also enabled the farmer to check and reflect upon the answers he provided. The potential livestock improvement options were then added to the calendar for discussion and an agreed set of best-bet options were then selected for subsequent trialling on each farm. Activity calendars for each of the 40 best-bet farms are included in the farm summaries shown in Appendix F. An example activity calendar is shown in Figure 1.

Figure 1. Activity calendar for farmer Muhammad, Harapan, Sulsel. Current activities are shown in green. Potential best-bet activities are shown in red.

Step 4. On-farm testing and extension of strategies

Having reached agreement on strategies that were both feasible from resource supply and social perspectives, and which were shown by the model to improve the financial welfare of the household, the next step was to test them on-farm.

These on-farm trials provided an opportunity for farmers to experience and test the best-bet strategies, provide data for validating the IAT and related assumptions (both biophysical and economic), and to demonstrate / communicate project findings and methods. So far as possible the trial sites were located in accessible, highly visible locations to facilitate extension activities. These trials served as a centrepiece for a number of field days at which farmers from neighbouring villages and other project villages were provided the opportunity to view the technology on offer, view performance data from the monitoring activities, and hear first hand, the views and experiences of the case study farmers (Figure 2 and 3).

Figure 2. Field day at Barru (July 2006)

Figure 3. Visit of Mertak farmers to SPA (October 2006)

To facilitate less formal, incidental exchanges between farmers and within farmer groups before, during and after the field days, permanent signs were established at each trial site detailing the objectives and methods of each trial (Figure 4). All materials were presented in Bahasa Indonesia and/or the local dialect.

Figure 4. Permanent sign detailing best-bet activity.

Impacts on forage availability and cattle performance were monitored using the same techniques adopted during the benchmarking activities and the results were regularly discussed with the farmers.

Farmers were periodically interviewed to evaluate their experiences and impressions of the technology. A comprehensive exit interview was conducted with each best-bet farmer at the end of the project.

6 Achievements against activities and outputs/milestones

Objective 1: To develop, test and apply tools, information and knowledge-sharing techniques appropriate for use at both farmer and extension levels to evaluate the impacts of management interventions into tropical rainfed crop-livestock systems.

no.	activity	outputs/ milestones	comments
1.1	Workshop constraints and opportunities with Barru, SPA, Mertak and Lemoa / Manyampa farmer groups. Identify best-bets using IAT. Select focus farms. Design best-bet trials and monitoring procedures around preferred options from workshops.	Barru, SPA, Mertak Lemoa / Manyampa best-bet options finalised and trial sites identified. Trial designs and monitoring methods finalised.	A series of one-day workshops were conducted in early April 2005 for farmers from SPA and Barru; and in July 2006 for farmers from Mertak and Lemoa / Manyampa. Approximately 20-30 farmers attended each workshop. Two separate workshops were conducted over a three day period for each of the SPA, Mertak and Lemoa / Manyampa farmer groups. The purpose of the first workshop was to review and clarify village benchmarking results collected during the previous AS2/2000/125 project and to identify constraints and potential solutions for improving livestock production. The potential impact and viability of these solutions were then explored and quantified using the IAT on the following day by Cam McDonald and Shaun Lisson with the results presented and discussed with the farmers at the second workshop, one day later. The key output from this workshop was a suite of agreed and viable livestock improvement options to be tested on-farm. At Barru, the objectives outlined above for the first workshop were covered in a workshop held in August 2004 as part of a previous bridging project (to link AS2/2000/124 to AS2/2005/005). Hence, just the one workshop was held during this workshop at Barru in April 2005 to review IAT results and to agree on options to be tested on-farm. Each best-bet farmer was interviewed separately for 1-2 hours. Barru and SPA farmers were interviewed in October 2005, and Mertak and Lemoa / Manyampa farmers in July 2006. The interviews were conducted at the farmers' house and were followed by a walk around the farm in order to help 'visualise' the management practices, constraints and opportunities that arose during the interview. The interview was conducted as a discussion in local language by one of the Indonesian team members who received prompts from a small group of the Australian contingent.

1.2	Benchmark Lemoa / Manyampa and Mertak sites. Collect required soil, crop and climate data for modeling. Identify farmer groups.	Benchmarking completed for Lemoa / Manyampa and Mertak. Farmer groups identified. Weather stations established, key soils characterised.	The period from project commencement (April 2005) to July 2006 was used to collect benchmark data for Mertak and Lemoa / Manyampa. Benchmark data for SPA and Barru were collected during the previous AS2/2000/124 and 125 projects. A preliminary appraisal of soil characteristics at Mertak and Lemoa / Manyampa was conducted by Neal Dalgliesh, Lia Hadiawati, Ahmad Suriadi, Rakhmat Rachman and Syamsu Bahar in October 2005 (see Appendix B). This involved a coarse survey of the key soil types in each region and a textural description of each based on soil cores taken to a depth of 1.2m. This information was subsequently used to select representative, generic soil files for use in the IAT modelling studies mentioned below. Soil characteristics for Barru and SPA were collected during the course of the AS2/2000/124 and 125 projects and are described in the final reports for those projects. Automated climate stations were established in April 2005 at each site for the collection of daily temperature, rainfall and radiation data. Data from these stations were combined with longer term climate data collected from nearby Bureau of Meteorology stations to develop longer-term climate files for use in the IAT modelling studies. Benchmark data relating to forage and cattle production were collected from a group of representative farmers in both Mertak and Lemoa / Manyampa. This covered the composition, quantity and quality of forage, feed management characteristics (i.e. grazing, cut and carry, supplements), cattle breeding cycles (i.e. times of mating, calving and weaning) and cattle performance (i.e. liveweight gain, condition score, disease, dimensions). These data were collected at critical times (e.g. change of seasons) to cover at least one complete set of seasons.

1.3	Establish trials on focus farms at Barru, SPA, Mertak and Lemoa / Manyampa and monitor the impacts on key resources	Trials successfully established and monitored according to accepted protocols. Data collated for analysis.	The establishment of best-bet trials commenced at Barru and SPA in late 2005 and at Mertak and Lemoa / Manyampa in late 2006. Trials were continued through until April 2008. Detailed schedules were developed for each best-bet activity. In the case of forage related strategies, the schedule included notes on the establishment and management of each trial and advice on how to use the resultant forage material. Consumables for best-bet implementation including seed and planting material, fertiliser, materials for constructing storages for crop residue or grey water conservation (where required) were provided by the project, with the farmer providing the necessary labour and land resources. These schedules are included in the individual farm summaries shown in Appendix F. The success or otherwise of best-bet implementation was regularly assessed by the project team. These assessments typically coincided with visits by the Australian team members; a total of nine visits were made by members of the Australian team to most study villages between July 2005 and February 2008. Suggested management adjustments arising from these reviews were identified in a “learning together” way with the best-bet farmers. In some cases this included decisions to re-plant or re-site forage trials which had failed or performed poorly due to seasonal conditions or unforseen site related issues. To help assess the performance and impacts of best-bet options, a program of regular forage and cattle monitoring was implemented for each best-bet farmer and study village. The frequency of monitoring was dictated by project resources but aimed to collect information at critical times through the season, such as early wet, late wet, early dry, mid dry and late dry seasons on forage supply, composition and quality, cattle performance and reproductive status. In both NTB and Sulsel, this averaged out to roughly 2-3 month intervals for both forage and cattle monitoring. Due to the low input nature and remoteness of the SPA site, monitoring was less frequent, while cattle monitoring at Mertak was conducted at roughly monthly intervals. These biophysical ‘snapshots’ were designed to compliment and calibrate regular farmer interview and evaluation data gathered as part of the best-bet impacts assessment process. Appendix C summarises the main forage and cattle variables monitored over the course of the project and the methods used. Data from these monitoring events (and from the climate stations) were sent to project data manager Lia Hadiawati, based at BPTP Mataram for collation into a central project database. During the course of the project, the local project teams undertook several rounds of visits to each of the best-bet farms involved in the project to check on their experiences to that point with the technologies that were being trialled in their systems - although less emphasis was placed on monitoring of the less intensive sites at SPA and Lemoa / Manyampa. Most of the household visits were conducted on a 4-6 weekly cycle to coincide with the forage and cattle monitoring activities and were generally of an informal nature. Records of purchases of inputs and sales of produce or revenue from non-farm sources were also included.

1.4	Develop and calibrate a new APSIM model for perennial legumes.	Draft APSIM model for perennial legumes completed and calibrated.	Plans to develop a component model for tree legumes were abandoned due to the early resignation of Jacqui Hill from the project (and CSIRO). In lieu of this, a simple, empirical biomass and feed quality model for Gliricidia was developed for use within the IAT model. Two Masters student projects were undertaken through Hasanuddin University to develop a component model within the APSIM framework for simulating the growth and development of Elephant Grass. A number of additions and changes were made to the IAT to improve the user interface and to simplify output interpretation. The main changes include: Replacement of village-based APSIM farming system output with output based on soil type X climate combinations. This makes the IAT more widely applicable without the requirement for detailed crop and forage modelling for individual villages; Language selection restructured to allow additional languages (e.g. Buginese, Sasak) to be added by the user if desired; The ability to save and reload parameter sets from previous analyses to ease comparison with new analyses; Allowance for seasonal variation in the amount of cut and carry fed to animals; Determination of manure production, economic value and labour requirement for collection and composting; Addition of costs and potential revenue from goats, chickens and other animals (this does not include full animal intake, liveweight gain and reproduction modelling as for Bali cattle); The addition of capability for the user to edit crop maintenance details, crop prices and labour requirements for planting, harvesting, etc. Other modifications were made to the cattle, fodder and socio-economic components of the IAT. These were tested and implemented as additional information became available on animal growth rates, pasture growth, and alternative farmer activities. Growth from native pasture is now included in the database of output from the APSIM model on introduced pastures (grasses and legumes). This simplifies the processing of the various sources of feed. Estimates of labour requirements for cut and carry material remain a highly variable component but, at the same time, an important aspect of intervention strategies. Increasing available on-farm forage can greatly reduce demand for labour for cut and carry both in the wet season, when farmers are busy with weeding of rice, and in the dry season when they often have to go long distances for forage. The IAT now has facilities for farmers to buy or collect fodder from other sources (e.g. rice straw from central Lombok) to offset their fodder shortage and reduce their labour demand. The labour and costs of obtaining this forage are incorporated into the socio-economic model. The display of model output has been updated to provide more complete visual representation of outcomes across the 10 year period of each model run. Detailed labour requirements/availability for each season for each family member and each farm activity can now be displayed for each of the 10 years rather than the overall summary provided previously. A graph of the monthly fodder requirements and availability highlights any periods of shortfall.

PC = partner country, A = Australia

Objective 2): To communicate the outputs of the project to smallholder farmers, both in the immediate vicinity of the case study sites and more broadly across eastern Indonesia; and also to other providers of research and extension services.

no.	activity	outputs/ milestones	comments
2.1	Project outputs disseminated / communicated via established channels.	Signage established at trial sites. Field days conducted at trial sites. Regular farmer bulletins prepared. Papers presented to regional and national conferences.	Field days were conducted at Barru in July 2006, at SPA in July 2007 and at Mertak and Lemoa / Manyampa in April 2008. These field days were attended by the best-bet farmers and other farmers from the focus village. Participants were taken on a guided tour of selected best-bet activities with commentary provided by both participating best-bet farmers and other members of the project research team. In addition to local farmers, best-bet farmers from Lemoa / Manyampa were bused to the Barru field day while Mertak farmers made a separate field visit to SPA in October 2006. These cross-site visits were particularly beneficial for Mertak and Lemoa / Manyampa farmers in providing knowledge, motivation and seed/cutting material. Prior to the field day, permanent (weather-proof) signs were installed at selected best-bet trial sites to promote the project and associated activities to passing farmers. These signs remained in place for the duration of the project and outlined the objectives and methods for each activity. The signs were prepared in Bahasa Indonesia. Brief (<1 page) fact sheets were prepared for many of the best-bet activities as handouts to participating and other farmers and for broader distribution by Dinas and staff from other agencies. These fact sheets were prepared in both English and Bahasa Indonesia (Appendix E). In addition to the more formal field days, best-bet farmers were regularly visited (at least once per month) by in-country project team members and less regularly (3-4 months) by Australian team members. The visits from in-country staff were typically for monitoring activities and staff would take the opportunity to discuss the progress of best-bet activities, provide additional advice and discuss cattle and forage monitoring results. A total of 8 conference papers relating to this project have been or will shortly be delivered to a range of Indonesian, southeast Asian, Australian and international conferences (see communication section for details). Authorship and delivery has been shared wherever possible by both Indonesian and Australian team members. A series of two seminal journal papers are currently being prepared for publication in Agricultural Systems Journal. The first is ready for submission and the second will be completed to submission stage by July 2008. A third journal paper has been prepared for submission to the Australian Journal of Tropical Forages. Two draft book chapters have also been prepared for an ACIAR monograph (yet to be published).

2.2	Evaluation of farmer, extension agent and researcher attitudes to project technology and extent of adoption of project outputs.	Evaluation plan developed and agreed upon at start of project. Cyclical evaluations conducted throughout project.	In order to obtain a broad overview of progress on the application of the best-bet practices by the participating households close to the point at which the project formally closed, a final series of interviews was undertaken at each study site in Sulsel, Lombok and Sumbawa in February 2008. This involved face to face interviews, conducted in the local language, with 39 of the households who had been participating in the trials. A semi-structured interview approach was used to canvass a series of issues associated with applying the forage and animal management technologies and practices; including the impact on household activities and welfare, the interest shown in the activities by other households within and beyond the immediate community, personal effectiveness for problem solving and future intentions with respect to employing the practices. The individual interviews involved 32 questions or issues and took approximately 2 hours to complete. Project staff were individually canvassed on two occasions (May 2005 and May 2007 coinciding with annual project meetings) on their understanding of the project objectives, their personal role in the project, their perception of the performance of the technologies and practices and whether they felt the project was delivering value to the smallholders. On both occasions there was a high level of satisfaction expressed with all facets of the project operation and team roles. There was universal agreement that the project was already delivering value to the smallholders. A major part of the high degree of concurrence is likely to be due to the outcome of similar exercises that were conducted for projects AS/2000/124 & 125 in which some serious problems of both a project and technology nature were identified and positive steps taken in this project to resolve them as part of the project team builiding and implementation strategy.
2.3	Prepare training manuals describing the theory and operation of component and integrated models.	Model training manuals (Bahasa Indonesia) completed.	A comprehensive manual describing the structure and operation of the IAT was produced to aid workshop participants and for future reference/support. The manual was originally written in English but is currently being translated into Bahasa Indonesia.

2.4	Conduct a training workshop in the theory and operation of component and integrated models and in extension and community engagement methods.	Workshop conducted and performance formally evaluated.	In August 2007 a 3-day training workshop was held BPTP Narmada, Lombok. This was attended by project participants from Lombok and Sulsel. The first day of the workshop covered the background theory to the IAT, including what assumptions are made, why they are made, and the implications for interpretation of the output. The second day was a detailed explanation of all the input requirements for the model, and what was required at each prompt. This day also covered detailed explanation of how to interpret the output from the IAT. The third day was a supervised practice session with all participants conducting their own hypothetical analyses, observing the changes in the predicted outcomes, and interpreting the implications. Whilst no formal assessment was made of participant competency, observation of their use of the IAT, the questions and discussions held, and their enthusiasm for its use, indicated that all were confident in its use. The following participants completed the full course and were awarded certificates: Lalu Wirajaswadi – BPTP Narmada, Lombok Lia Hadiawati – BPTP Narmada, Lombok Achmad Muzani – BPTP Narmada, Lombok Nurul Himliati – BPTP Narmada, Lombok Dahlanuddin – University of Mataram, Lombok Yusuf Sutaryono – University of Mataram, Lombok Rachmat Rachman – BPTP Makassar, Sulsel Syamsu Bahar – BPTP Makassar, Sulsel Nasruddin Razak – BPTP Makassar, Sulsel Marsetyo – Tadulako University, Palu, Central Sulawesi Asmuddin Natsir – Hassanuddin University, Makassar, Sulsel A number of other participants attended for short periods to gain exposure to the IAT and whole farm analysis. Separate two-day training workshops were held in Mataram and Makassar as part of the start-up meetings for the new scaleout projects. These workshops covered the theory and practice of the systems, participatory, modelling approaches developed and implemented over the course of the 005 project. This training was conducted by 005 project staff for the new on-ground team members of the scaleout projects. The Centre for Simulation and Modelling in Agricultural Systems was originally intended as a centre for ongoing training in farming systems science and modelling. The Centre was subsequently shut down during the course of the project. While disappointing this did not prevent the conduct of farming system and IAT training in the final year of the project. Various learnings and case studies from the project have subsequently been incorporated into the curriculum of the farming systems course under the direction of Dr Rusnadi Padjung. Furthermore, the IAT has developed into a generic tool that requires little ongoing ‘maintenance’.

PC = partner country, A = Australia

7 Key results and discussion

Part 1: Benchmarking

The benchmarking activities conducted across the four study sites showed that the structure and nature of smallholder crop-livestock farming systems are generally similar across these sites, indeed for most of eastern Indonesia. With this in mind, the following text summarises some of the key characteristics that define smallholder farming crop-livestock farming systems in eastern Indonesia derived from both the benchmarking activities in this project and selected references. More detailed insights into the structure and nature of the systems investigated in this project are provided in a separate benchmarking report prepared for Desa Mertak (Appendix D).

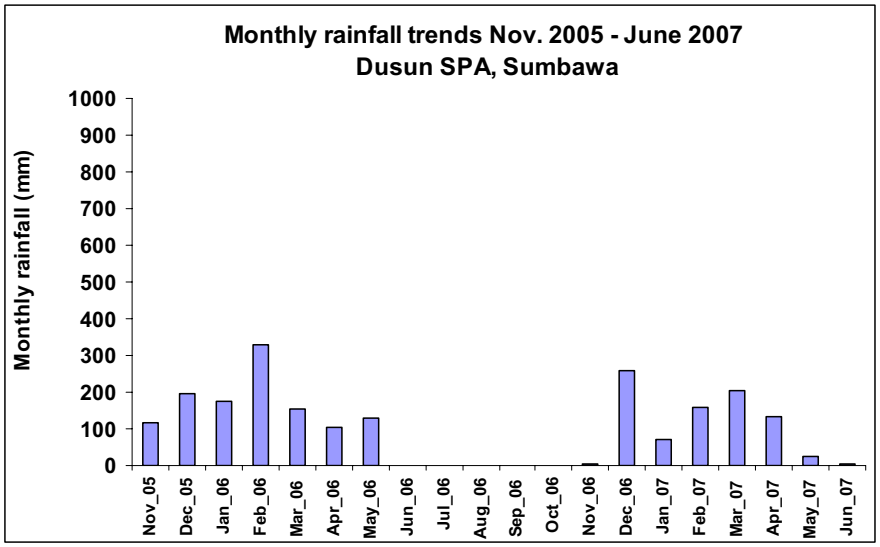
Key characteristics of the smallholder farming systems of eastern Indonesia

The smallholder crop-livestock farming systems that exist in eastern Indonesia are dominated by small farms (usually < 2ha) that comprise an integrated mix of crop, forage, livestock and human activities. Like those in much of Asia, Africa and the Pacific, these enterprises possess linkages between the 'farm' and 'household' that are argued to be much stronger and more mutually dependent than for western farming systems (Ruthenburg 1980, Norton et al. 2006). For example, labour is potentially used both on-farm and off-farm (e.g. ploughing, weeding, harvesting, herding for other farmers), and away from the farm in non-farming roles (e.g. operating a kiosk, construction).

Some crop and animal activities produce intermediate outputs that become inputs to other activities (e.g. Bali cattle provide crop nutrition inputs through manure and also provide draught power for cultivation). The products from these smallholder systems seldom have alternative markets and so opportunity valuations are given far less prominence in decision making than is the case in agricultural systems in more developed countries. Additional commitments to new activities can reduce opportunities elsewhere with consequences for family welfare.

Seasonal climate

The nature and timing of farm activity is strongly influenced by the seasonal climate pattern. While there is substantial spatial and inter-seasonal variability in the timing and extent of rainfall across eastern Indonesia, the 'wet season' typically commences about November-December and ends about April-June, followed by an essentially rain-free 'dry season' for the remainder of the year (Figure 5).



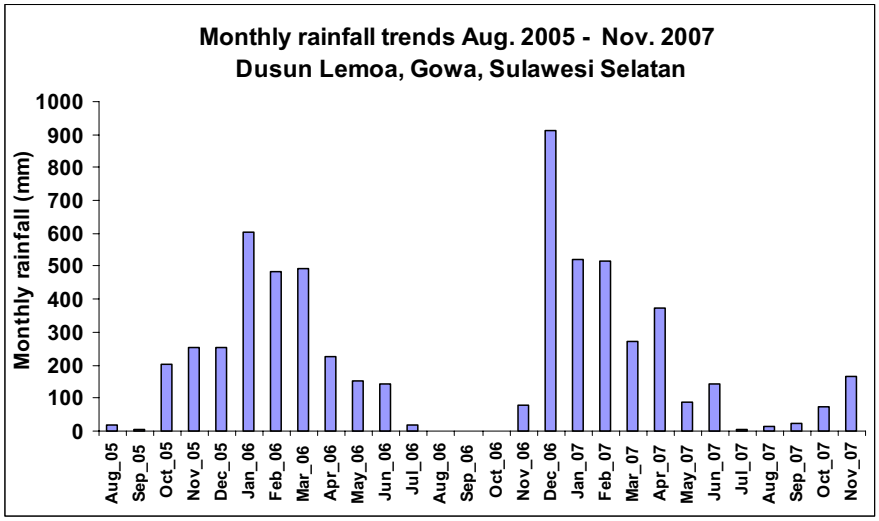


Figure 5. Monthly rainfall trends 2005-2007 for Desa SPA, Sumbawa and Desa Lemoa, Sulsel.

Land use

Smallholder farms are commonly comprised of two basic land types. 'Cropland' is characteristically close to the main residence, naturally flat or formed into terraces, with deeper and more fertile soils, often with access to simple irrigation and/or is bunded to retain overland flow. This land is used for cultivating a range of annual crops. Essential food crops such as rice and maize are grown during the wet season. The length of the wet season and/or access to irrigation determines the selection, extent and number of crop cycles in one year. Other important annual food crops that are grown principally in cropland areas include peanut, sweet potato, soybean, mungbean, cassava and tobacco.

'Upland' is typically further away from the house and less accessible, larger in area, often on sloping ground with shallow and less fertile soils and with no access to irrigation. These parcels of land are used to grow perennial fruit (e.g. mango, coconut, cashew), fibre (e.g. kapok) and timber crops (e.g. teak, bamboo). They are also important areas for the production of native and introduced perennial and annual forages and are important areas for cattle grazing. Many of the forage species grown in the upland are also grown around the perimeter of cropland as fences and/or on top of cropland bunds. Upland is often shared by more than one farmer and so usually the grazing in this land is communal, whereas cropland use is usually exclusive to the farm owner, although communal grazing of crop residues does occur in some locations.

Livestock production

Bali cattle play a central and multi-functional role in these farming systems as: (1) draught animals for field operations such as tillage, (2) a readily saleable store of capital to meet major household needs (e.g. school fees, house repairs and electronic equipment, Haj travel), (3) as a means of accumulating wealth and status over time, and (4) as a business enterprise to generate income (Padjung and Natsir, 2005). Traditionally the last of these roles, that of generation of an income stream from cattle production, has been rare. Depending on the time of year, cattle either free graze crop residue and/or 'native' pasture, are tether grazed, or are penned and hand fed various mixtures of 'cut and carry' and other supplements. In addition to Bali cattle, farmers keep a variety of other livestock types including buffaloes, goats, ducks, chickens and geese for the provision of meat and other animal products (e.g. milk, eggs) for home consumption.

Forage availability

Depending on the time of year, cattle either free graze crop stubble and/or 'native' pasture or forages, are tether grazed, or are penned and hand fed various mixtures of 'cut and carry' forage. Forage production tends to follow the seasonal climate pattern, with

maximum rates of biomass production occurring during the wet season, declining to near zero at the peak of the dry season. Hence, during the wet season when feed is plentiful, farmers allow their cattle to free graze in the upland and/or tether graze (often supplemented with some 'cut and carry' feed) closer to the house so as to avoid damage to the field crops. This situation continues for a period after the wet season with the grazing of 'pasture' supplemented by the grazing of crop residues and stubble following removal of the harvested crop.

As the dry season continues, the more accessible feed sources are gradually depleted and farmers are required to invest increasingly more labour to provide feed for their cattle, either manually gathering feed for stock (if penned or tethered) or moving their cattle more often and/or further away from the house (if grazed). The quality of available feed also declines during the dry season with greater dependence on less palatable, less digestible and protein impoverished feed.

The shortfall in both quantity and quality of feed can be addressed through the use of tree leaves, banana leaves and stem, occasionally perennial legumes such as Gliricidia, Leuceana and Sesbania or by the use of conserved leguminous crop residues in some regions, but usually the amount provided does not overcome feed deficiencies, leading to weight loss at this time of year.

Family structure and labour profile

The household family structure tends to be multi-generational (typically three generations) with all members contributing to a varying extent in the management and operation of farm activities. Key farm activities include: land preparation (i.e. ploughing); sowing and transplanting the crop; fertilising; chemical application; weeding; harvesting, threshing, bagging and transportation of the harvested product; cattle tending; forage gathering; and water gathering. Additional labour is often hired to help out with harvesting and land preparation activities; while supplementary income may be sought from off-farm activities that are both agricultural or non-agricultural in nature.

Part 2: Farmer workshops

Constraints to livestock production

There was substantial uniformity across the 4 project sites in terms of the key constraints to livestock production. The majority of the constraints described below were identified directly by the farmers during the workshops conducted in the first 12-15 months of the project. Some, such as housing and late weaning, were recognised by members of the project team.

Feed availability was recognised as a major constraint by farmers in Barru, Lemoa / Manyampa and Mertak, especially in the latter part of the dry season when 'cut and carry' feed sources are limited. Farmers in SPA had been encouraged in the previous AS2/2000/125 project to increase the production of tree legumes (mainly Gliridicia) for use as cattle feed, especially during the dry season. The adoption of this advice by many of the SPA farmers has to some extent reversed the feed shortfall reported at the commencement of the 125 project. However, at the time of the farmer workshop at SPA (April 2005), many of the farmers were still trucking feed in from off-farm locations (e.g. irrigated cropping regions near Dompu) and/or spending many hours each day collecting feed closer to home. In addition, it was clear to the project team and from our discussions with the farmers, that knowledge of optimal feed management practices (i.e. when and how much of what to feed animals of different age and condition) was limited.

Limited access to a bull for mating was listed as a constraint in each village. Most of the males were sold prior to breeding age to provide cash for large expenses such as schooling, house renovations, travel and, during the recent drought, to purchase food. Farmers typically pay for the services of another farmer's bull, but delays in availability severely reduce the efficiency of mating and conception.

In Barru, farmers complained about the monopolistic nature of the trading mechanism and the difficulty in estimating cattle live-weight in the absence of cattle scales. The sale price is based on the traders' estimate of weight which (not surprisingly!) is typically less than reality and/or the farmers estimate.

Drinking water for stock is sourced from community wells, dams and/or individual on-farm wells. Some farmers also capture rooftop water, but this is primarily used for household consumption. Typically, a member of the household employs part of their day (more during the dry season) collecting water from the communal source although in some cases (e.g. SPA), water is trucked in from outside the village and delivered (at cost) to individual farmers. Farmer knowledge about the optimum daily water requirement of cattle was also limited.

In most of the villages, cattle housing and feed troughs are either non-existent or poorly designed and maintained. This results in significant feed spoilage and may act to promote the incidence of various cattle diseases and other parasitic conditions.

Cattle disease and parasites were raised as potential production constraints by some of the farmers attending the workshops. However, these conditions appear to be isolated in nature and adequately controlled by the existing drenching and immunisation programs of Dinas Peternakan.

Labour availability, especially during the dry season, was mentioned as a constraint by farmers in Mertak, Lemoa / Manyampa and Barru. During this period when there is no crop-related activity, farmers often work off-farm to generate additional income, leaving the tending of cattle to the rest of the family.

Another consistent constraint to increasing livestock production is access to capital. Farmers typically don't have the cash reserves or access to loans to enable them to buy a bull or more cows for breeding. Hence, they must build up their herd independently and must buy the services of another farmers' bull. However, this is often difficult as farmers need to sell cattle to release cash for other household expenses.

In most of the villages, farmers are not producing a calf every year due to the stress imposed on the cow by a sub-optimal breeding cycle and delayed weaning. Currently, mating occurs late in the dry season to early in the wet season with calving (9.5 months later) during the following dry season. A lengthy weaning period follows where the cow's milk is supplemented with 'cut and carry' material. The lactation period coincides with the dry season when feed of high quality is in short supply. Once the wet season commences, the existing labour use is prioritised to field preparation and planting of rice. Consequently, the cutting and carrying of forages to supplement tethered or housed animals is a relatively low priority for farmers.

Furthermore, the mating cycle often leads to an overlap between milking/lactation and draught activities early in the wet season when the fields are being ploughed in preparation for rice planting. It is not unusual early in the wet season to see cows ploughing the field while being followed by milking calves. Additional stress can occur about this time of year when the diet changes from primarily dry forage to green forage as the wet season takes hold. This cycle leads to declines in the condition of lactating cows, calf growth rates and the reproductive ability of cows.

Strategies for addressing these constraints

A range of strategies was identified for addressing these constraints and discussed with the farmer groups in the village workshops. These strategies (summarised below) formed the basis of the farm-specific, best-bet activities/trials. Selected strategies relating to feed supply and quality and animal management, for which the solutions and the implications are typically more complex, were explored using the Integrated Analysis Tool (see following section).

Feed availability and management

Strategies for improving the quantity and quality of feed options on-farm fell into three main categories: 1) improved utilisation / management of existing fresh forages and crops; 2) introduction of new forage grasses and legumes to increase fresh forage supply options; 3) better use and improvement of crop residues.

Introduction of new, improved forage species

The selection of new forage species for on-farm trialling was based on the experience of forage scientists Jeff Corfield and Syamsu Bahar and with reference to the tropical forage database: Tropical Forages – An interactive selection tool (Peters et al, 2005). Selection took into account adaptation to the soil and climate conditions of eastern Indonesia and suitability for cultivation in a variety of locations and arrangements including: mixed forage banks in either lowland, upland or backyard areas; along bunds bordering lowland fields; after annual crops (i.e. as part of the crop rotation); and as an understorey to upland estate crops.

Figure 6. Forage bank comprising alternating strips of *Stylosanthes* and *Brachiaria* at Desa Harapan, Barru.

A total of 10 grass and 7 herbaceous legume species were introduced and trialled on-farm as part of the best-bet trials (Table 2). The majority of the seed was sourced from Southedge Seeds, Mareeba, North Queensland, while supplies of Mulato *Brachiaria* and *Stylosanthes guyanensis* CIAT 184 were obtained for the project by Dr Peter Horne from suppliers in Thailand and Mexico, respectively.

Table 2. Details of forage grass and legume introductions for forage best-bet activities.

Forage type	Use	Species	Cultivar
Grass	Pasture/ Cut and carry	*Bothriochloa insculpta*	Hatch
Grass	Pasture/ Cut and carry	*Brachiaria decumbens*	
Grass	Cut and carry	*Brachiaria X*	Mulato
Grass	Pasture/ Cut and carry	*Chloris gayana*	Katambora
Grass	Pasture	*Digitaria milanjiana*	Jarra
Grass	Pasture/ Cut and carry	*Panicum maximum*	Green panic
Grass	Cut and carry	*Panicum maximum*	Mombasa
Grass	Cut and carry	*Panicum maximum*	Simuang
Grass	Cut and carry	*Paspalum atratum*	
Grass	Pasture/ Cut and carry	*Setaria sphacelata*	Splenda
Herbaceous legume	Pasture / cut and carry	*Arachis pintoi*	Amarillo

Herbaceous legume	cut and carry	*Centrosema pascuorum*	Calavcade
Herbaceous legume	Pasture / cut and carry	*Centrosema pubescens*	Cardillo
Herbaceous legume	cut and carry	*Clitoria ternatea*	Milgara
Herbaceous legume	Pasture / cut and carry	*Stylosanthes hamata*	Verano
Herbaceous legume	Pasture / cut and carry	*Stylosanthes guyanensis*	CIAT 184
Herbaceous legume	Pasture / cut and carry	*Stylosanthes scabra*	Seca

Many of these, including *Panicum, Paspalum, Setaria, Chloris, Arachis* and *Stylosanthes* species had been previously introduced and distributed to farmers across eastern Indonesia by NGOs and previous ACIAR projects. However, subsequent adoption and distribution has been limited. Furthermore, the previous AS2/2000/124 and 125 projects introduced some of these genotypes into Lompo Tenggah (Mahmud land) and SPA (Amaq Sapri and Mamiq Anti) between 2001 and 2003.

When planning best-bet activities relating to new forage introductions there is a trade-off between having sufficient area to make an early impact on forage supply and livestock production, and having too much area for the farmer to manage. This is particularly so in the critical establishment phase which often coincides with crop planting in the early wet season in eastern Indonesia. Within the project team there were differences of opinion on which path to take in this regard, especially as the ability and resources of individual best-bet farmers varied across the study villages. As a consequence, there was considerable variation in trial plot size; ranging from small plots of <0.02ha to areas of around 0.2ha.

Improved use of existing forage and crop species

Many existing forage species are of high quality but are poorly utilised. For example, tree legumes such as *Gliricidia sepium* and *Leucaena leucocephala* are commonly used as a living fence but are not widely used as a feed source due to farmer perceptions of poor palatability. One of the reasons for this poor palatability is the infrequent nature of cutting which leads to a ‘woody’ feed with older, less palatable leaf material. Similarly, elephant grass (*Pennisetum purpureum*), while of poor quality, is popular in some regions due to its fast growth rate and persistence into the dry season. However, the management of elephant grass is often poor (i.e. cut too hard and too often, or let grow tall and rank).

Figure 7. Gliricidia ‘living fence’ at SPA, Sumbawa.

Participating best-bet farmers were provided with advice on optimum cultural practices and in the case of tree legumes, this information was collated into two fact sheets (Appendix E).

Better use and improvement of crop residues

There is potential in these systems for the conservation (after drying) and improvement of crop residues as well as current and introduced forage species. Legume crops such as cowpea and mungbean are grown for human consumption but their residues are not widely used as cattle feed. There is the potential to grow these crops in rotation with rice and other food crops on lowland fields with the resultant residue either fed directly or conserved. In most areas there is surplus native green feed during the wet season, some of which might be dried and conserved for use during the dry season (e.g. Glycine). Potential exists for improving the quality of rice straw, which is abundant in these systems, via ammoniation.

Figure 8. Conserved mungbean residue, SPA, Sumbawa.

Feed budgeting

Advice on the correct amount and composition of feed required by animals of different age, condition and activity was provided to participating farmers throughout the project and captured in a series of fact sheets (Appendix E).

3. Cattle breeding / weaning

Advice on optimum times for mating, calving and weaning was provided to each participating best-bet farmer. That is, the suggestion is to calve late in the wet season (March/April) and then mate after no longer than 3 months later to make it a 12 month cycle. With this schedule, the cow is being used for draught at a safe time of the pregnancy (avoid final 2 months of gestation) and is not raising a calf at the same time. Furthermore, the calf is born about the end of the wet season when there is still plenty of feed available and the cow is in good condition. Such modifications may result in improved growth rates for cattle and faster turnaround times from birth to sale.

Farmers were also encouraged to wean their calves at a younger age (~6 months) and to preferentially feed thereafter. This is known from the work of Panjaitan et al (2008) to maximise calf growth rates and to reduce the stress on the cow, especially during the dry season.

4. Stock drinking water

While some farmers already capture water from their roof into the house mandi (water reservoir for domestic water supply) using simple guttering (e.g. bamboo), this is limited in extent and restricted to the collection of household water. This strategy was promoted during the farmer workshops as an efficient means for collecting both household and stock drinking water.

Simple calculations were made to estimate the volume of rain water able to be potentially harvested from selected homes, based on the roof area and annual rainfall estimate. Typically, this volume was greater than the combined annual needs of both stock and household. The success of this strategy requires an investment in a tank or well to store the runoff. In the case of Mertak, the project purchased roof guttering and associated piping and sealant for an existing in-ground concrete storage tank.

Another strategy is to recycle household grey water (post washing) for use as stock water. This involves capturing the water in a simple above-ground, concrete-lined trough, from which stock drink either directly or from which water is decanted and carted to where the stock are located. Selected best-bet farmers were provided with bags of concrete and design plans to construct their own troughs.

Questions were raised by Dinas staff in NTB about the impact on livestock of household detergents in grey water and also the possibility of disease transfer (especially malaria). Observations in study villages indicate that in most cases household detergent use is very low and restricted to simple soaps, so this should present few problems for use of grey water by stock. The potential for grey water storages to act as possible breeding sites for malaria and other water borne diseases and parasites is less clear. At least one best-bet farmer reported that he only used his grey water resource during the dry season (when stock water is limited) and covered the storage structure in the wet season to prevent contamination or mosquito breeding.

The amount of water that should be provided to cattle of different age, size, sex and condition (e.g. lactating, pregnant) and options for improving water supply were incorporated into two farm notes provided to farmers and their advisors (Appendix E).

Figure 9. Grey water recycling as stock water, SPA, Sumbawa.

5. Access to bulls

Given that the success of best-bet strategies relating to cattle breeding require ready access to a bull, a decision was made at Mertak and SPA to purchase bulls for the use of the best-bet farmers (and through negotiation, by other farmers). These bulls were managed by one of the best-bet farmers.

6. Disease and parasites

The incidence of disease and parasites in cattle belonging to best-bet farmers was generally minor. All cattle health issues were brought to the attention of local Dinas Peternakan staff.

7. Cattle pricing

The 'tight' weight X girth X height relationships developed through the cattle monitoring activities of this and previous projects were used to develop estimation tables for farmers. By measuring girth and height with a simple (and cheap) measuring tape, farmers can use these relationships to estimate animal weight which can subsequently be used in negotiations with cattle buyers.

8. Cattle housing

Advice on the potential benefits and optimum design of cattle housing (kandang) and feed troughs were provided to each participating best-bet farmer.

Figure 10. Improved cattle housing, Lompo Tenggah, Sulsel.

Modelling the potential impacts of these strategies

Selected livestock improvement strategies relating to improving forage supply and quality and animal management (strategies 1 and 2 above) were put through the IAT in order to explore/quantify the potential impacts (for a 'typical' farm) on the whole-farm feed, labour and cash balances. The strategies were explored in a sequential fashion, commencing with consideration of the current farm design followed by a series of changes, such as increasing feed availability and quality, increasing the number of cows, increasing the amount of cut and carry fed to cattle each day, and the introduction of seasonal mating.

In response to a question raised at the Barru workshop, an additional scenario was set up to explore the potential financial impact of a 20% reduction in cattle price. At the Mertak workshop, there was a discussion about the merits of shifting away from rice production and placing more emphasis on cattle production (and purchasing food from cattle sales). This came about in response to the recent drought that had decimated much of the village rice crop. The resultant IAT scenario indicated that substantial financial gains were possible from the adoption of this strategy (notwithstanding the cultural/social reasons for growing rice). The results were presented to the farmers in a simple tabular form.

An example from the Barru workshop is shown in Table 4. Table 3 summarises the farm structural details upon which the simulations were based.

Table 3. An example baseline farm from the Barru workshop.

Farm structure	
Family	4 (2 adults, 2 children)
Land	0.6 ha lowland (L), 1 ha upland (U), 0.1 ha backyard (B)
Living costs	500,000 Rp/month
Rainy season crops	0.54 ha rice (L), 0.3 ha groundnut (U)
Dry season 1 crops	None
Dry season 2 crops	None
Forage crops	None
Crop retention	None
Cattle at start	2 cows + 1 calf + 1 weaner
Cut & carry	30 kg/day
Plantation crops	None
Tree legumes	None
Commodity prices	
Rice	1000 Rp/kg
Groundnut	3500 Rp/kg
Beef (weaners)	10000 Rp/kg
Beef (2 year-old)	14000 Rp/kg
Beef (old animals)	12000 Rp/kg

Table 4. Output for selected intervention strategies.

Case scenario	**No. cattle sold over 5 years**	**Annual fodder surplus/deficit (kg)**	**Dry season labour surplus/deficit (days)**	**Final cash balance after 5 years (Rp million)**
Case 1: baseline				
	6	-3000	-10	14
Case 2: baseline + retaining 80% of groundnut residue				
	7	-1000	+50	15
Case 3: case 2 plus 0.3 ha Elephant grass on upland, 40% of dry season rice straw fermented				
	8	+5000	+90	23
Case 4: as for case 3 plus increase number of breeding cows to 4, increase cut & carry to 40kg/day				
	14	-1500	+40	41
Case 5: as for case 4 but reduce beef prices by 20%				
	14	-1500	+40	36

Under current practice, over a 5 year period, the farmer sells only 6 animals, has a labour shortage for cut and carry in the dry season, a fodder supply deficit and accumulates only Rp14m. Strategies 2 and 3, indicate how the farmer might address the fodder by growing elephant grass on under-utilised upland, retaining 40% of rice crop residue and fermenting it, retaining 80% of peanut crop residue, and growing tree legumes along bunds and fence lines.

In doing so, the farmer can increase their off-take to 8 animals, generate a surplus in both fodder supply and dry season labour and increase the accumulated funds to Rp23m over a 5 year period, all without interfering with their primary activity of growing rice. The surplus fodder then allows more animals to be kept with the potential for offtake to be increased to 14 animals and accumulated funds to Rp41m. Naturally, the above outcomes would vary depending on the sequence of seasons experienced. Also, farmers may not be

able to implement all interventions simultaneously and are more likely to implement them in a step-wise fashion with subsequent incremental gains in offtake.

This example illustrates the value of the IAT as a communication tool to inform the dialogue between the operator (R, D and E agency staff) and farmer. It enables rapid analysis of the financial, resource and production impacts of livestock improvement strategies (identified by the farmer) and their sensitivity to key climate, soil, management and farm design variables. Less desirable strategies can be readily identified and discarded, leaving a shortlist of best-bet options that can then be assessed in the field by participating farmers. This provides a degree of confidence to both project staff and farmers that the actions they are about to undertake are unlikely to have an adverse effect. Furthermore, this screening enables a more efficient and targeted use of limited project resources. By being able to view the potential results of change prior to implementation, farmers commented that the modelling provided substantial motivation to participate further in the project.

The complexity of the smallholder farming systems in eastern Indonesia means that it is not possible to model all the component processes and associated interactions within it. A balance needs to be reached between the level of detail, the precision required, the model's flexibility and the input data requirements (Thornton and Herrero 2001). For example, the range of crop and forage genotypes able to be simulated mechanistically by APSIM (and included in the IAT database) does not cover the full range of genotypes currently occurring on-farm.

Furthermore, only some of the best-bet forage genotypes recommended for introduction are covered by APSIM. Consequently, simple, empirical models have been incorporated into the IAT to cover a number of the more important genotypes (e.g. tree legume). For other genotypes, the operator must choose a surrogate or 'like' genotype from those that are available and interpret the results accordingly. Furthermore, the crop and forage component models assume that production is not constrained by biological factors (e.g. insects, diseases, weed competition), micro-nutrient deficiencies, weed competition or other atypical/extreme events (e.g. waterlogging, storm damage). Similarly, the livestock models assume that growth is not constrained by parasites or other ailments. Some of these assumptions will break down under the low-input management practices and extreme climatic conditions that prevail in these regions.

Each of the component biophysical models that sit behind the IAT have been individually validated across a range of independent datasets. It is much harder to validate the performance of the integrated model against household data for all the reasons outlined above. The real power of the IAT lies in being able to compare the production, economic and social consequences of different scenarios and the tradeoffs between crop and forage/cattle production, where the difference between scenarios is typically more informative than the output for each individual scenario.

Part 3: On-farm testing of best-bet strategies

Uptake of best-bet strategies by best-bet farmers

A total of 142 best-bet options relating to forage and cattle management were identified for the 40 best-bet farmers. Of these, 85 were implemented by farmers during the period from November 2005 to February 2008. Only one of the 40 starting farmers dropped out of the project (Pak Nunding, Lompo Tenggah). One new farmer joined the project in mid 2006 (Ramli, SPA).

In the first season, best-bet activities focussed on forage related interventions for the following reasons:

- Forage supply and quality issues were often the major or most immediate constraint to improved cattle production

- In order to introduce farmers to animal management related best-bets such as early weaning, farmers needed to have a reliable source of high quality forage
- There is benefit in an incremental approach whereby farmers gain confidence and trust through tangible success with forage strategies (modest in size) before trying animal management strategies which require long-term planning and investment.

Figure 11 summarises the type, occurrence and status of best-bet activities across all sites based on exit interviews conducted in February 2008 (and other project records).

Note: The exit interview results shown in this section are based on the results from all sites. This is done to simplify the presentation but also reflects the high degree of response uniformity across all of the villages.

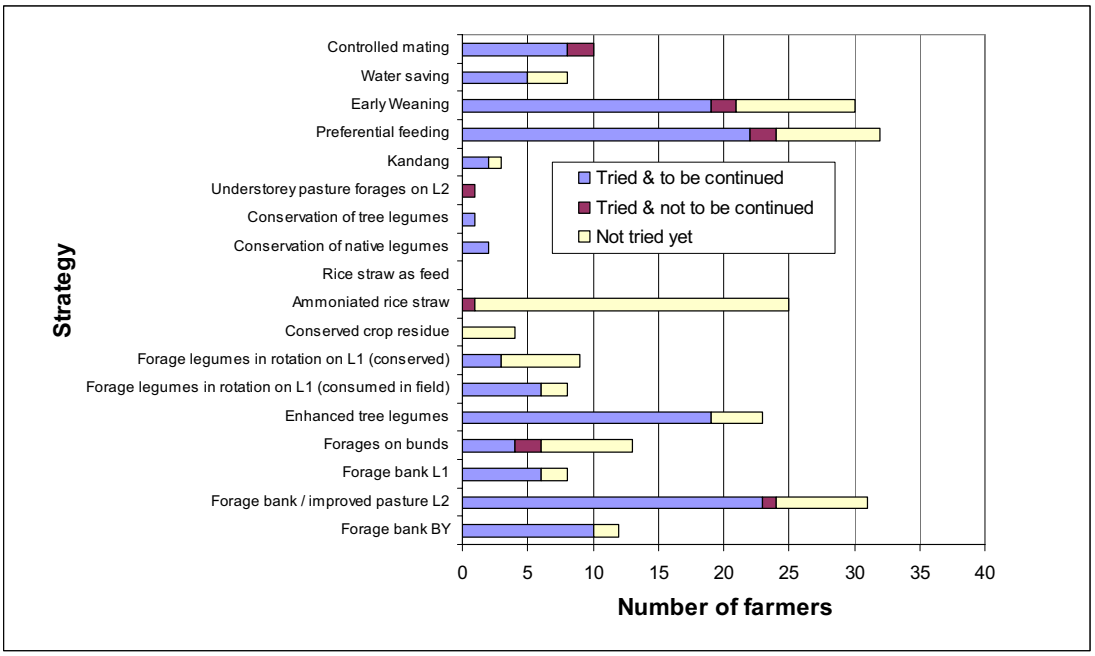


Figure 11. Application outcome for 'best-best' activities - all sites.

On the whole, the main forage improvement practices of establishing forage banks and tree legumes (or enhancing existing plantings in the case of tree legumes) were either successfully pursued by the majority of the households, were already being trialled to some extent, or would be in the coming season. Relatively few of the households reported having tried these particular practices and made a definite decision to abandon them in the future. Interest in Gliricidia was generally much greater in the NTB villages of Mertak and SPA compared to the Sulsel villages of Barru and Lemoa / Manyampa, due to the pre-existing familiarity with tree legumes (especially Gliricidia) in the former region.

Only a small number of households had undertaken any form of conservation of forages or crop residues, preferring to use the material when it was available in the field immediately after harvest, or to burn it. Rice straw ammoniation was trialled by just two farmers but is not to be continued due to the logistical difficulty in carting and storing bulky rice straw at peak labour times in the cropping cycle, and the perception that returns are better from other forage improvement options such as standing forage banks of elephant grass, tree legumes and / or new forages. A relative reluctance by local project colleagues to promote crop residue conservation in preference to new forage introduction also contributed to lack of adoption. A similar situation applied to promotion of Gliricidia use within Sulsel study villages, which again resulted in lower than anticipated uptake of a highly successful and valuable NTB forage technology there. Continued education and demonstration of impact to farmers and agency staff is required to address this in the follow-up scale-out projects.

Of the three main cattle management practices of controlled mating, early weaning and preferential feeding, only the latter two practices had been applied by more than half the households (Figure 11). Nevertheless, most of the remaining households recognised the claimed benefit of both practices and intended to employ them in the coming season or when they at least had a calf to warrant it.

The timing and extent of farmer uptake of early weaning / preferential feeding is dependent on the availability of calves and (simultaneously) high quality forage. While these options were identified in the original farmer interviews and canvassed with all best-bet farmers throughout the course of the best-bet program, they were mostly tackled once forage constraints had been addressed in line with the step-wise approach described earlier. This mainly occurred in the second wet season when calves of around 6-7 months age and high quality forage were both available.

Less than one quarter of the households had practiced controlled mating of their cattle, the majority of whom had achieved this independent of the project - failure to do so was largely due to inability to confine cattle or difficulties in finding suitable bulls at the appropriate mating time. The highest rate of adoption of improved cattle management strategies was in SPA. With the exception of Pattappa, at least some best-bet farmers in each study village had commenced some form of controlled mating by February 2008.

All best-bet households at SPA constructed a trough for recycling grey water in the dry season and had used it successfully during the course of the project. While attribution of this uptake to the current project is somewhat confounded by the fact that at least one of the best-bet farmers was recycling grey water prior to the project commencing, the approach was actively encouraged during the workshop and through the provision of cement to some of the best-bet farmers. Cement was also provided to each of the best-bet households in Desa Mertak, but no structures had been erected at the time of the exit interviews. This was due to problems obtaining suitable local sand for concrete.

For many of the best-bet farmers, the list of activities identified as having been undertaken at the end of the project differed to some extent from the initial farm specific recommendations. Farmers were influenced and motivated not only by the actions of the project team but by interactions with other farmers (via field days and less formal interactions) and the legacy of previous ACIAR projects. Hence, while most farmers adopted the initial best-bet strategies, there were some deviations over the course of the project. All best-bet farmers that attended field days at one of the other established sites commented that these visits were important in terms of providing both knowledge, ideas and motivation (and in many cases planting material!).

Forage production

Since the commencement of the best-bet program, many farmers have significantly expanded their original forage introduction best-bet areas. For example, Amaq Warni (SPA) plans to plant up to 1 ha of new grasses and legumes in his upland and re-locate all of his cattle operations to that site; Bella (Lemoa) has more than doubled his forage area under cashews from 0.2 to 0.5ha; Saiful (Lemoa) and Jufri (Lompo Tenggah) are developing significant new areas of forages in their upland; and Amaq Adul (Mertak) plans to double his stylo/grass/Gliricidia hedge grazing and cut and carry system in 2008. Of all the new forages trialled in the best-bet program, by far the most successful have been: new cultivars of *Brachiaria* X cv Mulato and *Panicum maximum* cv Simuang, both introduced via Peter Horne in 2007; *Paspalum atratum* which was originally introduced to Mahmud's land at Lompo Tenggah and *Clitoria ternatea* cv Milgarra. Verano stylo has been successful, particularly in NTB while *Stylosanthes guyanensis* CIAT 184 has worked well in the Sulsel locations.

Many farmers have also expanded plantings of pre-existing elephant grass and Gliricidia. For example, Sudding (Harapan) now has 1ha of elephant grass in addition to an area of new forages; Mahmud (Lompo Tenggah) has planted 600m of Gliricidia hedges for

forage; and Amaq Ahyar, Amaq Saekoni and Mamiq Anti of SPA have planted up to 1km of additional Gliricidia fences over the course of this project.

Farmer education on proper management of forage legumes to encourage tillering and ensure sufficient seed for regeneration remains a major challenge for such forage oriented best-bet programs. The same applies to education regarding forage grass cutting and fertiliser management. The challenge is to get farmers to see forage banks as a crop and to manage for optimum forage leaf production. When this happens, as in the case of Jufri (Lompo Tenggah), real breakthroughs can be made in the sustainability of quality forage production and improved animal nutrition.

Cattle production

Responses from exit interviews showed a strong level of agreement among roughly one quarter to two thirds of the households that the strategies employed during the project were already leading to improved cattle productivity (Figure 12).

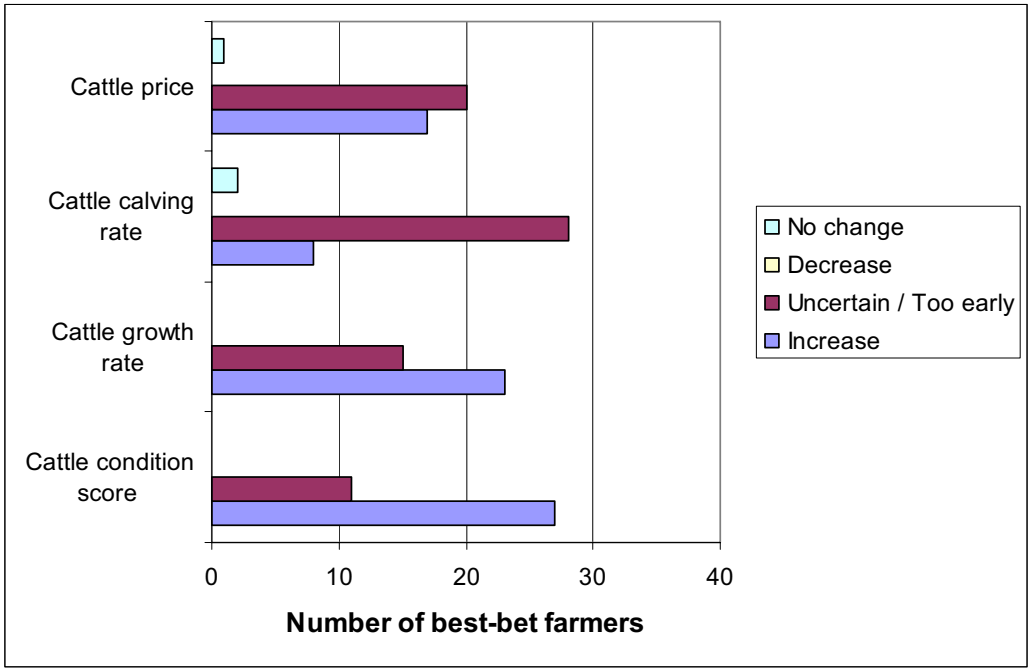


Figure 12. Impact on cattle from best-best practices - all sites.

The view that availability of forages was already having an effect on animal performance was particularly strong when considering the body condition of all classes of animals and the growth rate of young cattle. While less than one quarter of the households thought there had been an improvement in reproductive performance of their cows, almost half were sure that their cattle were now much more valuable than those of similar age and sex owned by other households in their communities, margins in the order of 33-50% being commonly suggested. Nevertheless, a significant number of households were uncertain as to whether there was any difference in animal performance or still thought it was too early to be definite - particularly with respect to calving performance and cattle prices.

Isolating the specific impact of individual best-bet activities through the on-farm monitoring activities is difficult, especially in the early stages of the new forage introductions where the contribution to total forage supply is often relatively small, and farmers often chose to save their forage banks for late dry season cut and carry use or as planting material. The difficulty is compounded by the relatively infrequent monitoring intervals. As these were mere snapshots of forage use at that time, they occasionally missed the feeding of smaller areas of new forages.

Furthermore, the utility of cattle monitoring data for assessing impacts arising from individual farmer best-bet activities is often compromised by the small numbers of stock involved and relatively short turnover times for some classes of animals, especially young males, which are sold off to meet planned or unplanned household cash needs or share farmed out to other farmers. Nevertheless there were many examples where the individual or combined impacts of a farmer's best-bet activities led to measurable improvements in both forage supply and cattle condition.

In SPA, the widespread adoption of tree legumes which was instigated by the precursor AS2/2000/2005 project (Figure 13a) provided the platform for rapid adoption of improved livestock reproduction and feed management strategies and has resulted in significant gains in late dry season cattle liveweight in that village (Figure 13b).

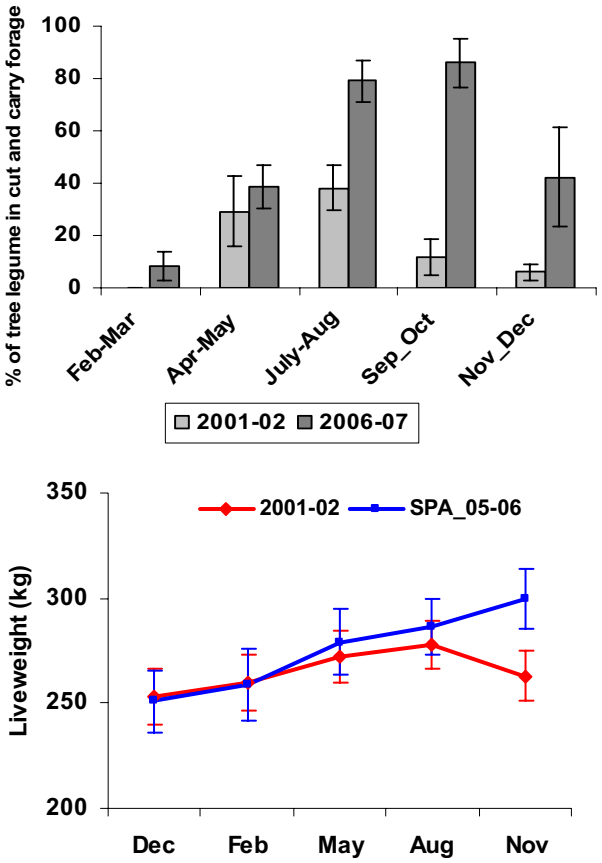


Figure 13 a) Comparison of tree legume fraction of cut and carry diet of Bali cattle at SPA village, Sumbawa between 2001-02 and 2005-06. b) Comparison of Bali cow liveweight trends at SPA village for 2001-02 and 2006-07. Data are mean liveweight and standard errors.

In Lompo Tenggah, Jufri established a 0.05ha forage bank of Clitoria ternatea, Setaria sphacelata, Gliricidia sepium and later Paspalum atratum which provided up to 40 % of fresh forage requirements for three yearling male cattle for most of 2006 and resulted in improved growth rates relative to other Lompo Tenggah farmers (Figure 14). Jufri's cattle grew at twice the rate (0.30kg/hd/day) of the Lompo Tenggah average of 0.14kg/hd/day.

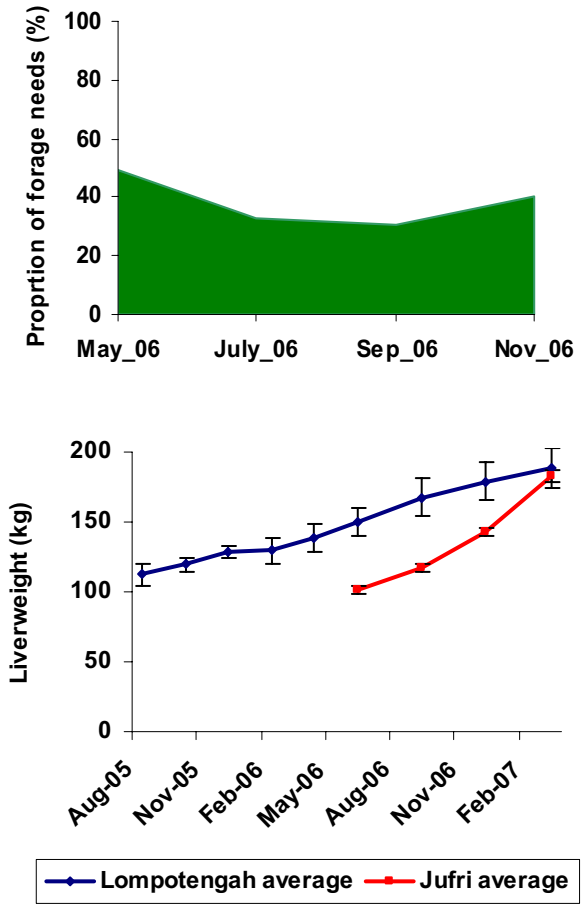


Figure 14 a) Proportion of cut and carry forage dry matter requirements supplied from Jufri's 0.05ha forage bank for 3 yearling male cattle during 2006 (assuming a daily dry matter requirement of 3% of body weight for maintenance and growth). Forage was a mixture of Clitoria ternatea, Centrosema pascuorum and Paspalum atratum and Setaria sphacelata which contributed around 17000kg/ha dry matter during 2006-07 or around 850kg dry matter from the 0.05ha forage bank. b) Comparison between growth rates of Jufri's yearling male cattle fed from his forage bank and average growth rates for similar young male Bali cattle at Lompo Tenggah during 2006-07.

At Harapan, the liveweight gain of La Matta's cows and young males exceeded the average gains across the other best-bet farmers within the village. This is attributed to the combined effect of new forage banks, better management of existing elephant grass to maximise leaf production and improved feeding management (Figure 15)

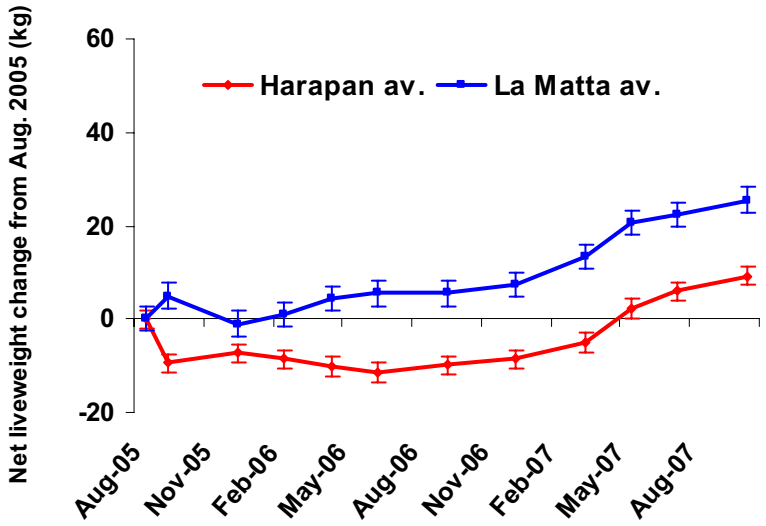


Figure 15. Net liveweight change comparison August 2005 to August 2007 between La Matta's cows and the average across the other best-bet farmers at Harapan, Sulsel.

At SPA, the relative performance of young male cattle belonging to Amaq Ahyar was better than the average across all other SPA best-bet farmers, due to the combined impacts of better management of tree legumes to optimise green leaf production, conservation and feeding of legume crop residues and newly introduced forages, early weaning and preferential feeding of young males in a backyard kandang (Figure 16).

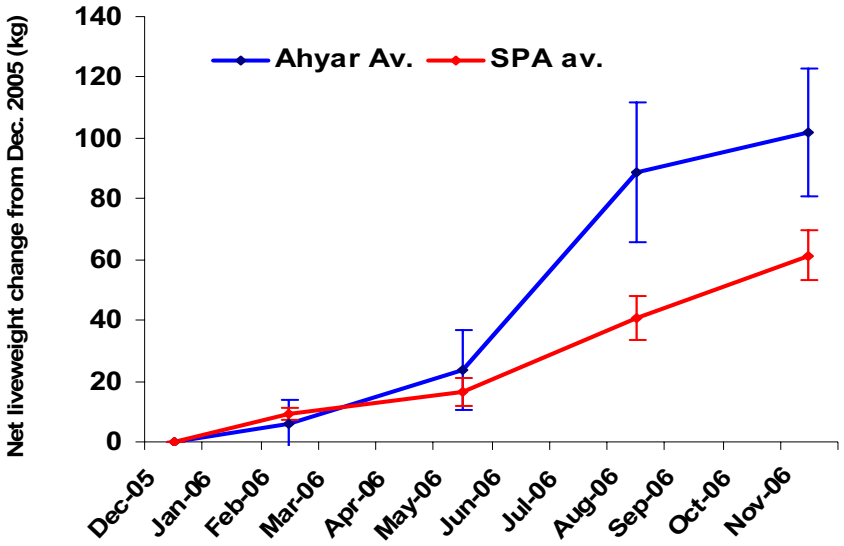


Figure 16. Net liveweight change comparison from Dec. 2005 to Nov. 2006 between Amaq Ahyar's young male cattle and the average across the other best-bet farmers at SPA, Sumbawa

Many of the best-bet farmers at Mertak had a best-bet strategy relating to the greater cultivation, utilisation and management of tree legumes as a source of high quality feed that persists through the dry season. Forage monitoring results show a sharp increase in the use of Gliricidia (previously under-utilised) from September 2006 (Figure 17), and the corresponding partial replacement of off-farm feed sources (i.e. trucked crop residues from outside the village (Figure 18). This uptake is attributable to the farmer workshop and SPA visit in July and October 2006, respectively. The Mertak farmers recognised the much better condition and size of cattle at SPA attributable to the improved utilisation of

Gliricidia (Figure 19). The decline in use in the second half of 2007 is attributable to reduced availability due to severe drought conditions and extensive harvesting during the preceding early to middle dry seasons.

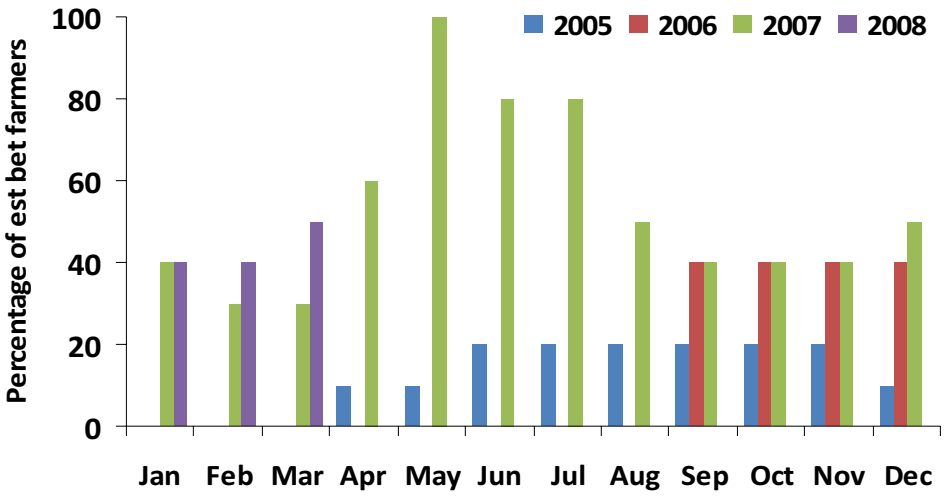


Figure 17. Percentage of best-bet farmers using Gliricidia sepium for cut and carry forage from 2005-2008 at Mertak, Lombok.

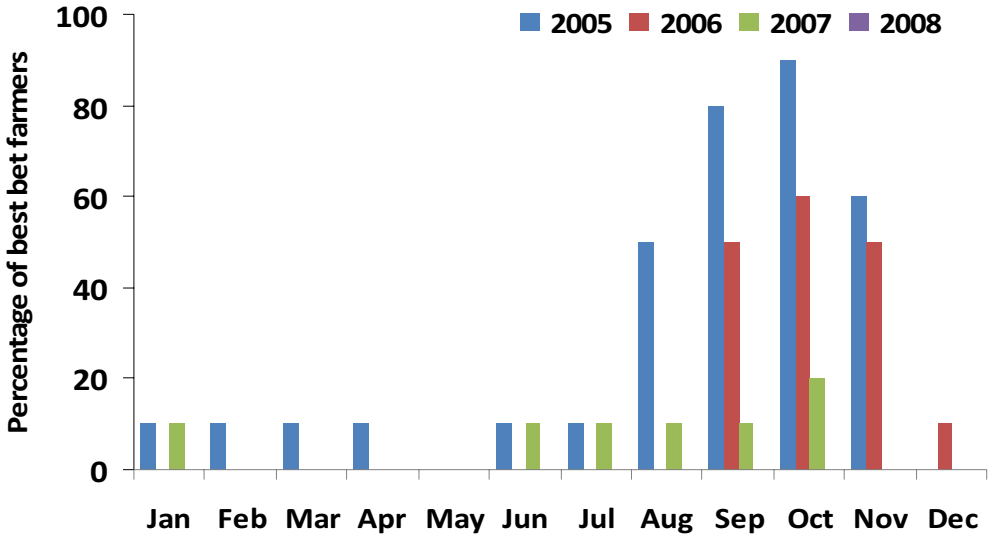


Figure 18. Percentage of best-bet farmers using cut and carry forage sourced off-farm Mertak, Lombok 2005-2008.

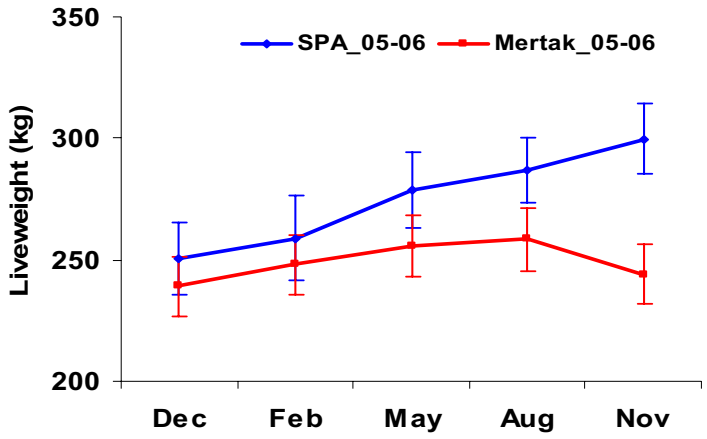


Figure 19. Comparison between SPA and Mertak seasonal liveweight trends for cows during 2005-06. Note that Mertak cow liveweights trend down in mid-late dry season, as they did at SPA prior to adoption of tree legume forage technology.

While the impact of changes in feed supply and usage is yet to show through in liveweight trends at Mertak (Figure 20), farmers did report a general improvement in cattle coat condition and wellbeing, which often precedes liveweight change. However, Figure 20 shows that the greater severity of drought in 2007 did not lead to the expected decline in performance compared to 2006.

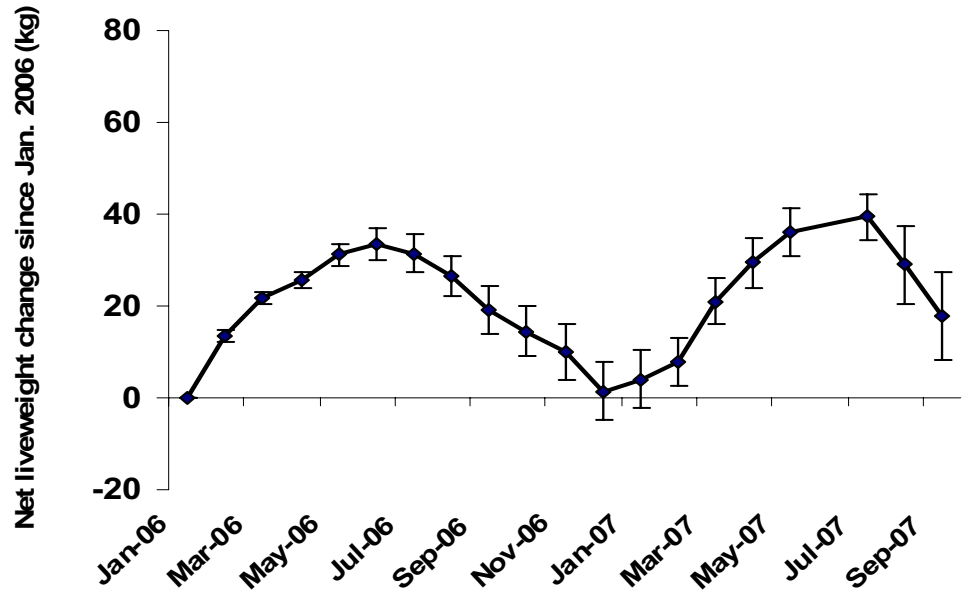


Figure 20. Seasonal trends in mean net liveweight change (with standard errors) since January 2006 for best-bet farmer cows.

While these examples indicate improvement in the performance of both cow and young male Bali cattle over the course of this project, the measured growth rates are still fairly poor at between 0.15 and 0.25 kg/head/day for young males. Exceptions to this are Jufri and Amaq Ahyar's kandang-fed young cattle at Lompo Tenggah and SPA respectively, which grew at around 0.4kg/head/day for several months during 2006-2007 until sold. Much of this constraint to optimal liveweight performance is tied up with the quantity and quality of forage fed to livestock, even when the availability of forage is adequate. Figure 21 shows the substantial variation in average cut and carry forage dry matter supplied per

adult animal equivalent (AAE) by best-bet farmers in the more 'mature' villages of SPA, Harapan, Lompo Tenggah and Pattappa (August 2005-February 2008). The broken line indicates the amount of dry matter required by a 250 kg Bali cattle for maintenance and growth based on 3% of body weight.

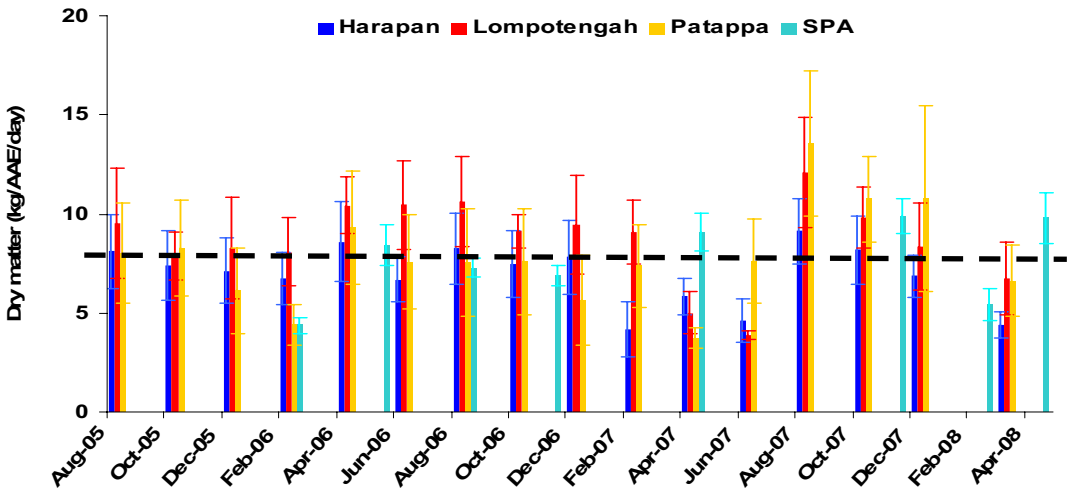


Figure 21. Seasonal trends in the amount of cut and carry dry matter offered per adult animal equivalent (AAE) per day in the older study villages of Harapan, Lompo Tenggah and Patappa (Barru, Sulawesi) and SPA (Sumbawa) between August 2005 and February 2008. Data are the mean of all best-bet farmers in each village. The dashed line represents the daily dry matter requirement for a 250kg Bali cow for maintenance and growth based on 3% of body weight (i.e. 7.5kg/head/day).

While the figure indicates considerable variability across the villages, the average amount of dry matter offered falls below recommended maintenance levels in many instances. While grazing is the source of significant forage requirements for some farmers, cut and carry forage supplies the bulk of quality forage for many farmers, especially in the dry season. This indicates that there is still considerable room for improvement in cattle performance and forage supply and a need for further farmer education in the relationship between Bali cattle nutritional requirement and forage supply and quality.

Crop production

Results from the exit interviews show that only 6 of the 39 best-bet households had actually decreased the area planted to food and cash crops, while another 2 households had made some direct change to the mix of cropping activities in their farming systems (Figure 22). Most of this small group had actually made a significant commitment to planting forages on their available land. None of the 39 households suggested that their present commitment to trialling forages and livestock had any adverse impact on the performance of their cropping activities, and a small number reported an improvement in their crop yields. The cases of increased crop areas and/or improved yields appear to have been facilitated by labour savings in cut and carry tasks resulting from more ready access to forage sources closer to their house yards (see labour section).

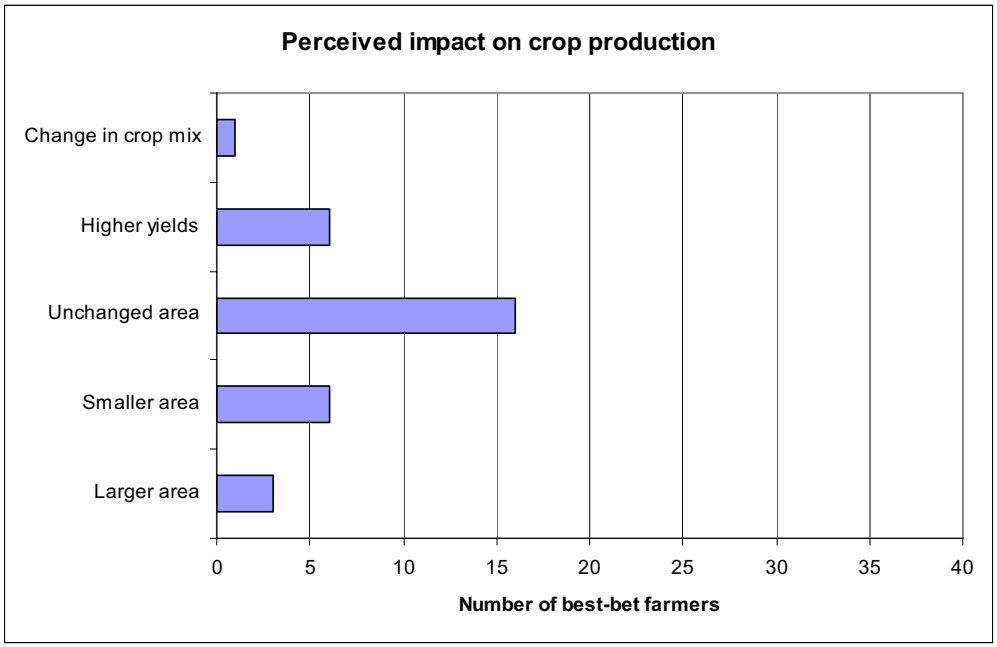


Figure 22. Impact on crop activities from best-bet practices - all sites.

Labour

Sourcing forages and water for livestock is typically a time-consuming activity for smallholder households, particularly in the dry season when forage availability becomes particularly limited. Therefore, the impact of trialling the forages and animal husbandry practices on household labour demands was of particular interest to the project - presented in Figure 23.

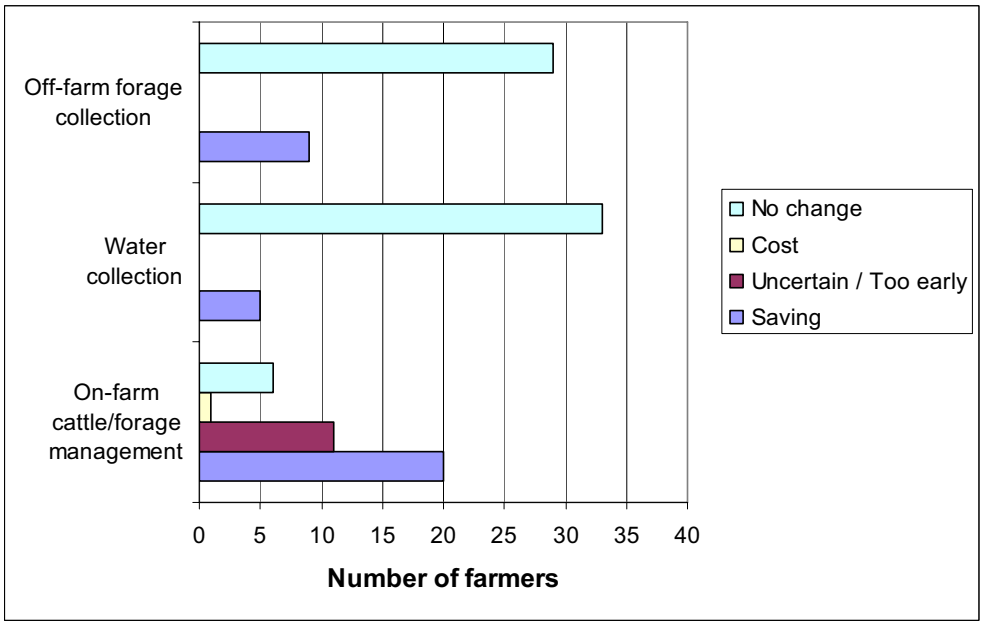


Figure 23. Impact on labour activities from best-bet practices - all sites.

With respect to sourcing forages from beyond the boundaries of the immediate community, the majority of households reported no change in the labour in this task. The 9 households that did experience a saving in labour used to source forages from outside their local community were all from SPA and Mertak (representing most of the best-bet households). These are particularly dry locations, for which hiring trucks to collect residues and straws from other regions several times during the dry season, was

previously a common and expensive practice. In most cases, this activity and its associated financial cost had been entirely eliminated (later section).

While the project recommended using household grey water, the majority of households also reported no change in labour committed to procuring water for their livestock. The 5 households that did report a saving in labour allocated to this task were all from SPA kampung which had previously been a recipient community for GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) sponsored rainwater tanks and in which several of the best-bet households had successfully trialled grey water recycling. The households in Mertak were keen to trial grey water recycling, but had encountered delays in procuring cement to construct troughs prior to the last dry season and, at the time of interview, also reported difficulties in locally obtaining suitable sand for making concrete.

By far the largest impact on labour relates to on-farm labour use for both forage and cattle management where almost half the households reported definite labour savings, and one quarter were uncertain about the impact to date. For the former group, the actual savings in household labour were quite significant with most households (not shown) reporting that previous practices had involved 1-2 family members spending 6-8 hours per day for most of the dry season (either supervising cattle grazing away from their house yards or undertaking cut and carry or cut and drop activities). Only 1-2 hours per day was now spent on feeding and managing cattle. The majority of households who felt that it was too early to determine if there was any labour saving had also only planted relatively small areas of forages. Most of this group intended to expand their forage areas (later sub-section) in the coming seasons and anticipated similar savings.

A specific example of labour saving in relation to on-farm cattle and forage activities from Lemoa / Manyampa is shown in Figure 24. Prior to the best-bet program and the visit to the Barru field day, most Lemoa and Manyampa farmers relied almost exclusively on free or tethered grazing for forage supply and did little cut and carry, due to a perception that it was more labour demanding. Subsequent forage and socio-economic monitoring showed a sharp increase in the uptake of cut and carry and a reduction in grazing activity. In many cases this resulted in a reduction in labour required for livestock management in those villages.

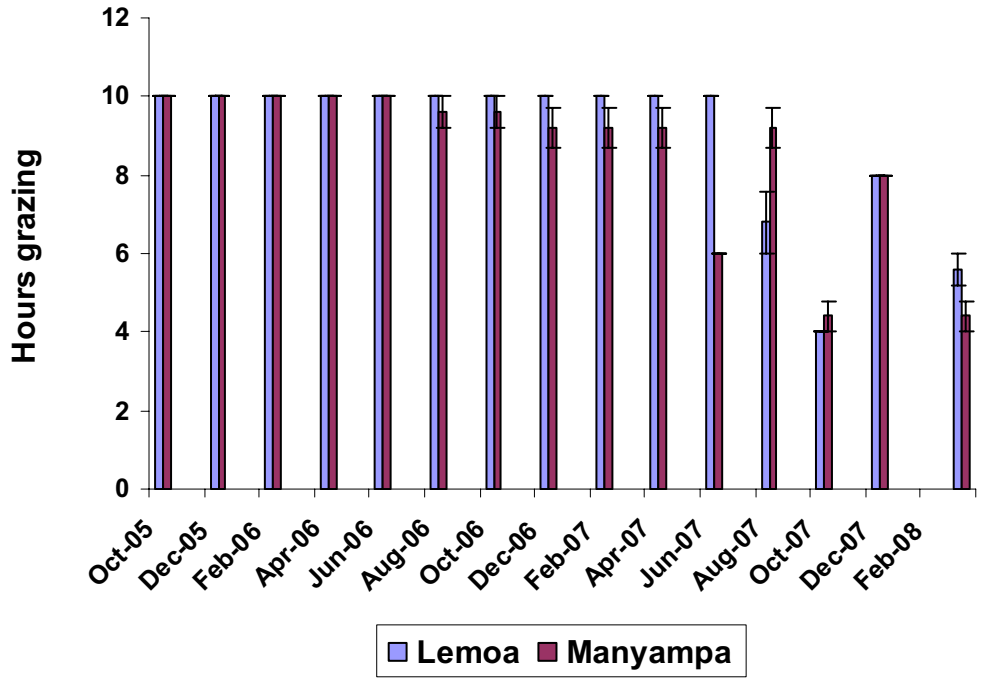


Figure 24. Trends in the average number of hours spent grazing each day by animals on best-bet farms at Lemoa and Manyampa sub villages, Gowa, Sulawesi. Note that forage best-bet activities commenced in wet season 2006-07 but only started to contribute significant cut and carry forage from April 2007, which coincides with a drop in the number of hours animals spent grazing. Data are means and standard errors. Note: the maximum hours recorded in these surveys was 10 per day. Actual hours may have exceeded 10 at times.

The use of freed up labour, for those households that reported labour savings, to support other farm and non-farm activities is presented in Figure 25 (from exit interviews).

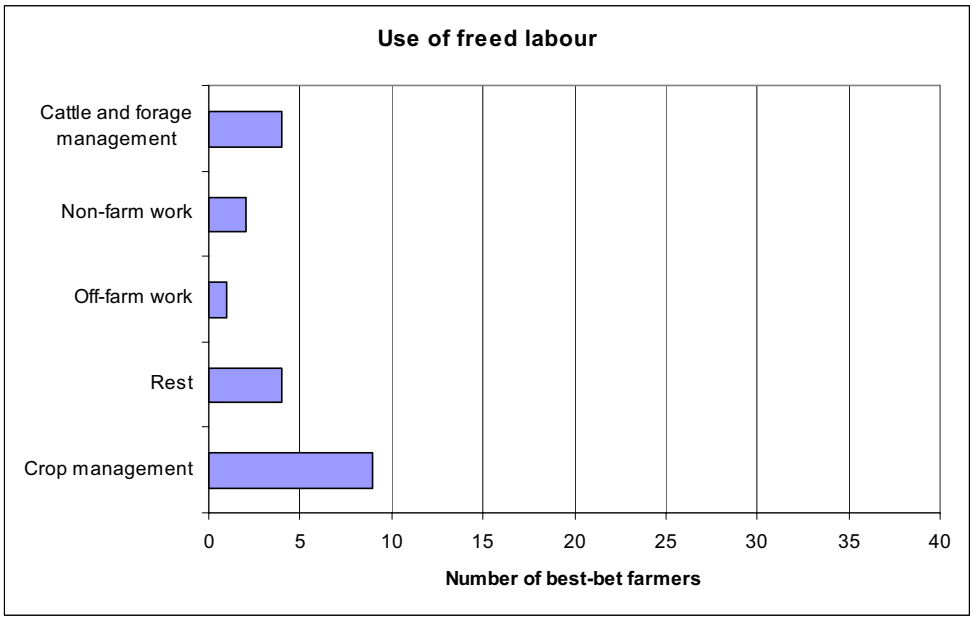


Figure 25. Activities to which labour freed up from previous forage and cattle management tasks was directed - households reporting labour savings.

Consistent with the previous observation that crop areas and, to a lesser extent crop yields, had increased or were unaffected by the best-bet practice changes for many of the households, most of the households reporting freed up labour allocated extra labour to

crop management tasks. About half that number used the freed up labour to further intensify their forage and cattle management practices and the remainder used it to support either non-farm or off-farm employment activities or simply to rest.

Household finances

Beyond the gains revealed in labour, crop and animal productivity for many households, an important consideration is whether or not the forage and livestock practices being trialled by the best-bet households are actually making them financially better off. Some indicators of this project impact are presented in Figure 26.

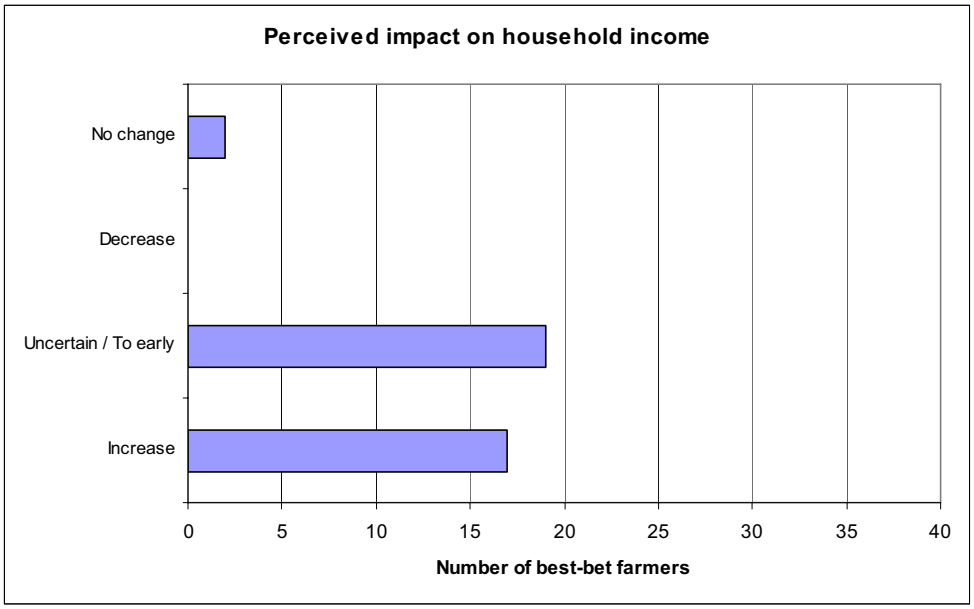


Figure 26. Impact on family income from best-bet practices - all sites.

None of the best-bet households reported having their income decrease as a direct result of trialling the forages and livestock management practices, and only 2 households were definite about there having been no change so far. The majority of households either had already experienced an increase in their income or were not yet in a position to respond positively.

Basically, the bulk of the income gain, where this was recorded was the result of producing additional cattle which to the time of interview had already been sold. Most of the households that were uncertain or felt it too early to report financial success either had more cattle on hand already (e.g. live calves) or had pregnant cows, but had not actually sold any more cattle yet. As many households had reported that their cattle were growing faster or were in much better condition than previously (Figure 12), there was a clear expectation that they would enjoy higher incomes in the future with the cattle being sold.

Many of the households who recorded increased incomes were reluctant to specifically state how much additional income had been generated from the livestock sales. However, the estimates that were provided were of the order of 50%-300% gain with young animals fetching around Rp 2-3million and typically involved selling 1-2 extra animals per year.

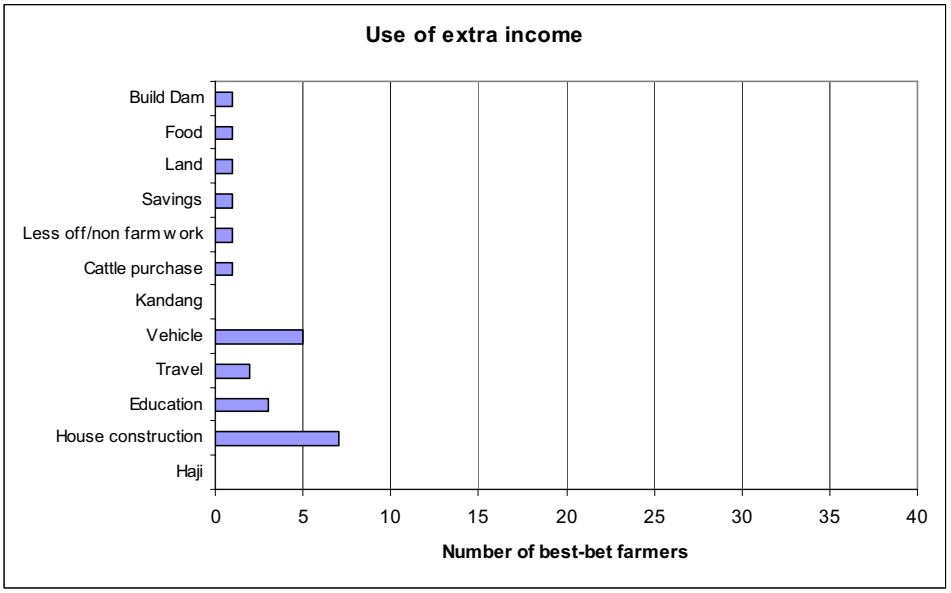


Figure 27. Uses to which any additional income had been put - all sites.

Having determined that the practices had already brought some financial benefit, or promised such. how this additional income might have been used was also of interest (Figure 27). Smallholder households in eastern Indonesia are generally not active participants in any formal market economy and cash outlays are frequently restricted to a narrow range of major and infrequent expenses and, to a lesser extent, small necessities to supplement their more dominant subsistence production and consumption activities (e.g. condiments, paraffin, fuel, herbicides etc).

Much of the additional income from cattle sales was used to acquire or improve major capital assets, particularly house construction and motor vehicles, and to a lesser extent purchase of land and more cattle. Education and travel were also financed by several of the households, mostly to support older children (school fees) and young adults (travel to distant work sites). While several households had previously constructed small kandangs to support their livestock activities, this was not a nominated use for any additional income. Also, while accumulation and sale of cattle are a long-recognised path to finance travel associated with religious aspirations (Haj) and several of the best-bet households were headed by community-respected Haji, none of the households had as yet used their additional incomes for this particular purpose.

Future intentions

As the exit interviews were conducted at a relatively early stage in the adoption cycle of new practices, the best-bet households were asked several questions relating to the future plans and aspirations for their farming enterprise (Figure 28), as well as the level of interest in what they had been doing by other households (Figures 29 and 30).

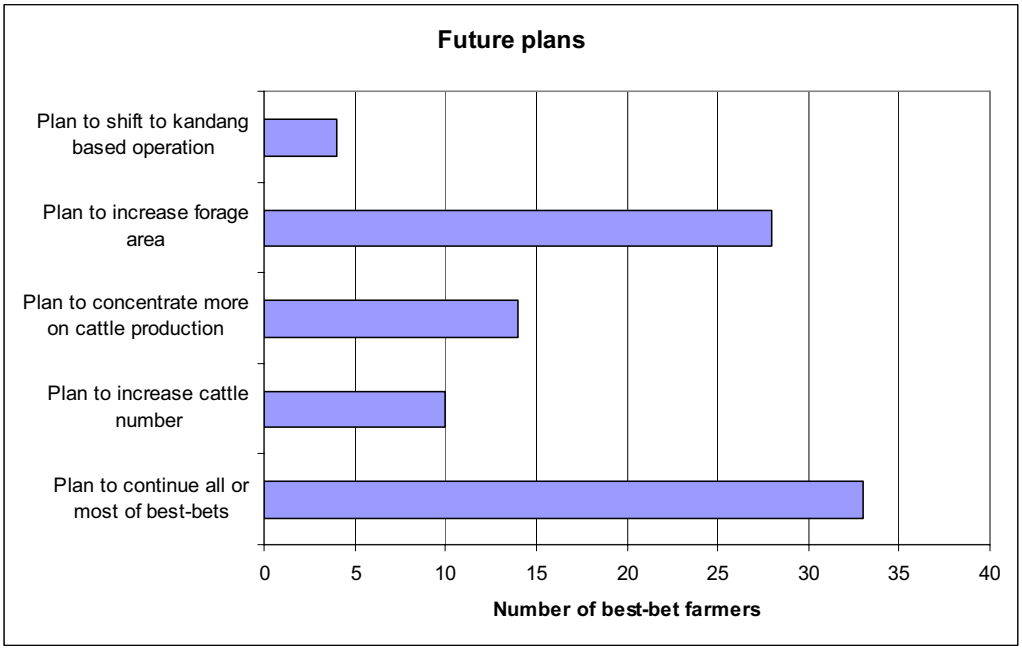


Figure 28. Future intentions with respect to employment of forage and livestock management practices - all sites.

The majority of households were planning to continue to employ most, if not all, of the best-bet practices that had been introduced to them by the project team. While a couple of households asserted that they would not employ any or most of the practices in the future, most of those who were not definitely proposing to continue remained uncertain about their future plans. Of the practices that would proceed in the future, increasing forage areas was predominant with a lesser commitment to either running more cattle or becoming increasingly specialised in cattle production.

This order of priorities largely reflects the constraint that limited forage availability places on cattle raising and the fact that many of the best-bet households have still only relatively small areas of forages established to date. It also reflects the fact that many of the households already have more cattle than they can realistically feed and 'more cattle' is synonymous with 'poor cattle' until the feed restraint has been addressed. Four of the households were planning to concentrate on a kandang-based feeding system in which animals would be held in specialist enclosures and fed entirely on forages grown elsewhere on the owners' land and cut and carried to those animals.

Interest from other farmers / scaleout

Beyond a major role in trialling and refining their best-bet practices, the participating households were also seen to represent important platforms for extending the practices to other households as part of the natural technology diffusion process. The households were asked about the interest shown in what they were doing by other households in the community (Figure 29).

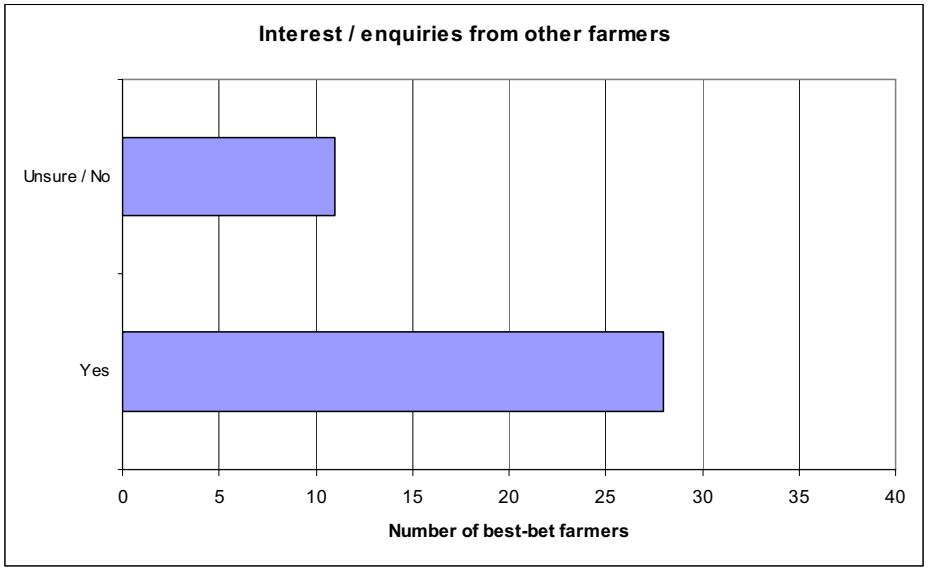


Figure 29. Interest shown in best-bet involvement by other households - all sites.

The majority of best-bet households interviewed had fielded some inquiries from other households about their involvement in the project or about some particular aspect of the practices that they had been trialling. Results from the exit interviews (and from records kept by individual farmers) indicate significant interest from other farmers in best-bet activities. The number of inquiries was generally higher at the more mature sites of SPA (~130) and Barru (~120) compared to Lemoa / Manyampa (~17) and Mertak (~10).

A comprehensive assessment of the geographic extent and nature of scaleout of best-bet technologies is beyond the scope of this project but a separate comprehensive study is planned for the second half of 2008 (with follow-up surveys to be performed later). A preliminary survey of 15 known scaleout farmers in the immediate vicinity of Lompo Tenggah conducted in April 2008, showed that ~80% of these farmers had implemented forage improvement technologies such as new forage introductions (sourced from the original best-bet farmers) and forage conservation; with more than 50% having trialled preferential feeding and kandang based feeding. All farmers interviewed commented that there had been a positive effect on cattle condition. Most plan to continue some or all of the activities into the future.

The nature of the interest shown by the inquiring households was heavily skewed towards establishing forages (Figure 30). Most of the household to household inquiries related directly to requests for access to cuttings and seeds of various forage species - often after the inquiring household had participated in a field day or been told about forages by other households who either were growing forages or had also participated in a field day or workshop.

Advice on establishing and feeding forages, especially tree legumes, was also a major reason for some households to specifically seek out best-bet households. Topics relating to cattle management, other than feeding, were not common enquiries. While some interest was shown in early weaning practices (usually ‘why’ and ‘how’), this did not extend to controlled mating and preferential feeding practices which complement early weaning as a package.

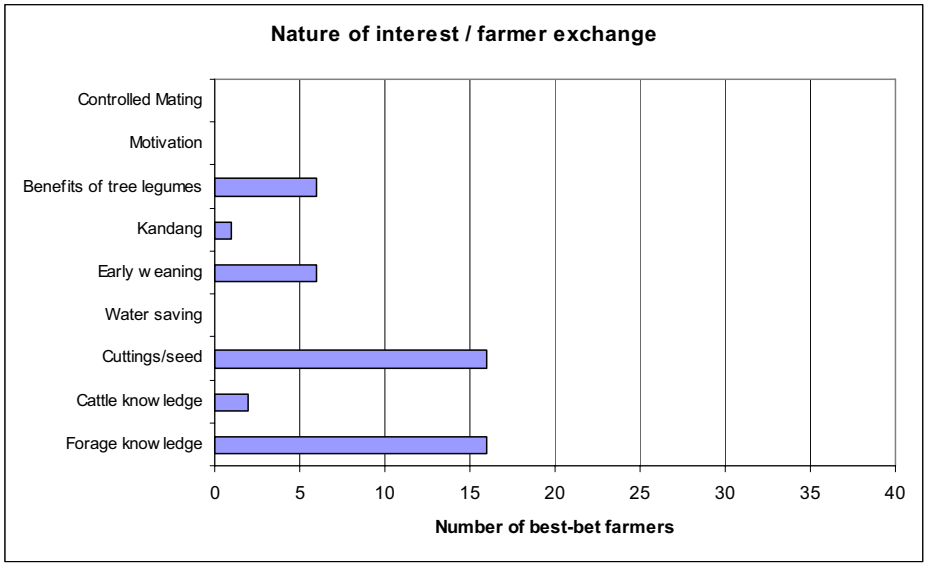


Figure 30. Nature of inquiries by other households - all sites.

Value of farmer workshop

The first major project-related activity that many of the best-bet households would have actively participated in were the series of workshops conducted in 2005 at which the project was discussed, local issues relating to livestock production canvassed and general options explored using the Integrated Analytical Tool (IAT). Not all of the households participated in those workshops, with only 45% of the present best-bet households having a member attend. The majority of best-bet farmers joined the project after they were held. While a good many of the households who had attended the workshops could not recall a great deal of what was specifically discussed, about a quarter of those who did attend recalled that it provided motivation and knowledge.

Value of field days

While there were many forms of interaction between the individual best-bet households and the project team on either an individual or a group basis through the life of the project, one other significant activity that was thought to have some scope for impact was the field days at Lompo Tenggah (Barru) and SPA (Sumbawa) in 2006. A key feature of these two exercises was that the field days did not just involve the immediate local communities, but also involved transporting household members from Lemoa / Manyampa (Gowa) to Lompo Tenggah and from Mertak to SPA.

Just over half of the best-bet households participated in one of the two field days. There was a more even spread of interest across both forage and cattle management topics. Of note is the interest in using tree legumes for forage which was particularly noted by the Mertak households who visited SPA where this practice largely underpinned the success of cattle raising activities by overcoming dry season feed shortages; and the use of kandangs for feeding cattle which featured at both sites.

A major impact of both field days on the participating farmers was the opportunity it provided to take forage materials (both cuttings and seed) to plant and trial on their own land - over and above the materials that the project was formally providing to each household.

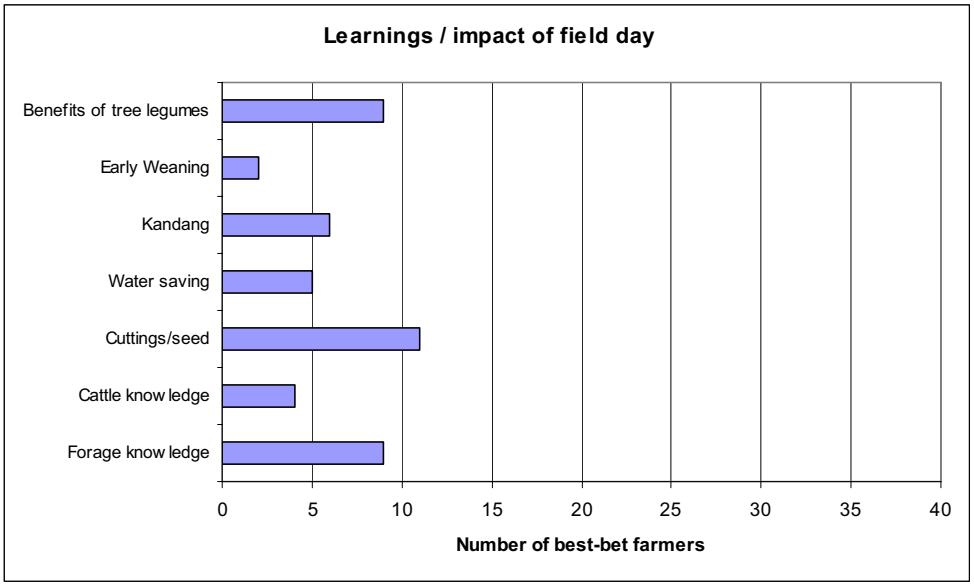


Figure 31. Useful learnings / impacts from field days - all sites.

Overall perspectives of project participation

On the question of lasting value from project exposure, with almost no exceptions, each of the participating households claimed during the exit interviews to have received something of value from the project and their experiences in trialling various aspects of the technologies and practices associated with the project. For example, bar 2 households whose heads claimed to be too old for future activity, all of the households were prepared to work with another project in the future. However, this participation was also conditional on a prior understanding of what the project would actually be about.

While rooted in apparent common sense, this proposition warrants reflection because many of the households had previously been exposed to aid projects that from their perspective promised something of immediate value but most often delivered little of lasting or tangible benefit. This was eloquently summed up by one householder who described most previous projects as being like 'pasar malam' (traditional night markets) - set up this afternoon and gone by tomorrow morning.

This ACIAR project was typically described as having delivered much of lasting benefit because it addressed problems of major significance, adapted solutions to individual capabilities and circumstances and, importantly, provided repetitive reinforcement and technical support. In terms of lasting value another householder said that the project technologies were now habit and like Suharto's original edict for Indonesia to become self-sufficient in rice production were now 'encultured' in his practice.

This positive attitude toward the project was also expressed in mid-project farmer interviews conducted in November 2006. The participating households who had already trialled the forage options for at least one growing season (Barru and SPA) reported high levels of satisfaction with the materials that they had been working with, even in cases where the progress and performance of the plantings had been disappointing to the project team. In these cases, there was a commonly expressed belief that the project (unlike many previous projects) was bringing genuine prosperity to their communities.

Several households in Barru actually reported a firm intention to abandon cropping activities within their farming systems altogether in order to specialise in growing forages for cattle raising and finishing activities. This was backed up with informal estimates of the net profitability of cattle being ~400% higher than subsistence and cash cropping if all of the produce to be sold and food for family consumption purchased from local sources. (Note: At the time of writing none of the households had entirely abandoned their food crops, highlighting the entrenched cultural value that may be placed on households

directly meeting their own food needs as a mark of farming proficiency and a right to hold community respect). Similarly, households (Mertak and Lemoa / Manyampa) just setting out to trial the various forage and cattle management options had a high level of belief that the outcomes would be good, even when faced with set-backs to their principal food crops (i.e. drought).

The basis of this optimism was largely underpinned by members of these households previously travelling to the villages which had already incorporated the forages into their farming systems as part of the previous APS/2004/124/125 projects in Barru and SPA, and personally seeing the results and/or engaging with the farmers there. In all cases, the interviewees expressed a strong belief that the forages would perform better in their own context either because they believed that their local resource endowment was much better than in the visited sites or because there was a large amount of forage materials (notably Gliricidia, and to a lesser extent Leucaena) already present in and around their villages from previous re-afforestation or development projects. The appropriate management of this resource material for livestock production had never previously been demonstrated to them.

Another insight from the mid–project farmer interviews was the belief expressed by several of the households at Lemoa / Manyampa (and the Kepala Dusun) that the wider establishment of improved forages would ultimately enhance social harmony by lessening the potential for inter-household conflicts over the limited forage supplies on communally held land (especially in the late dry season). Other interviews revealed a community belief that forage material, even when grown on land recognised as belonging to an individual household, was generally available to all community members unless it was enclosed by a secure fence. Once a secure perimeter was established (e.g. by planting a tree legume fence around the parcel), the exclusive ownership was generally respected - although some younger household heads noted that they had not yet earned sufficient respect to have their property rights entirely respected by some older community members.

In the exit interviews, several households quite honestly stated that they had originally participated in the hope of getting something free - especially cattle - and had initially become a bit disillusioned when nothing material was immediately forthcoming. However, they came to realise that the project was offering valuable opportunities and information to support real welfare gains for both themselves and their community, and had subsequently become very enthusiastic about their participation - reinforced particularly by a visit to another community (SPA) where the results were not only impressive, but were something that they quickly recognised could be accomplished for themselves.

This sense of project value was often described in terms of confidence and security (Figure 32). In fact, when asked what they thought the most important impact of the best-bet practices might have been on overall household welfare many households identified that they felt less vulnerable to the sorts of crises that had beset them in previous years. For example, when food and cash crops failures, or sudden illness of family members, had forced them to quickly liquidate their limited reserves of wealth under quite unfavourable circumstances.

Beyond seeing forages and cattle as being more capable of withstanding climatic shocks than crops, having access to increased numbers of cattle and the ability to feed them year around meant that they held security against such setbacks. Moreover, owning such collateral also meant they were sufficiently creditworthy to be able to access credit if it were needed on much more favourable terms than otherwise. Many households suggested that they were more confident to face the future because, not only were they more financially secure, they also felt that having overcome the hurdle of safeguarding their financial future through a major shift in their farming systems, they could apply similar problem-solving capabilities to tackle new challenges as such emerged.

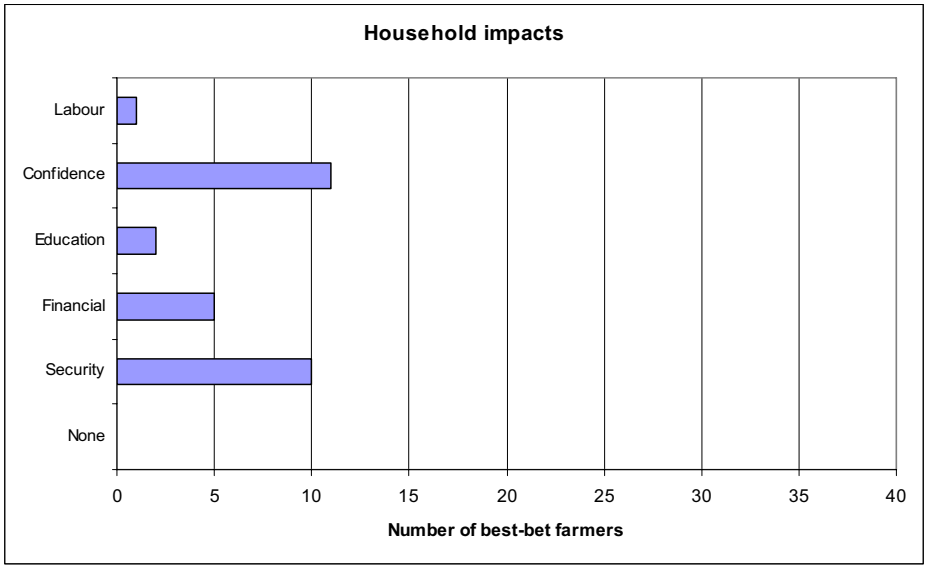


Figure 32. Overall impact of project participation on family welfare - all sites.

8 Impacts

8.1 Scientific impacts – now and in 5 years

This project (and its predecessors AS2/2000/124 & 125) has successfully developed and tested an approach combining the principles of participatory, on-farm engagement with farming system analysis and modelling, to encourage the uptake of technologies that improve the productivity and welfare of smallholder farmers.

While the specific focus in this project has been on livestock improvement for smallholder farmers in eastern Indonesia, the approach and tools are generic in nature and can be readily adapted for application in other environments and to address other farming systems issues.

Indeed, the success of this current project has led directly to the establishment of two new projects based in Sulsel (Building capacity in the knowledge and adoption of Bali cattle improvement technology in South Sulawesi, SMAR/2006/061) and Lombok (Scaling up herd management strategies in crop-livestock systems in Lombok, Indonesia, SMAR/2006/096). The objective of these projects is to expand in-country capacity in the approaches and tools developed in the 005/124/125 and related projects, and to then use that capacity to improve livestock production and household welfare in a large number of households across eastern Indonesia. These projects commenced in late 2007 and will run for at least 3 years. Consideration is currently being given to using these same approaches to improve livestock production in south-central Vietnam.

8.2 Capacity impacts – now and in 5 years

The capacity of project staff from BPTP, the Universities and Dinas to undertake the approaches and analysis outlined in this proposal commenced in the earlier AS/2000/124 & 125 projects and has been further enhanced over the course of this current project. Most of the learning/training has been of an informal nature via regular contact with the Australian project team. To enable this, one or more of the Australian team visited Indonesia every two to three months for up to two weeks at a time. Most of those visits were spent in the field, talking with farmers and discussing/ reviewing/adjusting techniques. At every possible opportunity, in-country project staff were encouraged to try themselves (i.e. learning by doing).

These informal approaches were complemented by more formal, targeted training in modelling, scientific writing, forage and cattle monitoring. Separate model training workshops were conducted at the University of Hasanuddin and Mataram University for project staff and other invited students and university staff. A more comprehensive training workshop was held toward the end of the project covering the broader principles of farming systems and participatory approaches. The latter workshop involved new staff from the new SMAR projects. The overall success of these capacity building activities is illustrated in a number of ways:

- The co-ordination and delivery of material and subsequent farmer engagement at the farmer workshops and field days was primarily performed by in-country project staff
- In-country staff successfully undertook many of the project activities in the absence of or with limited input from the Australian staff
- In-country staff played a lead role in delivering summaries of project activity at each of the sites at the project annual review meetings

- The same staff are now entrusted with providing the training for new on-ground staff in the two new SMAR projects (SMAR/2006/061 and SMAR/2006/096). It is hoped that at the end of the SMAR projects, these people will return to or be recruited by Dinas, BPTP and the Universities and continue to apply the techniques and skills developed during these projects
- Most of the in-country staff have presented project summaries at internal agency conferences and collaborated with Australian team members on the various journal and conference papers listed below.

Importantly, when directly canvassed about the impact of the project on themselves in two evaluation sessions (May 2005, 2007) the majority of the project team members identified growth in personal capacity as a major impact of their exposure to the project approach and constituent activities. This contrasts with a similar exercise conducted previously for project 124 & 125 in which a relatively high proportion of the teams reported some ambiguity in role understanding or personal contribution to project outcomes.

The results from the exit interviews clearly show substantial gains in forage and livestock management knowledge by participating farmers. Indeed, virtually all farmers nominated knowledge gain as the most important gain from the project. Many made the comment that the knowledge was now 'part of them' and that they had greater confidence to go forward, try other options and/or expand current activity. This increase in capacity was achieved through a combination of informal (e.g. conducting their own on-farm trials, discussions with other farmers and project staff) and more formal activities (e.g. village workshops and field trips).

8.3 Community impacts – now and in 5 years

The feedback from farmers and the results from the monitoring of field trials show quantifiable gains in forage and livestock production, labour savings and gains in household income over the life of the project. It is reasonable to expect that this will continue into the future as most farmers intend to continue (and in some cases expand) successful strategies beyond the life of the project. There is also evidence of significant adoption/adaption of the livestock improvement technologies by other (non-project) farmers. This is expected to extend further to other farmers.

There was some indication (notably Lemoa / Manyampa) that the use of forages in specialised plots was likely to increase community cohesion through less disputation over forage resources on communally used lands. There was also a high level of agreement in the exit interviews with the best-bet farmers that their successful participation in this project had given them confidence to seek solutions to other problems that were confronting their communities - not necessarily relating to forages or cattle management.

8.3.1 Economic impacts

For full details see Results and Discussion.

During the exit interviews, many of the best-bet farmers reported substantial savings regarding on-farm labour use for both forage and cattle management. Increased feed availability closer to home has particularly resulted in both labour and cost savings for SPA and Mertak farmers who regularly trucked feed materials in from some distance during the dry season. Freed labour was primarily used to intensify cattle production and/or to increase crop production.

The majority of households have either experienced an increase in their income or are not yet in a position to respond with confidence - but expect this to be the outcome. The increase in income was typically attributed to the sale of additional cattle and the higher price obtained for those cattle. The magnitude of these income gains varied, but was in the order of 50%-300% higher than their existing incomes.

8.3.2 Social impacts

Each of the participating households (40 in total) claimed during the exit interviews to have received something of value from the project and their experiences in trialling various aspects of the technologies and practices associated with the project.

Many of the farmers commented that the main benefit from this project was knowledge and that they saw this as having more lasting impact than a 'handout' (e.g. bull). The project was typically described as having delivered much of lasting benefit because it addressed problems of major significance, adapted solutions to individual capabilities and circumstances and, importantly, provided repetitive reinforcement and technical support.

At Lemoa / Manyampa, (noted before) it was commented that the wider establishment of improved forages would ultimately enhance social harmony by lessening the potential for inter-household conflicts over the limited forage supplies on communally held land (especially in the late dry season).

Project value was often described in terms of confidence and security. Many farmers identified that they felt less vulnerable to the sorts of crises that had beset them in previous years. They also felt more confident to face the future because, not only were they more financially secure, they also felt that having overcome the hurdle of safeguarding their financial future through a major shift in their farming systems, they could apply similar problem-solving capabilities to tackle new challenges as they emerged.

8.3.3 Environmental impacts

While not the primary focus of the project, many of the strategies identified for improving livestock production may also have significant positive benefits for the environment. The addition of new forages and/or the improved use of existing forages will impacts on whole-of-farm nutrient cycling and hence production. For example the use of forage legumes and/or grasses (e.g. Arachis pintoi) under estate crops will provide additional nitrogen and/or improved weed control. On those farms where forages can be grown as relay crops, the forages have the potential to provide both additional soil nitrogen and organic matter to subsequent cropping phases. Under systems where higher quality forages are being produced and fed, higher quality manure has the potential to enhance crop production.

Upland areas used for rice, maize etc are quite steep and are highly susceptible to soil erosion. Better integration of forages and fodder trees in the cropping system, which has a primary aim of improving animal production, will help to conserve soil resources. Increasing problems with massive soil erosion and accession of contaminants from cropping lands into the local watershed in the Parangloe subdistrict of the Gowa Regency in Sulsel highlight the importance of adoption of farming practices which retain soil surface cover on smallholder hill farms.

8.4 Communication and dissemination activities

Publications and presentations

Journal papers

Sutaryono YA and Corfield J. Forage resources in livestock-cropping small holder systems of Sumbawa, Indonesia. Tropical Grasslands Journal. (under review).

Shaun Lisson, Neil MacLeod, Cam McDonald, Jeff Corfield, Rachmat Rahman, Lalu Wirajaswadi, Tanda Panjaitan, Yusuf Sutaryono, Rusnadi Padjung, Sania Saenong, Syamsu Bahar, Andrew Ash, Bruce Pengelly and Lisa Brennan. A participatory farming systems research approach to improving Bali cattle production in the smallholder crop-

livestock systems of eastern Indonesia I. Description of process and simulation models. Agricultural Systems (draft stage).

Neil MacLeod, Cam McDonald, Jeff Corfield, Shaun Lisson, Rachmat Rahman, Lalu Wirajaswadi, Tanda Panjaitan, Yusuf Sutaryono, Rusnadi Padjung, Sania Saenong, Syamsu Bahar, Andrew Ash, Bruce Pengelly and Lisa Brennan. A participatory, farming systems research approach to improving Bali cattle production in the smallholder crop-livestock systems of eastern Indonesia II. Application to two contrasting villages. Agricultural Systems (draft stage).

Bai X. Wieczorek AJ, Kaneko S, Lisson S, Contreras A (2008). Enabling sustainability transitions in Asia: the importance of vertical and horizontal linkages. Technological Forecasting and Social Change Journal (in press).

Conference papers

McDonald,C. K., N. MacLeod, S. Lisson, A. Ash, B. Pengelly, L. Brennan, J.Corfield, L. Wirajaswadi, T. Panjaitan, S. Saenong, Y. Sutaryono, R. Padjung , R.Rahman and S. Bahar (2004) Improving Bali cattle production in mixed crop-livestock systems in eastern Indonesia using an integrated modelling approach. In: New Dimensions and Challenges for Sustainable Livestock Farming, H.K.Wong et al. (eds.). Proceedings of the 11th Animal Science Congress, Kuala Lumpur, 2004. Vol. II, pp.116-119.

Cam McDonald, Shaun Lisson, Neil MacLeod, Rachmat Rahman, Lalu Wirajaswadi, Tanda Panjaitan, Yusuf Sutaryono, Rusnadi Padjung, Sania Saenong, Syamsu Bahar, Jeff Corfield, Andrew Ash, Bruce Pengelly and Lisa Brennan (2004) A whole-farm system approach to enhancing Bali cattle production in the mixed crop/livestock systems of eastern Indonesia. Proceedings Seminar Nasional Pemberdayaan Petani Miskin di Lahan Marginal Melalui Inovasi Teknologi Tepat Guna, Mataram 2004. pp1-8.

MacLeod, N.D., McDonald, C.K., Lisson, S.N. and Rahman, R. (2007). Modelling for scenario analysis for improved smallholder farming systems in Indonesia. In. (Oxley, L. and Kulasiri, D. Eds) MODSIM 2007 International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, December 2007, pp. 109-114. ISBN: 978-0-9758400-4-7.
http:/www.mssanz.au/modsim07/Papers/DegreeofSite_s44_Basenet_.pdf

MacLeod N., Lisson S, McDonald C, Corfield J, Rahman R, Puspadi K (2008). Integration of smallholder crop-forage-livestock systems in South East Asia - an eastern Indonesian case study. Keynote paper to IRC-IGC Conference, Hohhot, China, 28th June to 5th July 2008.

Corfield J. et al (2008). The impacts of enhanced tree legume utilisation in the smallholder crop-livestock farming systems of eastern Indonesia, AAAP Conference, Hanoi, Vietnam 2008 (draft stage).

Wirajaswadi L, Sutaryono YA, Dahlanuddin, Puspadi K., Lisson S, Corfield J., MacDonald C. and Hadiawati L. (2006). 'Perbaikan Sistem Tanaman-Ternak Skala Kecil di Lahan Kering Indonesia Timur (Kasus Nusa Tenggara Barat)', Prosiding Seminar Nasional Balai Besar Pengkajian dan Pengembangan Teknologi Pertanin (BP2TP), Mataram, Lombok.

Book chapters (draft only)

MacLeod N., Lisson S. & Pengelly B. (2008). Farming systems, potential impacts, adoption and outputs. ACIAR book chapter.

Lisson S. and MacLeod N (2008). Farming systems, potential impacts, adoption and outputs – Indonesia case study. ACIAR book chapter.

Other presentations (project overview)

Lisson and McDonald, University of Copenhagen, May 2007.

Lisson, ACIAR Program review, Brisbane, August 2007.

Lisson, CSIRO Sustainable Ecosystems Program Review Meeting, May 2008.

Lisson, UTAS seminar series, April 2006.

Other communication and extension activities

Field days were conducted at each of the project sites: Barru in July 2006, SPA in July 2007, and Mertak and Lemoa / Manyampa in April 2008.

Fact sheets were prepared for many of the best-bet activities as handouts to participating and other farmers and for broader distribution by Dinas and staff from other agencies.

Permanent (weather-proof) signs were installed at selected best-bet trial sites to promote the project and associated activities to passing farmers.

In addition to the more formal field days, best-bet farmers were regularly visited (at least once per month) by in-country project team members and less regularly (3-4 months) by Australian team members. The visits from in-country staff were typically for monitoring activities and staff would take the opportunity to discuss the progress of best-bet activities, provide additional advice and discuss cattle and forage monitoring results.

9 Conclusions and recommendations

9.1 Conclusions

This project has identified a range of factors that are constraining livestock production in the smallholder farming systems of eastern Indonesia including: availability and quality of forages, especially during the dry season; poor knowledge and/or capacity to implement optimum feed management practices; limited supplies of readily accessible stock water; bull availability; inadequate cattle housing; labour availability; extended and sub-optimal breeding cycles; diseases; marketing constraints and limited access of smallholders to the formal credit sector for acquiring cattle and livestock handling materials. Some of these constraints are largely beyond the power of the individual farmer to overcome (e.g. access to capital, market shortcomings). Others are comparatively easy to rectify with generally predictable, positive results (e.g. stock water availability and cattle housing). A third group of constraints is characterised by solutions that require more skill and knowledge to implement, and for which the implications are often more complex and less predictable (e.g. feed availability, breeding cycle) due to inter-dependencies between the various components of these farming systems. Uniquely, this project has utilised a whole-farm simulation tool collaboratively with farmers to analyse the inter-dependencies and associated system impacts of strategies in this latter grouping, prior to on-farm trialling.

The pathways to adoption varied with the region and the technology concerned. While the participatory nature of this project and the regular contact with, and knowledge provided by the project team were highly regarded by the best-bet farmers, adoption was strongly influenced by the involvement and support of village 'champions'. For example in Lompo Tenggah, Mahmud is a highly respected leader of the local farming group and fostered strong engagement of the best-bet farmers within the group and other non-project farmers. Amaq Sapri played a similar role in SPA. The substantial expansion of Gliricidia plantings at SPA occurred prior to the commencement of the current project and the implementation of the process described above. Prior to the commencement of the pre-cursor project, Gliricidia served as a 'living fence' but was not valued as a source of feed. Once convinced of the feed value via involvement in the pre-cursor project (AS2/2001/125), farmers readily embraced the technology so that by the time the current project commenced it had become a vital source of persistent dry season feed and could be used as a 'platform' for the delivery of other livestock improvement technologies. The rapid uptake of Gliricidia, achieved with minimal input from the project team, is perhaps attributable to the fact that the farmers were already familiar with the species and its cultivation (i.e. simple, vegetative propagation) and that being suited to field perimeters and fencelines it did not involve significant displacement of other more productive areas. Conversely, the uptake of new forage species requires greater input from the R, D and E agencies, especially if that uptake involves the partial displacement of other activities. Typically, an incremental approach was taken to the rollout of best-bet strategies. The initial focus was to address forage supply and quality constraints through modest plantings of selected forages. The confidence and trust arising from successful adoption of these comparatively simple technologies was then used as an entry point for more complex animal management strategies which require long-term planning and investment.

Participatory approaches in which farmers, researchers and extension experts come together to co-learn through the identification, exploration and on-ground testing of new agricultural management options have been shown to be successful for forage technology uptake by smallholder farmers (Horne and Stür 2003). Dimes et al (2003) note that there can be synergies between simulation models and participatory approaches. The approach developed and used in this project employs whole farm simulation modelling as an

analysis and learning tool within a broader participatory process aimed at improving Bali cattle production and household welfare for smallholder farmers in eastern Indonesia.

The feedback from the best-bet farmers and indeed their on-farm actions indicate that the participatory, farming systems approach has been successful. There is a range of evidence to support this:

- Willingness of farmers to participate in project activities and to allocate farm and personal resources to trial best-bet strategies.
- Quantifiable gains in forage and livestock production, labour savings and gains in household income over the life of the project.
- The intention of most of these farmers to continue (and in some cases expand) successful strategies beyond the life of the project.
- Virtually unanimous farmer appreciation of the knowledge provided by this project and the close and regular contact with project staff. There was matching criticism/cynicism toward the 'single-visit / ‘handout' philosophy of previous projects.
- Evidence of significant adoption/adaptation of the livestock improvement technologies by other (non-project) farmers. Unanimous sentiment amongst these farmers that cattle condition has improved. Most plan to continue some or all of the activities into the future.

The Integrated Analysis Tool (IAT) was found to be a useful component of the overall approach in the following ways:

- A communication tool to inform/underpin the dialogue between the project team and the farmers.
- Enabling rapid analysis of the financial, resource and production impacts of livestock improvement strategies and their sensitivity to key climate, soil, management and farm design variables.
- The screening out of less desirable strategies and shortlisting of feasible and viable best-bet options for subsequent on-farm testing, thus ensuring a more efficient and targeted use of limited project and farm resources.
- Providing a degree of confidence to both project staff and farmers that the strategies to be tested on-farm are unlikely to have an adverse effect.
- Providing motivation to some farmers about the potential impacts of proposed livestock improvement strategies.

The modelling and the results from the on-farm trials highlight the strong inter-dependencies / interactions between the various elements of these smallholder farming systems and the value of the holistic R, D and E approach. Clearly, changes in one part of the system can and do have profound effects elsewhere. For example, expansion of more accessible and persistent cut and carry resources on-farm were found to not only increase cattle growth, cattle price and household income but in some cases acted to free up labour previously used to shift cattle to feed sources or to collect fodder off-farm. This freed labour was then used to improve crop production (either area or yield).

9.2 Recommendations

The apparent success of the approaches developed and tested in this project provides support for wider adoption in other regions of Indonesia. Servicing the scaleout of this approach will require a substantial investment in capacity building within the key R, D and E agencies within Indonesia. Local universities can play a role in the training of future technicians in farming systems approaches and tools. Indonesian development agencies such as Balai Pengkajian Teknologi Pertanian (BPTP) have a role in the ongoing

maintenance, adaptation and application of these tools to new regions. Extension agencies provide a conduit to farming communities and facilitate the on-farm activities and outscaling of the best-bet technologies.

The efficient and widespread scaleout of the approach trialled in this project will necessarily require some rationalisation, especially in relation to the scope (and hence duration and resourcing) of the benchmarking and monitoring activities.

There is a need for a comprehensive assessment of the geographic extent and nature of the scaleout of best-bet technologies from the best-bet farms in this project. Results from this study should provide valuable insights into the scaleout mechanism that would be of benefit to the conduct of the aforementioned scaleout project. This activity should also revisit the best-bet farmers to assess the extent and nature of uptake beyond the life of the project, especially considering the lag in many instances between uptake of the technology and demonstrable impact.

Consideration should also be given by ACIAR to supporting ‘maintenance’ visits for the Mertak site. Uptake of livestock improvement technologies has been slower at this site due to effect of drought and hence, some ongoing (low input) involvement would be beneficial.

10 References

Adiku SK, Carberry PS, Rose CW, McCown RL, Braddock R. (1993). Assessing the performance of maize-cowpea intercrop under variable soil and climate conditions in the tropics. Proceedings of the 7th Australian Society of Agronomy Conference, September, Adelaide, South Australia p382.

Bouman BAM, Kropff MJ, Tuong TP, Wopereis MCS, ten Berge HFM, van Laar HH (2001) ORYZA2000: modelling lowland rice. Los Banos (Philippines): International Rice Research Institute, and Wageningen: Wageningen University and Research Centre, 235p.

Carberry PS, Abrecht DG. (1991) Tailoring crop models to the semi-arid tropics. In: Muchow RC, Bellamy JA (Eds), Climatic Risk in Crop Production: Models and management for the semiarid tropics and subtropics. CAB International, Wallingford, UK, pp157-182.

Carberry PS, Gladwin C, Twomlow S (2004). Linking Simulation Modelling to Participatory Research in Smallholder Farming Systems. In: Delve, R.J. and Probert, M.E. (Eds.) Modelling nutrient management in tropical cropping systems. ACIAR Proceedings No. 114. pp32-46.

Castelan-Ortega OA, Fawcett RH, Arriaga-Jordan C, Herrero M (2003a). A decision support system for smallholder campesino maize-cattle production systems of the Toluca Valley in Central Mexico. Part I – Integrating biological and socio-economic models into a holistic system. Agricultural Systems, 75 1-21.

Castelan-Ortega OA, Fawcett RH, Arriaga-Jordan C, Herrero M (2003b). A decision support system for smallholder campesino maize-cattle production systems of the Toluca Valley in Central Mexico. Part II – Emulating the farming system. Agricultural Systems, 75 23-46.

Devendra, C., Lee Kok, T. and Pathmasingham, M. (1973) The productivity of Bali cattle in Malaysia. Malaysian Agricultural Journal, 49: 183-191.

Hennessy, D.W., Williamson, P.J. and Darnell, R.E. (2000) Feed intake and liveweight responses to nitrogen and/or protein supplements by steers of Bos taurus, Bos indicus and Bos taurus x Bos indicus breed types offered a low quality grass hay. Journal of Agricultural Science, Cambridge, 135, 35-45.

Herrero, M., Thornton, P.K., Googenboom, G., Ruiz, R., Fawcett, R.H., Jones, J.W., 2002. An integrated modeling platform for animal-crop systems. In: Proceedings of the 17th Symposium of the International Farming Systems Association. November 17–20, 2002, Lake Buena Vista, FL, US. p.107.

Horne, P. and Stür, W.W. (1999). Developing forage technologies with smallholder farmers – how to select the best varieties to offer farmers in Southeast Asia. ACIAR Monograph No. 62. 80pp.

Horne PM and Stür WW (2003). Developing agricultural solutions with smallholder farmers – how to get started with participatory approaches. ACIAR Monograph No. 99. 120pp.

Ivory, D.A. (1986). Performance of germplasm in new environments. In: G.J. Blair, D.A. Ivory and T.R Evans, eds., Forages in Southeast Asian and South Pacific agriculture: proceedings of an international workshop held at Cisarua, Indonesia, 19-23 August 1985. ACIAR Proceedings No. 12 pp 61-68.

Keating BA, Carberry PC, Hammer GL, Probert ME, Robertson MJ, Holzworth D, Huth NI, Hargreaves JNG, Meinke H, Hochman Z, McLean G, Verburg K, Snow V, Dimes JP, Silburn M, Wang E, Brown S, Bristow KL, Asseng S, Chapman S, McCown RL, Freebairn

DM, Smith CJ (2003). An overview of APSIM, A model designed for farming systems simulation. European Journal of Agronomy 18, 267-288.

Little, D.A., Kompiang S. and Petheram, R.J. (1989) Mineral composition of Indonesain ruminant forages. Tropical Agriculture, 66, 33-37.

Makeham, J.P., and Malcolm, L.R. (1981). The Farming Game, Gill Publications, Armidale, N.S.W.

Mastika, M. 2003. Feeding strategies to improve the production performance and meat quality of Bali cattle (Bos sundaicus). In: Entwistle, K., Lindsay, D.R. (Eds.) Strategies to Improve Bali Cattle in eastern Indonesia. Proceedings of a Workshop 4-7 February 2002, Bali, Indonesia. ACIAR Proceedings No. 110, Canberra.

McCool, C. (1992) Buffalo and Bali cattle – exploiting their reproductive behaviour and physiology. Tropical Animal Health and Production, 24, 165-172.

Norman D. and Collinson M. (1985) Farming systems research in theory and practice. In: Agricultural Systems Research for Developing Countries. ACIAR Proceedings No. 11 pp 16-30.

Panjaitan TS, Fordyce G, Quigley SP, Winter WH, Poppi DP (2008). An integrated village management system for Bali cattle in the eastern islands of Indonesia: The 'Kelebuh' model. AAAP Conference, Hanoi, Vietnam 2008 (under review).

Paris, T.R. 2002. Crop-animal systems in Asia: socio-economic benefits and impacts on rural livelihoods. Agricultural Systems 71, 147-168.

Peters M. (2005). Tropical Forages: An interactive selection tool. DPIF (Queensland), CIAT and ILRI. CD-ROM.

Poppi, D.P., McLennan, S.R., Bediye, S., de Vega, A. and Zorilla-Rios, J. (1999) Forage quality: strategies for increasing nutritive value of forages. Proceedings XVIII International Grassland Congress, Winnipeg, 1997, pp.307-322.

Probert ME, Dimes JP, Keating BA, Dalal RC, Strong WM (1997). APSIM's water and nitrogen modules and simulation of the dynamics of water and nitrogen in fallow systems. Agricultural Systems 56, 1-28.

Robertson MJ, Carberry PS, Chauhan YS, Ranganathan R, O'Leary GJ (2001a) Predicting growth and development of pigeon pea: A simulation model. Field Crops Research 71, 195-210.

Robertson MJ, Carberry PS (1998) Simulating growth and development of soybean in APSIM. Proceedings 10th Australian soybean conference, Brisbane, 15-17 September, 130-136.

Robertson MJ, Carberry PS, Huth NI, Turpin JE, Probert ME, Poulton PL, Bell M, Wright GC, Yeates SJ, Brinsmead RB (2001b). Simulation of growth and development of diverse legume species in APSIM. Australian Journal of Agricultural Research 53, 429-446.

SCA (1990) Feeding Standards of Australian Livestock: Ruminants. Standing Committee on Agriculture, Ruminants Sub-committee, Corbett, J.L. (Ed.). (CSIRO Publications, Melbourne).

Schultze-Kraft, R. (1986). Exotic and native legumes for forage production in Southeast Asia. In: G.J. Blair, D.A. Ivory and T.R Evans, eds., Forages in Southeast Asian and South Pacific agriculture: proceedings of an international workshopheld at Cisarua, Indonesia, 19-23 August 1985. ACIAR Proceedings No. 12 pp 36-42.

Sukarini, I.A.M., Sastradipradja, D., Sutardi, T., Mahardika, I.G. and Budiarta, I.G.A. (2000) Nutrient utilization, body composition and lactation performance of first lactation Bali cows (Bos sondaicus) on grass-legume based diets. Asian-Australian Journal of Animal Science, 13, 1681-1690.

Talib C., Entwistle K., Siregar A., Budiarti-Turner S, Lindsay D. (2003). Strategies to improve Bali cattle in eastern Indonesia. ACIAR Monograph Series No.110, 94pp. (ACIAR Canberra).

Teleni, E, Campbell, R.S.F. and Hoffman, D. (1993) Draught animal systems and management: an Indonesian study. ACIAR Monograph Series No.19, 167pp. (ACIAR Canberra).

Wirdahayati, R.B.(1994) Reproductive characteristics and productivity of Bali and Ongole cattle in Nusa Tenggara, Indonesia. Ph.D. thesis (University of Queensland, Brisbane).

11 Appendices

11.1 Appendix A. Description of Integrated Analysis Tool (IAT)

The IAT integrates three separate models: the farming system model (APSIM), a model for Bali cattle growth and a smallholder enterprise economic model.

APSIM (Agricultural Production Systems Simulator)

APSIM simulates the growth of a wide range of crop types in response to site-specific soil, climate and management data (Keating et al. 2003). Simulation modules representing different parts of the farming system are integrated to represent the system of interest. In this case, crop modules for rice (Bouman et al 2001), peanut (Robertson et al. 2001a), mucuna (Robertson et al. 2001b), cowpea (Adiku et al. 1993), maize (Carberry and Abrecht 1991), stylosanthes, soybean (Robertson and Carberry 1998) and mungbean (Robertson et al. 2001a) were combined with the soil water module SOILWAT2 (Probert et al. 1997), the soil nitrogen and carbon module SOILN2 (Probert et al. 1997) and the residue module RESIDUE2 (Probert et al. 1997). These modules were parameterised using management, soil and climate data collected from the farmer surveys and biophysical benchmarking/monitoring activities.

APSIM simulations were configured for a range of species X soil type X climatic zone combinations, with the resultant model output relating to forage and crop yield and quality incorporated into a database within the IAT. The IAT user selects the APSIM configuration that best matches the conditions of the farm under consideration. Additional regional databases can be added as the approach is adopted in new areas.

It should be noted that while APSIM captures the key processes influencing crop and forage production, it does not capture all the yield limiting constraints such as weed competition, insect damage, waterlogging and severe weather effects. Hence, simulated yields and related resource demands often exceed reality, especially in these low input systems. In the absence of comprehensive field trials, model ‘validation’ was based on comparison of model output (e.g. yield) with village records and/or individual farmer records. This is considered adequate for the purposes of this application.

Bali cattle growth model

The component cattle model needed to be precise enough to predict realistic livestock production outcomes and yet simple enough to be integrated into the larger IAT model. There are many published models of liveweight gain for beef cattle, but many of these require detailed information on passage rates of forage through the rumen, information which is not readily available for many feedstuffs used by Indonesian smallholders, or were developed for European breeds. The latter could not be confidently applied to Bali cattle as these animals are small in comparison with European breeds with estimates of mature weight of females ranging from 250-350 kg and males up to 450 kg (Devendra et al. 1973; McCool 1992; Sukarini et al. 2000). They are well adapted to heat, can work up to 5 hours per day without apparent physical disturbance and survive well on poor pasture (Teleni et al. 1993; Sukarini et al. 2000). They have higher fertility rates than other cattle breeds and buffalo under similar conditions (McCool 1992), but milk production is poor (Sukarini et al. 2000) and calf mortality rate is high (Wirdahayati 1994). Nevertheless, the key determinant of animal growth, reproduction and mortality rate is animal nutrition. Forage quality, as measured by digestibility and protein availability, commonly limit production, but smallholders have an array of different feed sources of varying quality (Little et al. 1989) available at intermittent intervals e.g. native and introduced grasses and legumes, field crop residues, plantation residues (leaf, stem, fruit), tree leaves etc.

A spreadsheet-based model was developed from published data and data collected during the life of the project relating to animal liveweight, liveweight gain, milk production, age at first calf, and calving interval as well as the quality, composition and quantity of the various sources of feed. The model is based largely upon the energy functions outlined by SCA (1990) with coefficients recalibrated for Bali cattle, but also includes intake restrictions based on the estimated crude protein requirements of the animal (Poppi and McLennan 1995). Currently, the model is specific to Bali cattle and to the feeds and husbandry practices of Eastern Indonesia. It is robust enough to capture responses to both grazing and cut and carry systems, and to cope with distinct wet and dry season conditions and the feeding of crop residues.

Data input is restricted to pasture protein concentration (g/kg) and dry matter digestibility (%) of the forage, with annual pasture and forage residue biomass, nitrogen content and date of harvest, input from the database of APSIM output. Seasonal changes in crude protein concentration (CP) and dry matter digestibility of native pasture are empirically derived based on values quoted in the literature for northern Australia and field measurements over 3 years in Indonesia.

Animal growth is determined from the quantity and quality of animal intake. Potential intake is determined from the age and current or previous highest weight of the animal. This is then adjusted for the effects of available forage (for grazing), forage quality, or whether the animal is currently lactating. Based on the adjusted intake, necessary protein requirements are calculated (Hennessy et al. 2000), and if insufficient, intake is reduced linearly in relation to CP required and CP supply. The digestibility and calculated intake determines the digestible and metabolisable energy intake which is then partitioned into energy for maintenance and, if sufficient, energy for growth. The animal growth rates predicted by the model are in reasonable agreement with observed values however, a high degree of correlation could not be expected due to extreme variability in observed values.

Calving interval, age at first calf and calf mortality rate are related to cow condition, based on the survey data of Wirdahayati (1994) and field observations during the project. The derived functions indicate a 200kg animal will have its first calf at around 2.5-3 years of age, and a cow needs to be approximately 260kg to have a calf at 12-monthly intervals. These values are in good agreement with observed calving intervals.

Labour requirements for cut and carry of necessary forage are varied according to forage availability, or lack-there-of if none is available on farm. The greater the shortage of forage, the greater the labour requirement as farmers need to go further afield to collect forage or spend time herding animals on common land. The model runs on a daily basis with information on calving, animal liveweight, sales, and labour requirements passed to the socio-economic model on an annual basis.

Smallholder economic model

The complexity of a typical farm-household system in Eastern Indonesia is presented schematically in Fig. 1. While the overall system performance might be judged in terms of a monetary unit (e.g. annual net profit in Rupiah as depicted) it is immediately evident that production and consumption pathways are typically indirect and not always well defined. A key task of the biophysical and socio-economic modelling components of the project was to better understand how these pathways might operate in order to generate improved system performance and welfare outcomes.

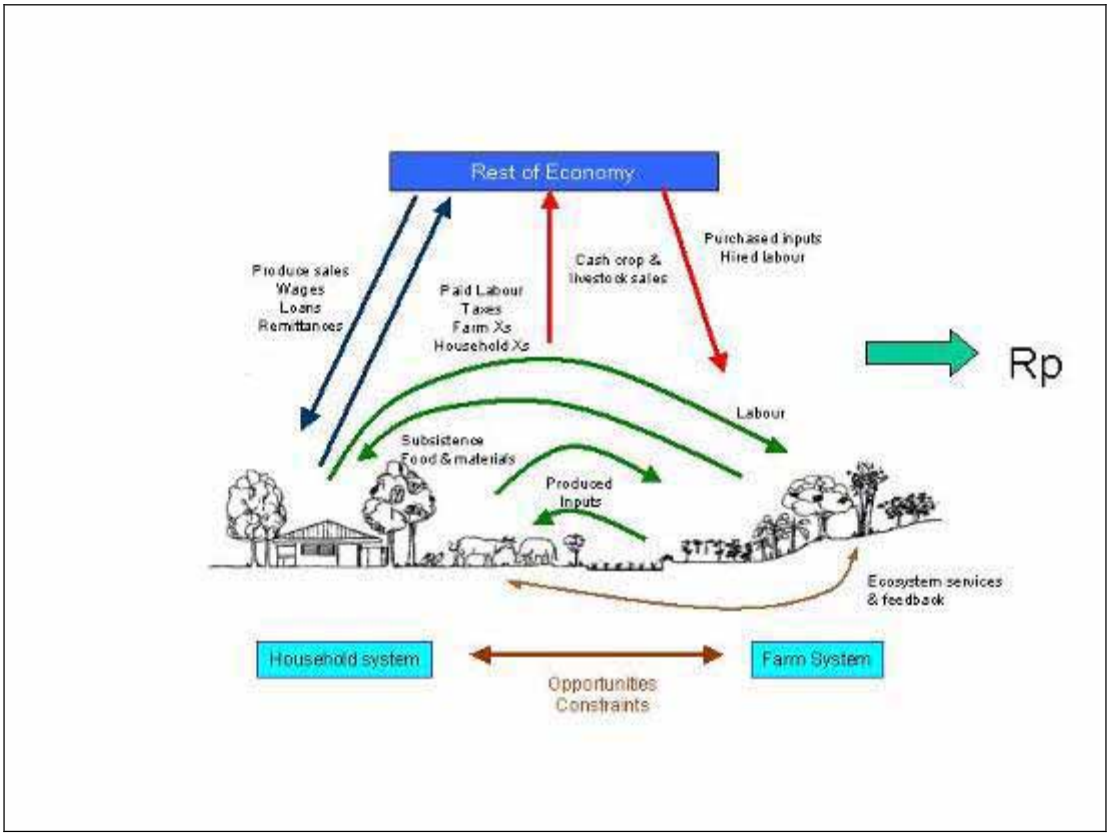


Fig. 1. Schematic representation of farm-household and resource flows between production and consumption activities.

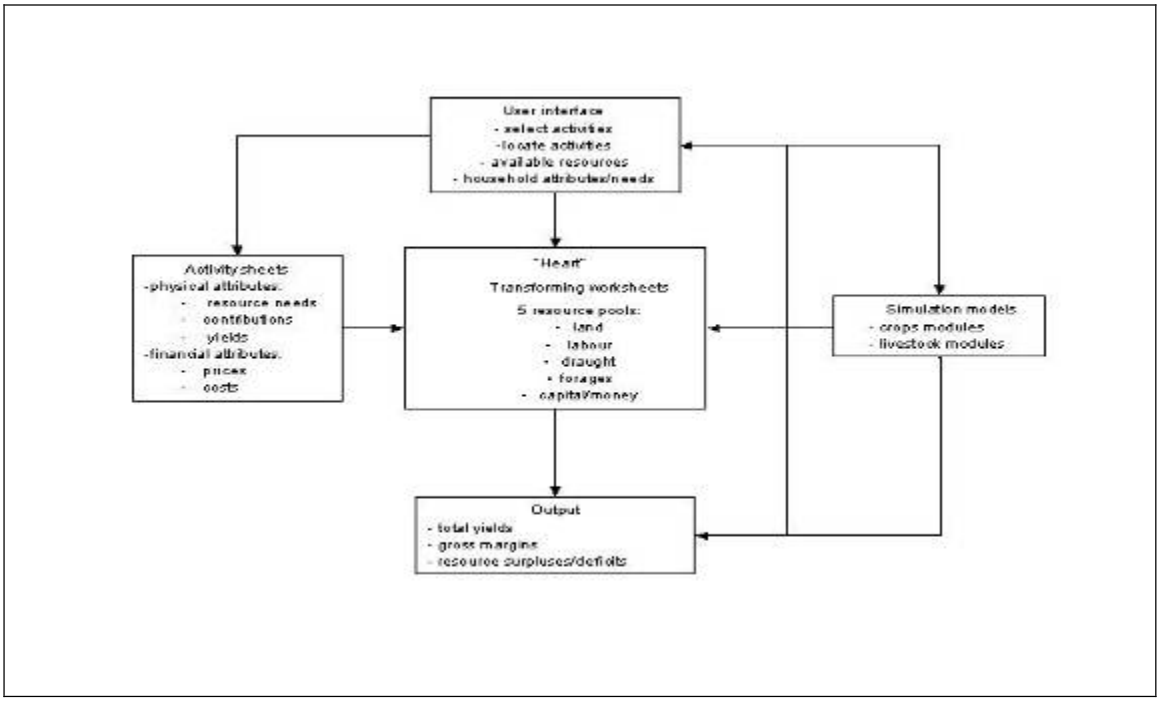


Fig. 2. Schematic representation of farm-household economic model structure.

The economic model is built on a Microsoft Excel spreadsheet platform and its central features are presented schematically in Fig. 2. Consistent with the interlinked “farm” and “household” dependencies illustrated in Fig. 1, the economic model is constructed around a wide array of activities that may be undertaken by the household. These include crop, forage, livestock, off-farm and non-farm activities that are linked systemically through five resource “pools” on which they either draw or contribute. The crop, forage and livestock

activities include both final and intermediate farm activities, which represent the farm activity mix, or “farm enterprise” as it is commonly known in western farming systems. Off-farm activities (e.g. contract ploughing, planting, weeding and harvesting etc) are those which are still farm-based in orientation and may draw on the same resources as on-farm activities. Non-farm activities (e.g. operating a kiosk, construction labour) also potentially contribute to, or draw on, the resources available to the family for production, consumption (e.g. education, consumer goods) or wealth accumulation (including increased herd sizes). By including all of the activities that are available to, or necessary for, the household to meet its needs and objectives, the model is able to more accurately provide an indication of whether different crop and forage options will actually make them better or worse off.

The heart of the model is the constraining and enabling potentials of five resource pools. These include (a) labour including casual labour - by functional category and season, (b) land by type and quality, (c) draught available for ploughing, (d) forage by type and seasonal availability, including crop residues, and (e) cash (working capital to support production and consumption activities) and credit. The starting size of the different pools is set according to assumptions on the resource endowment associated with the case farm-households under review. Crop and livestock activities also provide input for home consumption, which are treated as a sixth pool. As different activities, and their respective levels, are entered into the model their net demands and contributions to the various pools are evaluated and a series of “flags” is created on the user interface screen that will confirm whether or not the activity mix and levels is feasible given the resources available to the farm-household. The model specifically identifies which pools are acting as constraints on the particular activity mix being explored, and the extent to which other resources are free to provide opportunities for other activities on or off the farm. In this way, it contains functions that are similar to a linear programming format – the difference being that it does not automatically identify the “optimum” solution. The rationale for not selecting an optimising algorithm format is examined further below.

Inputs to the economic model are from several sources. Yield data for crop, forage and livestock activities are from the APSIM database and the livestock model. Price and cost data, production input levels (e.g. fertiliser, seed, materials), and home consumption needs of different products and family expenses are derived from the baseline survey.

The main measures that are produced by the economic model include: (a) total gross margin – including value of home consumed produce, (b) disposable income after household consumption, (c) net cash position, and (d) the level of household capital and/or outstanding debt. These measures are calculated by placing prices on produce outputs and production inputs along with “opportunity values” for home consumption and other non-market uses or disposals of activity outputs (e.g. food crops, residues, manures etc). The major advantage of the gross margin budgeting approach lies in its simplicity and transparency for potential users of the model. It has the further capacity to run simple sensitivity and risk analyses by varying the main parameter values in the gross margin budgets.

Mathematical programming that would have enabled optimization of all the constraining resources as a single package was not employed. Such an analysis typically requires the problem setting to be heavily simplified and the process of finding solutions is rarely transparent. These constraints were considered to be major drawbacks when using the model to assist smallholders (and parties who provide them with information) with their decision-making processes and to better understand the consequence of different crop-livestock choices.

Rather than employing an optimization strategy, it was judged that an alternative method that enabled a more appropriate counter balance of the complexity of the farm-household linkage with simplicity and transparency was required. A creep budgeting approach was subsequently selected. This strategy combines the simplicity and transparency advantages of gross margin budgeting and the ability of mathematical programming

techniques to consider the constraining impact of all resources and to provide an optimal solution. This approach involves re-specifying large numbers of input and output variables in a systematic manner to explore the response to these changes (Makeham and Malcolm 1981). That is, the decision-maker “creeps” around the economic response surface in a systematic fashion to examine whether there is a shift towards or away from a more optimal solution. In this way, the use of “what-if” questions is able to provide farmers, researchers and extension specialists with a good many insights into how the economic position of the farm-household system will respond to different activities, input and output levels and their respective prices. Moreover, we believe that the progressive search for a more optimal position is more closely aligned to the intuitive way that many farmers actually approach their own decision-making tasks. The model has been structured to be amenable to creep budgeting processes and to provide a high level of transparency concerning the impacts on the household resources and welfare of adopting various production and consumption activities both on and off the farm.

Integrated Analysis Tool

The IAT integrates the three models to enable a whole-of-farm analysis of alternative forage and livestock options (Fig. 3). An easy-to-use interface (Fig. 4) forms the ‘hub’ of the IAT with links to other input forms. Different regions/climatic zones can be selected to align with the appropriate village. User forms allow entry of farm-specific details (i.e. model inputs) relating to farm area and design, family structure, labour allocations for family members, cattle herd structure and management, crop sequence and management. Sub-forms allow more detailed information on crop input costs, non-farm income, labour etc. This information parameterises the cattle and economic models and directs the selection of input from the database of APSIM output. The ‘real-time’ cattle and economic models are then run over a 10-year period with the exchange of relevant output. Final model output is then presented in graph or tabular form describing: (a) biophysical characteristics of the system (i.e. crop and forage yield/biomass and animal liveweight gain); (b) labour details and; (c) economic performance (cash balance and gross margins).

Output can be saved for later comparison. The parameter settings used to generate the particular output are saved with the output and these can be reloaded at a later date. The operator can choose between English and Indonesian language versions.

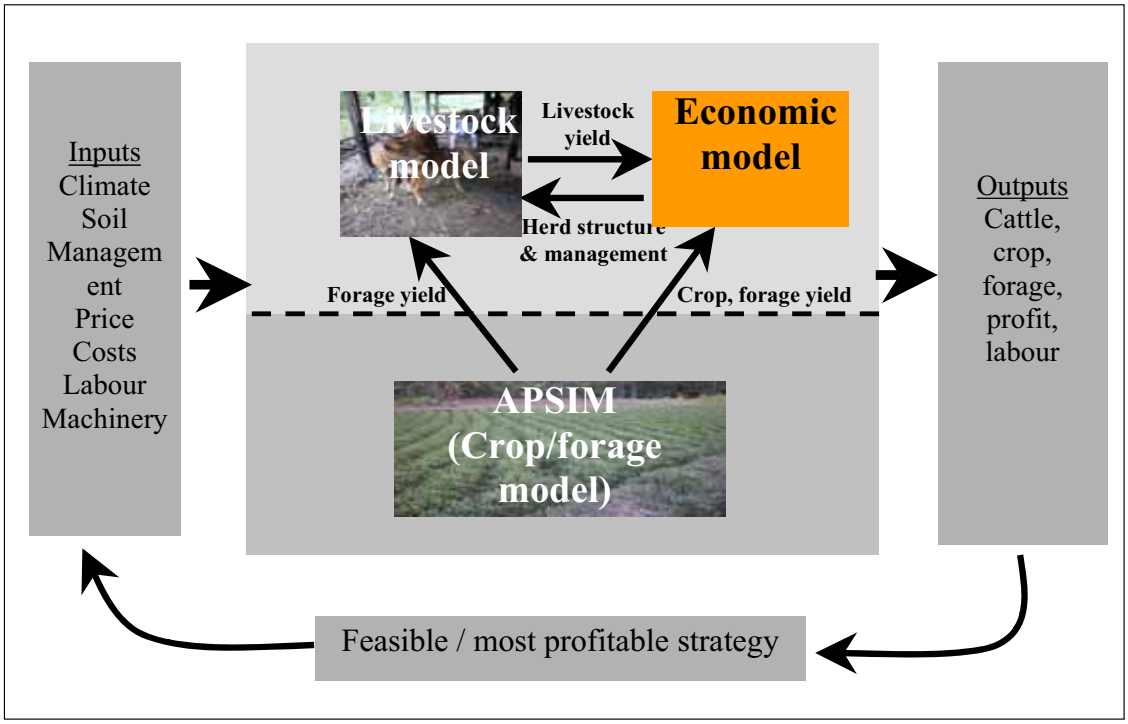


Fig. 3. Structure of Integrated Analysis Tool (IAT).

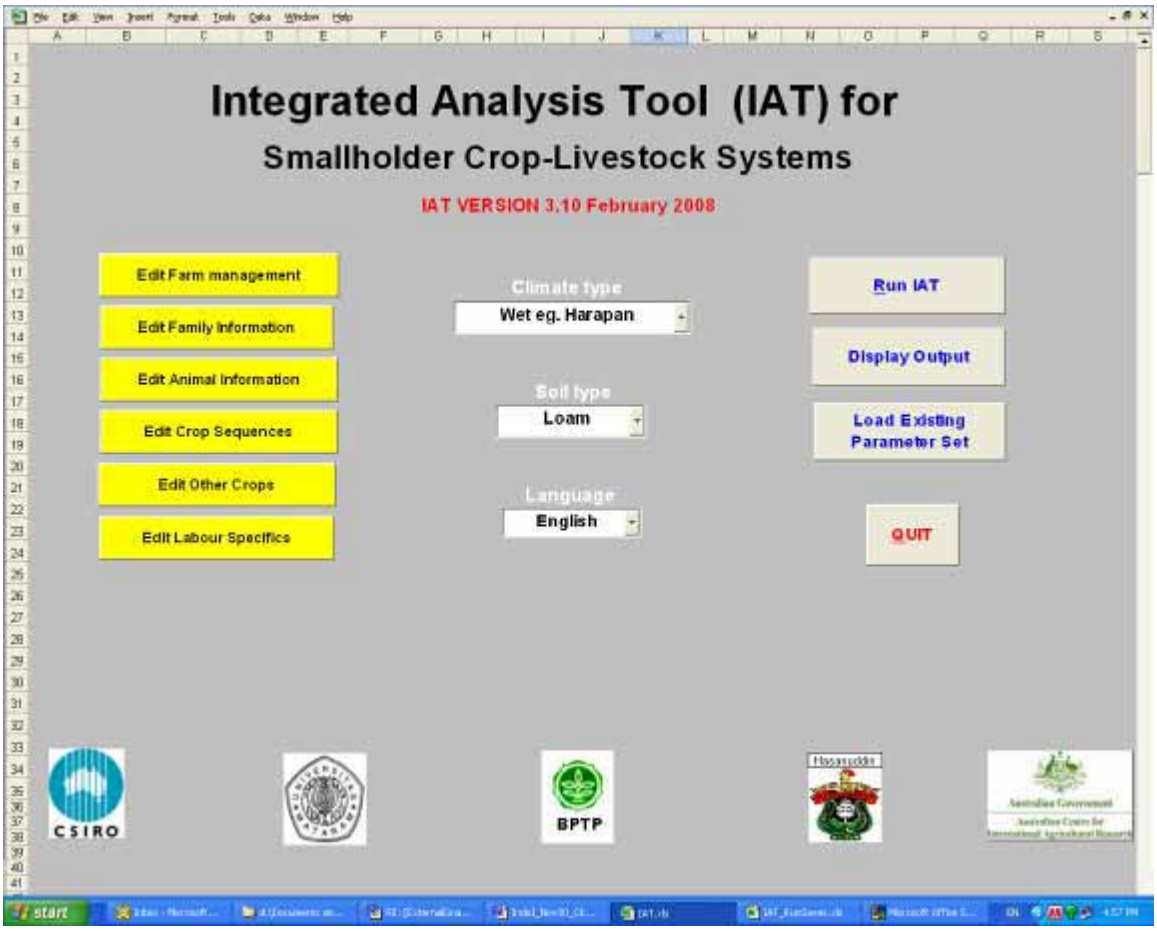


Fig. 4. Initial screen of the IAT user interface.

11.2 Appendix B. Soil characterisation report

Introduction

Between 23rd September and 2nd October 2005 research sites were visited in southern Lombok and South Sulawesi, Indonesia to participate in soil identification and characterisation for Plant Available Water Capacity (PAWC). This work forms a component of the ACIAR Project: AS2/2004/005-Improving smallholder crop-livestock systems in eastern Indonesia, and is a pre-requisite for simulation of local farming systems using the APSIM model.

Mertak village, 80 km south-east of Mataram, Lombok and Manyampa/Lemoa villages 35km south-east of Makassar, Sulawesi were surveyed in terms of land use and soil type. Based on the survey results the major soils, in terms of agricultural potential, were identified for characterisation. A collaborative process including research staff, local sub-village chiefs, and agricultural extension staff was used to identify potential sites for further work. It is anticipated that the majority of the physical activity associated with soil characterisation, including the field work and chemical and physical analyses, will be undertaken by the Indonesian team in consultation with CSIRO staff.

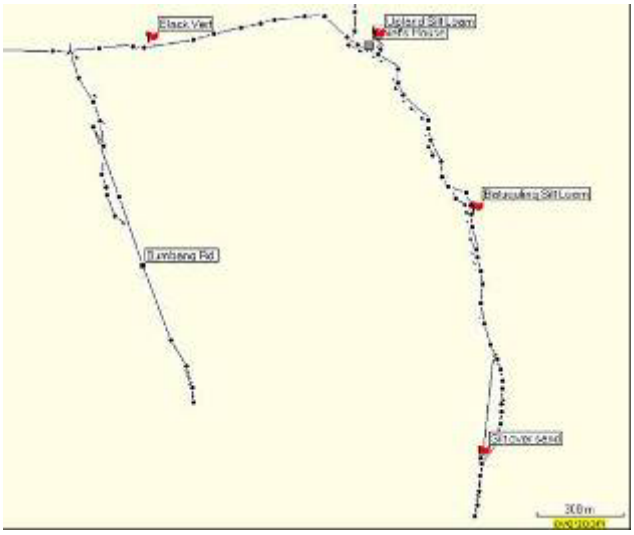
Lombok-Mertak Village

A familiarisation visit was made to the village on the 24th September by Ahmad Suradi and Lia Hadiawati from BPTP, Mataram and Neal Dalgliesh, CSE. In consultation with the local chief, four likely variations in soil type were identified and sampled to a depth of 90 cm. to inspect profile characteristics. Sites were located from the top of the catchment at an elevation of approx. 40-60m, to near sea level (and a short distance from the shore).

Site Description

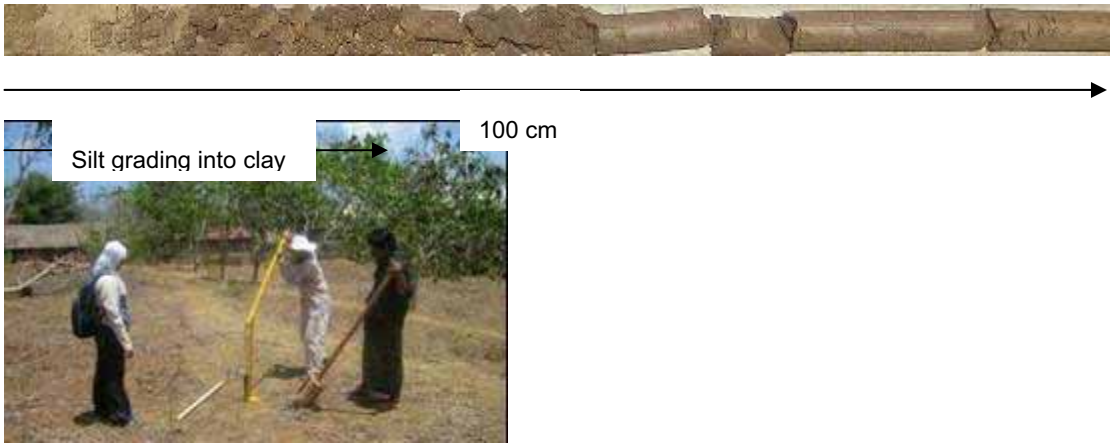
Two major soils were identified in the village area, the dominant one being a brown silt loam located at both the higher and mid elevations of the village. Rocks were evident in the highly eroded version of this soil on the tops of the hills and also present at one of the sampling locations (Batuguling). The other major soil type was a black cracking clay which was limited to a relatively small area (in terms of the whole village area) adjacent to a watercourse. Field texture assessments will be confirmed through particle size analysis.

Co-ordinates of preliminary sample sites		
Site	**Site Name**	**Co-ordinates**
a)	Upland Silt Loam	S8 53 03.2 E116 22 35.9
b)	Black Vertisol	S8 53 03.5 E116 22 10.1
c)	Batuguling Silt Loam	S8 53 22.6 E116 22 47.0
d)	Silt over sand	S8 53 50.0 E116 22 47.8
Datum: Indonesia 74		



- Upland Silt Loam

This site, adjacent to the Chief's house (at approx. 40m elevation) is a brown silt loam grading into clay at approx. 30 cm. It is recommended that consideration be made to sampling this profile on horizons instead of standard sampling depths.



- Black Cracking Clay

The profile sample indicated a typical black Vertisol with severe surface cracking and slicken-slides present at depth. There was substantial soil moisture present (close to DUL) from a depth of approx. 60 cm. Whilst this may just indicate limited soil water requirements by the last crop, it is recommended that EC, Chloride and Exchangeable Sodium levels be determined to rule out sub-soil constraints.

90 cm

- Batuguling Silt

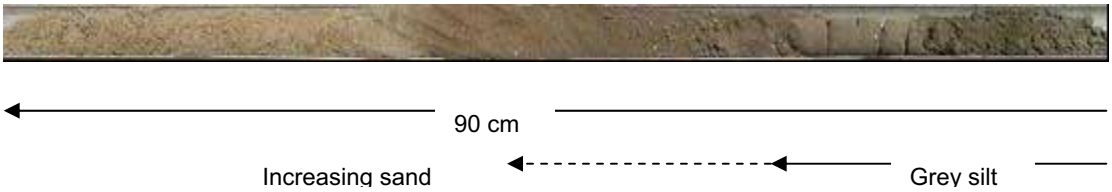
Located at approx. 25m above sea level this profile was similar to the upland Silt Loam, grading to clay at approx. 30-40 cm depth. Surface soil was light grey compared to the brown found at the higher site. Whilst the local farmers indicated that this soil was rocky (and some were observed in the locality) no problems were encountered during sampling.

100 cm

Grading to clay

- Silt over sand

This profile was taken at approx. 5m above sea level and consisted of grey silt, with little organic matter, overlying coarse sand. The sand commenced at a depth of approx. 30-40 cm. Due to its location in the landscape it is possible that this soil is prone to transient water logging and salt incursion.

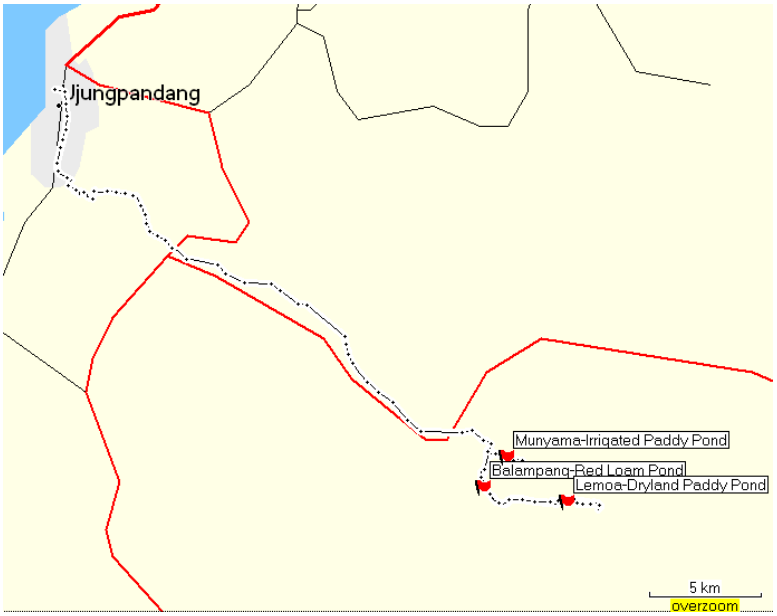


Recommendations for Lombok

It is recommended that characterisation be undertaken on sites representative of the upland Silt Loam and the Black Vertisol. It is considered that the Batuguling Silt Loam is similar to the upland Silt Loam, and the Silt over sand is likely to be limited to the very lower end of the catchment and not representative of the major soils of the village. Actual characterisation sites are to be identified by Ahmad Suriadi and should be located in close proximity to the preliminary evaluation sites, taking into consideration proximity to trees, bunds and the operational requirements of land owners.

9. Southern Sulawesi, Lemoa/Manyampa villages

A visit was made to the village on the 27th September by Rakhmat Rachman and Syamsu Bahar of BPTP, Makassar, Ahmad Suradi, BPTP, Mataram and Neal Dalgliesh, CSE, with the intention of gaining an understanding of the topography and soils of the area. After a preliminary tour of the village with local officials, three sites were selected for soil characterisation based on soil type and land use. Over the following two days initial assessments were done at these sites including soil coring to a depth of 180 cm for measurement of soil depth and physical and chemical evaluation.



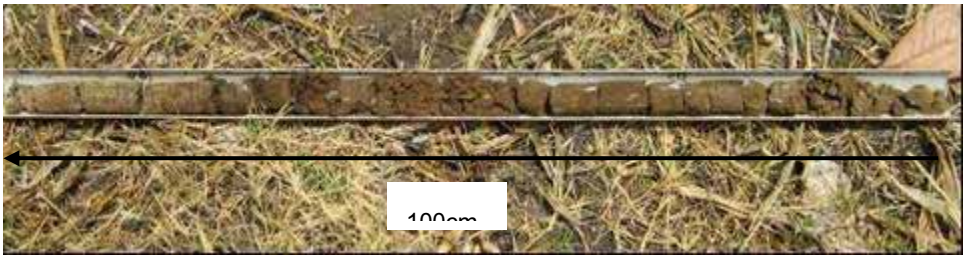
Site Descriptions

The predominant soils of the village range between a red loam and a medium clay. The landscape is dominated by steep hills (>40% slope) and undulating valley floors with elevation ranging between 50 m and >250 m. The soils at the higher elevations are highly eroded, shallow and interspersed with large exposed rocks. Most of the agricultural production is done at the lower elevations although annual crops (such as maize) and tree crops are grown higher up the slopes during the rainy season. The soils for characterisation were selected at the lower elevations. If required, characteristics for the soils of the upper slopes will be able to be developed using information obtained for the lower elevation soils. These soils have been formed through movement of alluvium from the upper slopes and are very similar physically, (particularly the case with the Lemoa dryland paddi soil). Field texture assessments will be confirmed through particle size analysis.

Co-ordinates of characterisation sites		
Site	Site Name	Co-ordinates
a)	Lemoa Dryland Paddi (Loam)	S5 18 44.3 E119 36 56.8
b)	Balampang Red Loam	S5 18 22.6 E119 34 55.6
c)	Manyampa Irrigated Paddi (Clay)	S5 17 39.5 E119 35 29.5
Datum: Indonesia 74		

- Lemoa Dryland Paddi

This soil is predominantly used for dryland rice production with one crop grown annually during the rainy season. The soil is a grey/brown loam grading into gravel at approx. 80 cm. Depth of sampling varied between 135cm and 170 cm The profile was dry to full depth although roots were only found to a depth of 120 cm.



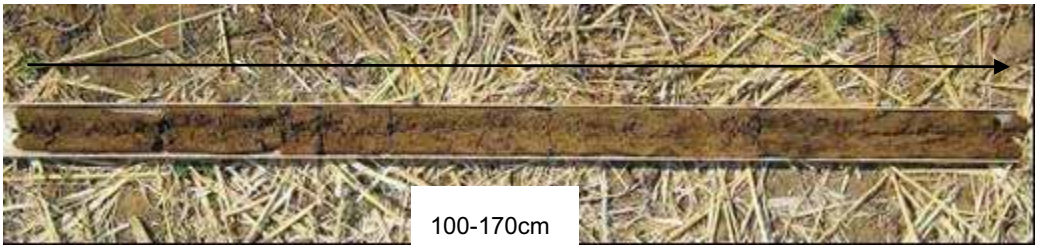
- Balampang Red Loam

This soil is used for dryland crop production (maize and sugar cane) during the rainy season. The soil is a sandy loam/clay loam with gravel at approx. 80 cm. Depth of sampling was 170 cm. with roots to a depth of 80 cm, some moisture was evident below this depth.

100cm

- Manyampa Irrigated Paddi

This brown clay soil is used for intensive rice production with a crop grown during the rainy season and a second under irrigation during the dry. The continuing irrigated rice mono-culture has resulted in some compaction in the top 30 cm. There is limited water use below this depth, likely as a result of compaction and a reduced requirement for crops grown under irrigation to seek water deeper in the profile. No roots were found below 30-40 cm. with the soil at near field capacity at depths >60 cm. Some soil mottling and soft, black nodules (5-10 mm diam) were evident below 90 cm.



Recommendations for South Sulawesi

Soil characterisation has commenced with sampling for chemical and physical analysis during this visit. PAWC will be determined from field measurement over the coming season. It may be necessary, due to the operational requirements of the farmers, to undertake the characterisation of the Manyampa irrigated paddi soil during the second seasonal rice crop, although this will be decided as the season progresses. The other two sites will be characterised during the wet season with soil sampling for DUL and BD planned for the end of the rainy season (~April).

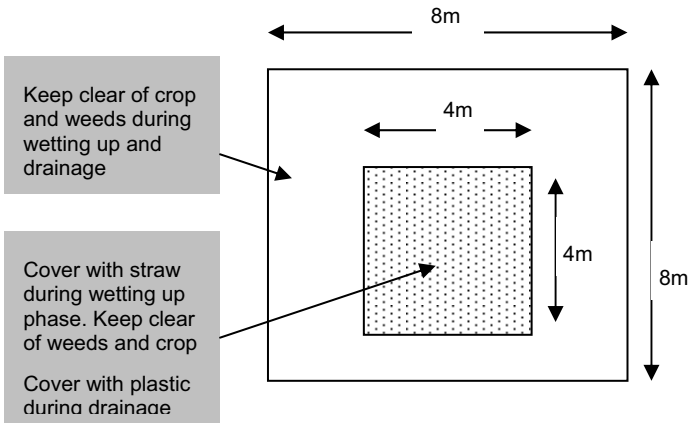
General characterisation recommendations

- Characterisation to be undertaken to a maximum depth of 150-180 cm. or to depth of parent material.
- The Black Vertisol soil at Mertak and the irrigated clay at Manyampa should be sampled using standard depth increments of 0-15 cm, 15-30 cm and 30 cm layers thereafter. Other soils may need to be sampled on horizons but this decision will have to be made at the time of sampling.
- Field based determination of Drained Upper Limit (DUL) and Bulk density (BD) to be undertaken after appropriate wetting up of each soil site. Access to the soil profile will be via a pit. DUL and BD will be determined from the same sample using a ring of known volume (nominally 70-75mm diameter by 50mm high). 2-3 replications per depth layer should be taken. Samples to be dried at 1050 Celsius. Samples to be either weighed in the field (immediately after sampling) or stored in sealed plastic bags until return to the laboratory. Accurate recording of sampling ring dimensions and sample weights is important.

- Drained Upper Limit is also to be determined by laboratory analysis. Dr S. Gusli of Hasanudin University has recommended using the sintered funnel technique with 5 KPA as the measure of DUL. Dr Brian Bridge (CSIRO, Toowoomba) has endorsed this technique with the suggestion that a No. 4 funnel and 10 kpa would be appropriate (this needs to be discussed). Analyses will be undertaken by the university and will require 3-4 replicates per soil layer. As samples will need to be shipped from Lombok to Sulawesi appropriate packaging is critical.
- Due to issues with technique it has been recommended that lower limit of water extraction not be determined by laboratory analysis. Crop Lower Limit (CLL) for at least one crop per soil needs to undertaken during the coming season (likely to be rice or maize). This will require the erection of a plastic rain-out shelter to protect the maturing crop from rainfall. The protected area should be at least 3m x 3m and erected on well grown crop adjacent to the wetting-up area.
- The BPTP laboratories at Mataram and Makassar will undertake physical (particle size) and chemical analysis of soils. Syamsu is to investigate obtaining a copy of a recent laboratory analytical accuracy comparison report which is done routinely for all BPTP labs in Indonesia. Data to be forwarded to Neal Dalgliesh (data to include individual lab results for range of chemical analyses in which we are interested, mean over all labs and CV%).
- It is suggested that a small set of samples (~6-10) from South Sulawesi and Lombok be analysed at both BPTP labs as a check on analytical accuracy and consistency. Consideration should be given to sending a small set of control samples from a lab in Australia for analysis at both of the Indonesian labs (NPD to talk to Shaun Lisson).
- Chemical analysis to determine any underlying sub-soil constraints, as well as inputs required for APSIM, should be undertaken for each depth layer. Sampling has already been completed at Pattalikang. At Mertak it is recommended that samples be collected either from the pit during soil characterisation, or adjacent to the pit site (when identified) using samples from 2-3 bulked cores. Samples should be dried at 400 Celsius or air dried. Analysis is required for pH, EC, Chloride, CEC, and Organic Carbon. Duplicate samples should be archived in case re-analysis is required.
- Particle size analysis (texture) to be done to confirm field assessments of texture.
- Suriadi to finally select the sites at Mertak village and undertake soil sampling for chemical analysis and soil characterisation.

Location of Characterisation Sites

It seems logical that the wet season be used to our advantage allowing rainfall to fill the profile before determination of DUL and BD. The difficulty will be ensuring that the profile is not allowed to dry out at the end of the rainy season and/or the profile is inadequately drained when sampling takes place. It is important to locate the sites away from bunds, trees and crops to ensure that soil water is not ‘stolen’ by the nearby vegetation, particularly during the drainage phase. I would suggest that an area of at least 8m square be identified as far from perennial vegetation as possible. This area will need to be kept clear of crop and weeds during the season. Covering the actual measurement area with organic material (rice straw for example) would be advantageous in terms of reduced evaporation, improved infiltration and reduction in weeds. It will be necessary to cover the measurement area with plastic sheeting whilst drainage is occurring. Plastic should be sealed around the edges to minimise evaporation. Sampling should be undertaken in the centre of the site. Animals should be excluded from the characterisation area.



If it is considered that the rainy season has been sufficient to wet the profile to full depth (assuming 180 cm) it is recommended that the ponds be left for 6-8 weeks after the final rain (or after water has been drained from field) before sampling. This will allow time for drainage and will be particularly important on the Black Vertisol at Mertak and the irrigated clay at Manyampa, both of which will be very slow draining. It is during the drainage phase that the covering of the sites with plastic sheeting will be critical in minimising evaporation.

If an opportunity arises (after rainy season crops have matured and/or after subsequent crops such as soy beans) to sample for Crop Lower Limit it is recommended that 3-6 cores be taken for soil water determination within close proximity to the soil characterisation site (within 10 metres of the site or on other fields with similar soil type). It is important that the same sampling increments be used for all sampling activities undertaken on the one soil type, both during characterisation and in subsequent monitoring of soil water and nutrients.

Soil equipment requirements

Both BPTP Mataram and Makassar have reasonable levels of soil sampling equipment available. The majority of gear imported during Phase 1 of the project is still in operating order although needing some maintenance.

- Lombok: fabrication of 180 cm x 31mm diameter tubes is required to replace those damaged during phase 1.
- Sulawesi: tubes are in good order although the tip of the 180 cm x 37mm diameter tube needs to be removed and re-formed. A new handle for the Dormer auger is also required.

All tubes should be fabricated using 1.6-2.0 mm thickness steel pipe. It is suggested that a number be fabricated at each site to ensure that sampling is not interrupted through lack of equipment. It is critical that tubes be cleaned internally and oiled regularly (both internally and externally) during use and long term storage. Cleaning and oiling with vegetable oil reduces tube blockages and rusting.

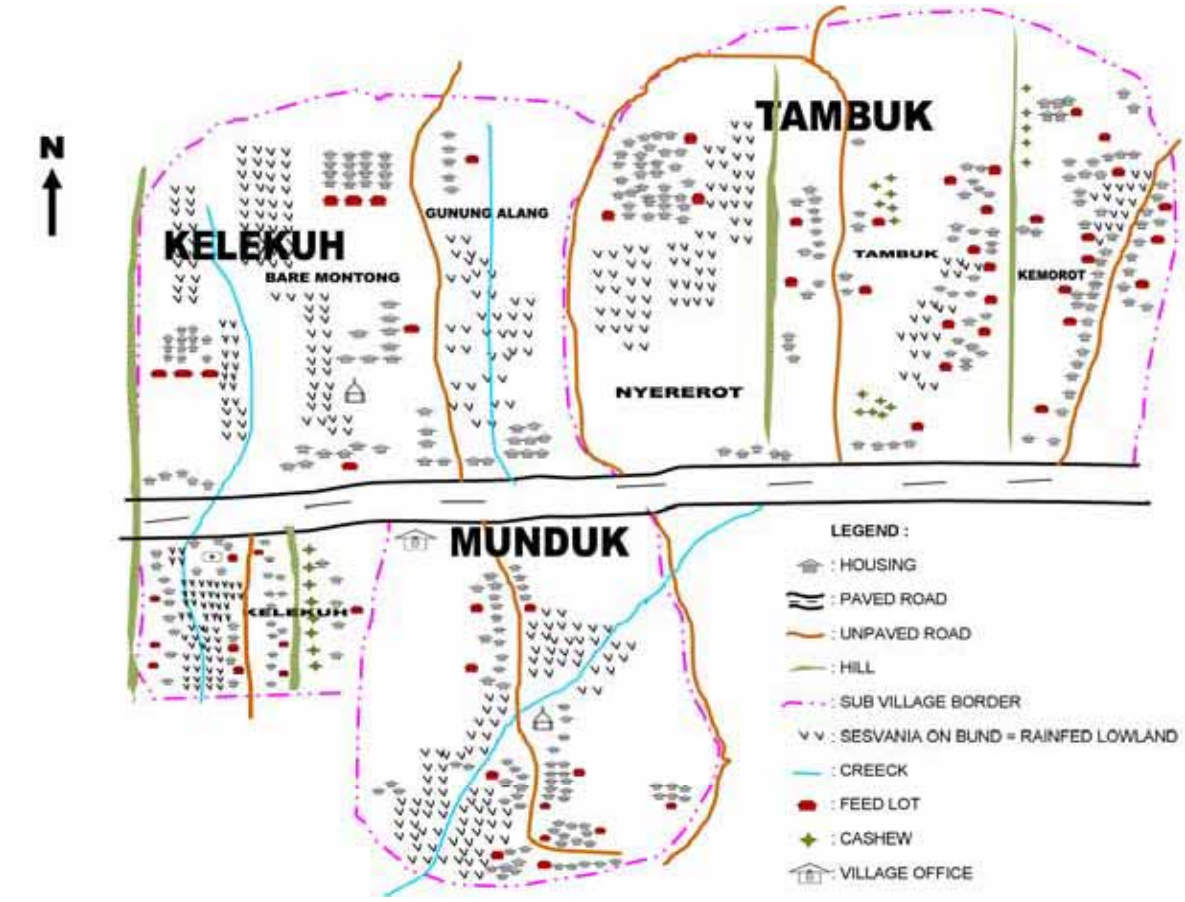
11.3 Appendix C. Details of variables assessed during best-bet forage and cattle monitoring

Forage monitoring		Cattle monitoring	
Variable	**Method/measure**	**Variable**	**Method/measure**
a. Cut and carry		**Performance**	
Biomass offered	kg fresh & dry	Cattle ID	farmer/age code
Composition	% estimate	Liveweight	weighing (kg)
Leaf proportion	% estimate	Condition score	estimate
Greenness	% estimate	Girth & height	tape (cm.)
Residue	% estimate	Age	mouthing
Source	location of forage source	Sex	
Number cattle fed	no. and class	Reproductive status	lactating, calving pregnancy stage
Water offered	l/head/day	Fate of animal	died, sold etc.
b. Grazing resource			
Biomass	estimate kg/ha		
Composition	% estimate		
Defoliation score	rating		
Time spent grazing	hours/day		
Size of area grazed	estimate (ha)		
Number of cattle grazing	no. and class		
c. Pasture exclosures			
Biomass	kg/ha		
Composition	% dry weight		
d. Best-bet forage banks			
Biomass	kg/ha		
Composition	% dry weight		

11.4 Appendix D. Key characteristics of the smallholder farming systems of Desa Mertak, Lombok

Desa Mertak in Central Lombok was selected as the target region after some reconnaissance trips to West, East and Central Lombok and a series of discussions between the BPTP collaborating staff, Dinas and Regency officials. The choice of Desa Mertak was largely based on community need, overall agro-ecological context, local cattle populations, and enthusiasm of the community leaders to participate. Mertak is comprised of 21 sub-villages and further segregated into approximately 63 sub-sub-villages (~ kampungs, although sub-sub-sub-villages do exist in some smallholder communities which would also have this descriptor). From this grouping, local data from the Kepala Desa's office and consensus meetings with sub-village leaders (Kepala Dusun) identified 3 sub-villages and 4 sub-sub-villages that were visited to assess their potential suitability for participation. The criteria included cattle ownership, enterprise types, local agro-ecological contexts, access and usefulness as exemplars to other sub-sub-villages. The 3 sub-villages that were investigated were Kelukuh, Tambuk and Semunduk, from which 4 sub-sub-villages were investigated, viz. Kelukuh, Bare Montong, Kemorot and Semunduk. The location of these sub-sub-village communities is presented in Figure 1.

Figure 1. Location of 4 sub-sub-villages in Desa Mertak, Lombok



Data on households, cattle ownership, and cattle numbers for these sub-sub-villages is included in Table 1.

Table 1. Households and cattle in 4 sub-sub-villages of Desa Mertak, Lombok (2005)

Sub-village	Sub-sub-village	No. Households	Household with cattle	No. Cattle	Cattle per household*
Kelukuh	Kelukuh	43	32	105	3.3
	Bare Montong	36	32	88	2.9

Tambuk	Kemorot	17	17	34	2.0
Semunduk	Semunduk	110	74	220	3.0
Total		206	155	447	3.0
** Households with cattle.*					

From this example, it can be seen that kampung communities range in size, although Semunduk is on the larger end of the scale with more than 100 individual households, and the majority of those households have cattle, although the number of cattle owned or managed per household with cattle is generally small - often a single cow and last season and this season's calves.

B. Household data

The household structure and employment status in these sub-sub-villages are presented in Table 2.

Table 2. Household characteristics in 4 sub-sub-villages of Desa Mertak, Lombok (2005)

	Kelukuh	Bare Montong	Kemorot	Semunduk
Age household head (yrs)	34	39	41	41
	(25-40)	(30-50)	(29-50)	(30-50)
Family members (no.)	5	5	4	4
	(4-7)	(4-8)	(3-4)	(3-6)
Full time farm workers (no.)	3	3	2	3
	(2-4)	(2-6)	(2-4)	(1-5)
Part-time farm workers (no.)	1	1	1	2
	(0-3)	(0.25-1)	(0-1)	(0-2)

For the selected communities, households of around 4-5 people are typically headed by a working age adult (usually male), and include 2-3 working adults and 1-2 dependant children. The adult family members commonly include an older grandparent who will look after dependent children and livestock. Many households may include a younger adult who has yet to establish their own independent household and may be supporting their attempts to establish a capital base through part-time work.

Land ownership and general land type for the 4 sub-sub-villages are presented in Table 3.

Table 3. Land area/type for households in 4 sub-sub-villages of Desa Mertak, Lombok (2005)

	Kelukuh	Bare Montong	Kemorot	Semunduk
Lowland rainfed (ha)	0.5	0.3	0.3	0.9
	(0-1.0)	(0-0.9)	(0-1.0)	(0-3.8)
Upland (ha)	0.4	1.0	0.8	1.3
	(0-1.1)	(0.6-1.3)	(0.5-1.4)	(0-2.8)
Private grazing land (ha)	0	0	0.3	0
	0	0	(0-1.0)	0
Backyard (ha)	0.2	0.1	0.1	0.1
	(0-0.3)	(0-0.3)	(0-0.1)	(0-0.5)

The land ownership pattern for the selected sub-sub-villages is reasonably typical of smallholder communities across the region - households have a small backyard (occasionally 2 when multiple households are involved) on which their dwelling, garden plots and livestock housing are usually located. These home yards typically adjoin to form the kampung village structure. Food crops are usually produced on lowland paddy fields that are either irrigated or rainfed (Mertak is located in a dry region with no formal irrigation scheme). Most households also have additional upland areas on which cash cropping and estate cropping activities are often located, and to a lesser extent additional

food cropping for household consumption. Livestock may also be grazed in these areas, especially during the rainy season when the lowland sites are under crops. The upland areas are often larger than the lowland areas (Kelekuh is an exception being located in a lowland area with limited upland in the near vicinity), and some sub-sub-villages may have further access to private grazing land (Semunduk in this case is also predominantly a lowland site, but is also located near some hill country that was formerly used for forestry).

The farming systems in the communities are often relatively complex and there is usually some variation between households, and also between years. An example of a general cropping calendar for one farming system in Desa Mertak is presented in Figure 2.

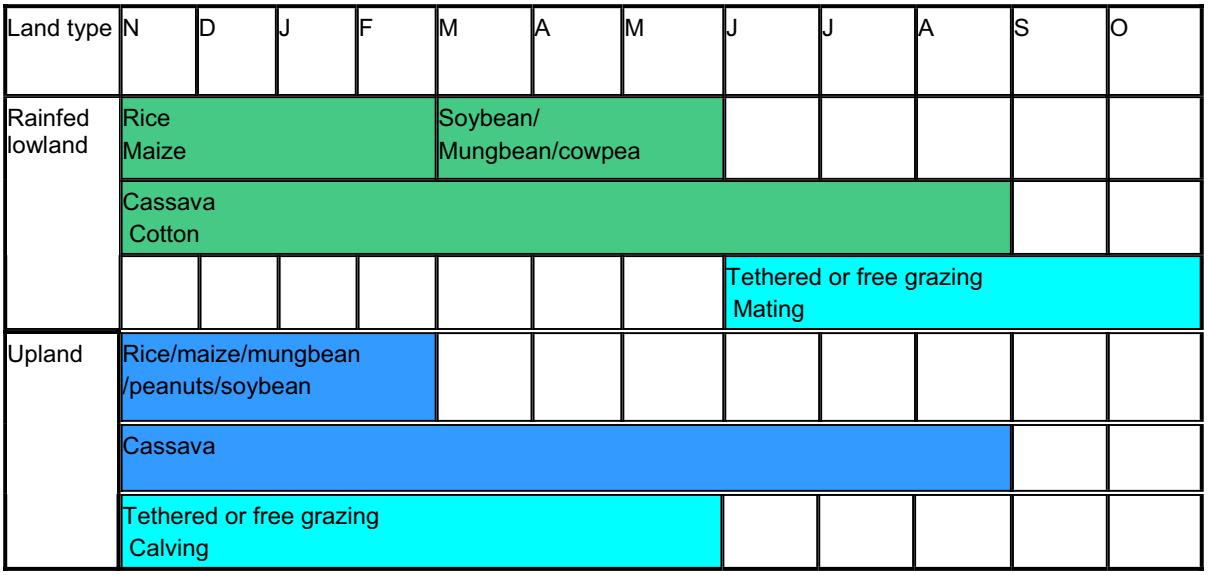


Figure 2. Generalised cropping and livestock calendar for smallholder farming system in Desa Mertak

Cropping choices depend considerably on seasonal conditions, relative price ratios between crops (including whether a market actually exists by harvest time) etc. Typically several crops are co-located (e.g. maize and cassava grown on bunds around rice crops), or inter-row cropping. Nevertheless, both lowland and upland crop areas can lie in fallow for much of the dry season and the actual area of cropping can vary between land types and seasons (e.g. 1ha of available upland fields might only have 0.2 ha of crops planted on them during the dry season). Mating of cattle can depend on availability of bulls or occur indiscriminately, and many young cattle are self-weaned at some time around 12-14 months. Cattle are generally tethered or free grazed for between 7-12 months each year, although access to grazing can become limited between July and September when crops are still standing in both lowland and upland fields - tether grazing becomes more common at this time. For cropping activities the peak demand for labour is usually between October/November through to February/March, while livestock labour demand peaks between July and November when dry season feed availability is limiting. Cropping activities on the majority of smallholdings are concentrated on producing food crops for direct family consumption.

The general mix of cropping activities on smallholder farms and how it may change between households and seasons is further illustrated in Figure 3(a to e) - taken from the monitoring of 10 `best-bet' households in Mertak from 2005 to 2008.

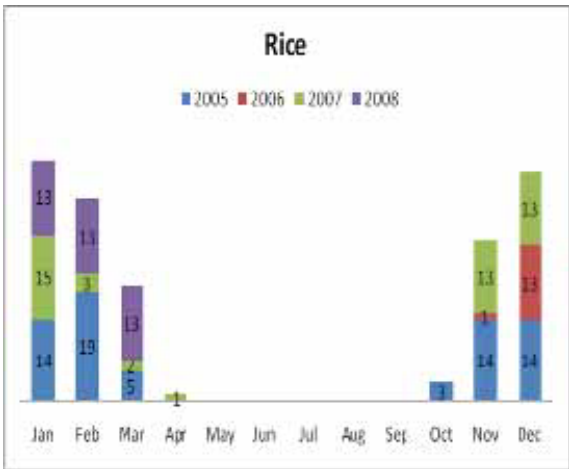


Figure 3a. Number of parcel planted to rice

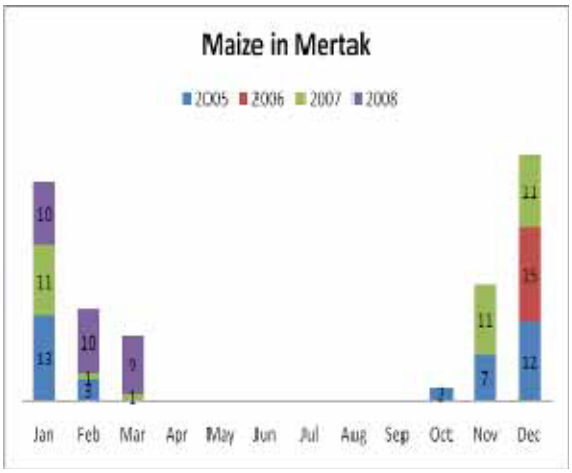


Figure 3b. Number of parcel palnted to maize

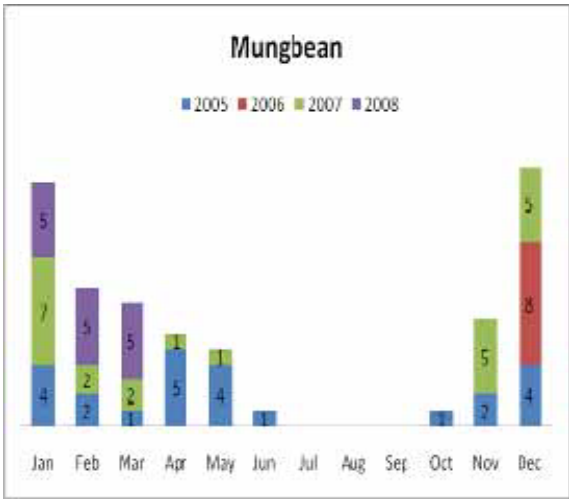


Figure 3c. Number of parcel planted to mungbean

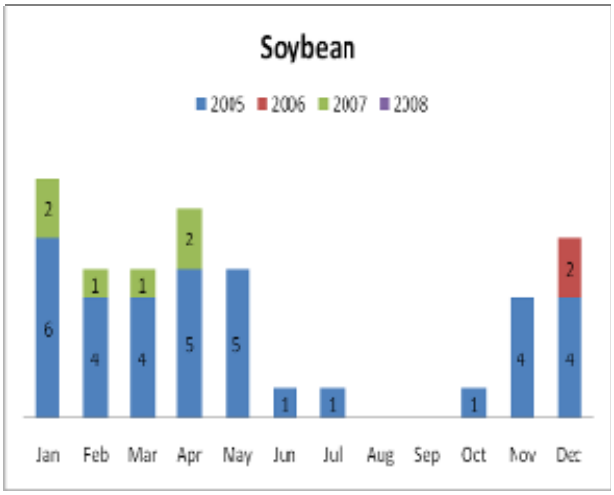


Figure 3d. Number of parcel planted to soybean

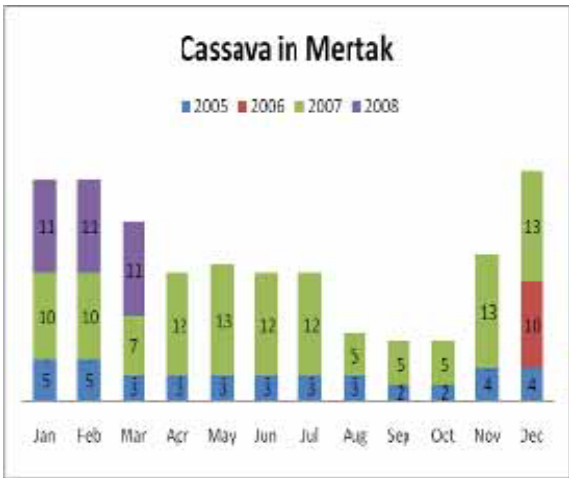


Figure 6e. Number of parcel planted to cassava

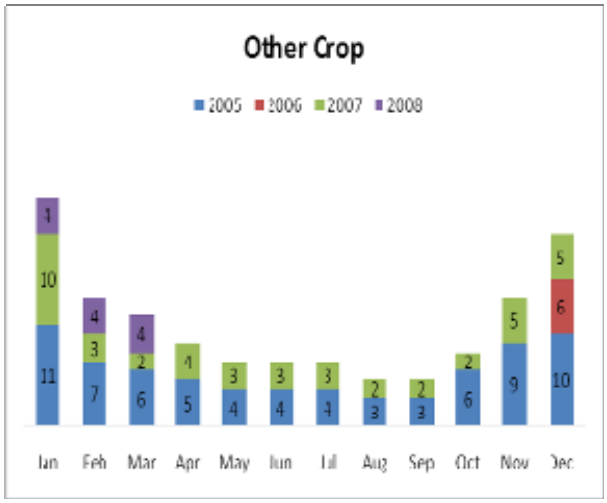


Figure 6f. Number of parcel planted to other crops

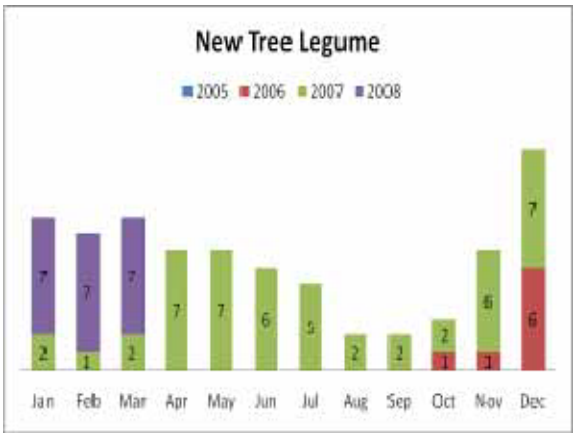
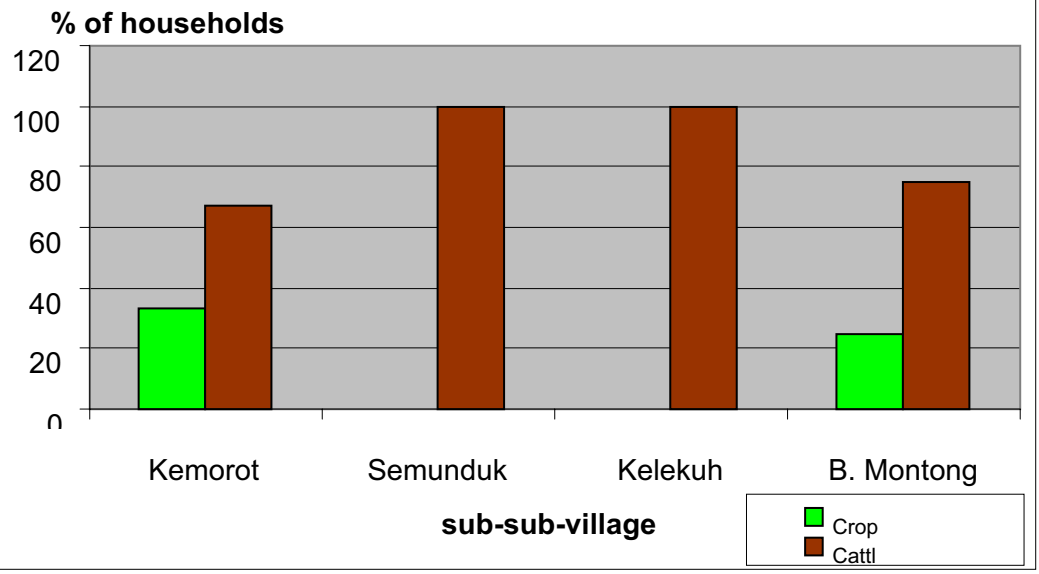


Figure 6g. Number of parcel planted to new tree legumes

Again the dominant crops that were grown by the 10 households are rice, maize, soybean, mungbean, cassava and a wide range of other crops grown on relatively small areas of land. Most of the households have several parcels of cropping land and the sub-figures record how many parcels of land were sown to a particular crop, and in which months the crop is present on that land. Rice is grown in each year on as many land parcels as will support this subsistence crop. However, from 2005 to 2007 the crop failed and many of the farmers sold cattle to purchase rice for household consumption (se again below). Maize is also mixed cropped with cassava, rice, mungbean and soybean by all of the households - with the grain fed to chickens and young leaf and stalks fed to cattle. The mungbean and soybean are grown for cash sales although this is a limited source of cash for most families (see below), while the residues are also fed to cattle. Cassava was planted in 2005 for household consumption, home industry and to a lesser extent cattle feed. However, due to the dry conditions experienced in 2006, most of the cassava was fed to cattle and some of the households also purchased cassava from other households to feed their cattle. While the area and number of parcels of land planted to cassava grew from 2006, plantings of mungbean and soybean began to decrease. Finally, since the project commenced in 2006, the area of new plantings of tree legumes has progressively increased.

Most of the cash income earned by smallholder households is derived from a relatively narrow range of farming activities, including cash cropping, with a significant role played by livestock (notably cattle) in generating cash resources. The principal sources of family income for the 4 sub-sub-villages examined in Desa Mertak are presented in Figure 4.

Figure 4. Principal source of family income (%), Desa Mertak 2005



Cattle are the principal source of cash income for the majority of households in all of the 4 sub-sub-villages, although cash crops are also the main source of cash income for 25% and 30% of households in Bare Montong and Kemorot, respectively. Part-time paid employment - either within local communities (e.g. performing farm activities for other households), or elsewhere (e.g. labouring, running kiosks, trading, ojek etc) - can also supplement family cash income for smallholder households, although this was not a primary source of cash income for any of the households canvassed in the 4 sub-sub-villages under review.

Table 4. Average number of cattle sold by households in 4 sub-sub-villages of Desa Mertak, Lombok (2005) and the principal reason (% households) underlying these sales.

	Kelukuh	Bare Montong	Kemorot	Semunduk
Cattle sold (no.)	0.5	1.3	1.3	1.3
	(0-1.0)	(0-4.0)	(1.0-2.0)	(0-4.0)
Principal reason for sales.				
Main source of income (%)	0	0	33	22
Special occasion (%)	25	50	33	44
Capital item (house, motorcycle) (%)	0	0	0	11
Other (Haj, emergency, school fees) (%)	75	50	33	33

While cattle (and other livestock - e.g. goats, chickens) sales are the principal source of cash income for many smallholder households (Figure 4), the principal motivation for selling cattle in any particular season is not necessarily to support an ongoing stream of income for household consumption and wealth creation. The average number of cattle sold by the smallholder households in the 4 sub-sub-villages in 2005 is presented in Table 4 along with the principal reason given for selling these animals.

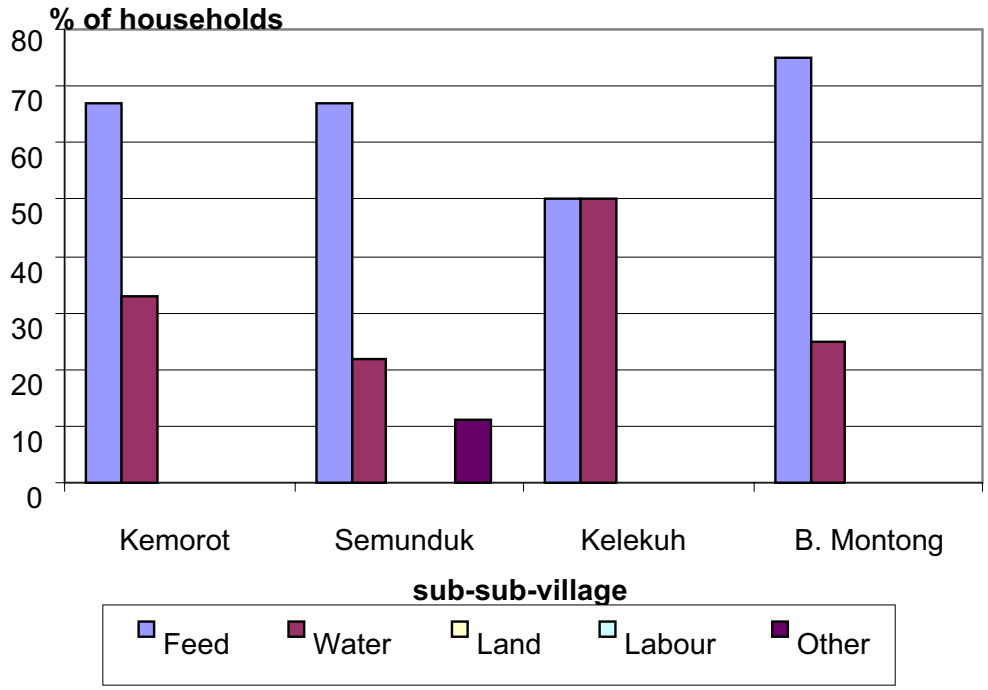
Consistent with relatively small number of cattle held by individual households (Table 1), the average number of cattle sold is also quite small, rarely involving more than 1 or 2 animals in a given year. While some households in 2 of the 4 sub-sub-villages (Kemorot and Semunduk) were reliant on cattle sales as a source of regular income, this still involved one third or less of those communities. Rather, the decision to sell cattle is more typically triggered by the need to meet some larger expense such as a medical emergencies, family celebrations (e.g. weddings, coming of age), school fees, house renovation or erection, purchase of transport (motorbike, truck or chidomo), or undertaking

travel for Haj etc. For this reason, cattle sales for any given household can be quite irregularly undertaken between and within years.

A farming systems approach to improving the performance of existing smallholder livestock production activities will necessarily be interested to identify the smallholders' own perceptions of what factors might be significantly constraining their existing activities. The response to this question by the smallholders in the 4 sub-sub-villages is presented in Figure 5.

Given the relatively dry environment of the southern section of Central Lombok, it is probably not surprising that the principal constraint identified by the smallholders themselves in all 4 sub-sub-villages is the availability of feed for their cattle; followed by the availability of water for stock. Land and labour resource availability was not seen to be constraining expansion of cattle production at all, although labour required to feed cattle in the dry season is not an insignificant task - as noted in the following paragraph.

Figure 5. Principal constraints to cattle production, Desa Mertak



Something of the nature and scope of the problem confronting smallholders planning to intensify cattle raising activities, as well as the opportunities created by integrating specialised forages into their farming systems, is identified in Table 5 which presents data on cut and carry and water provision activities for the 4 sub-sub-villages.

Table 5. Cut and carry activities by households in 4 sub-sub-villages of Desa Mertak, Lombok (2005).

	Kelukuh	Bare Montong	Kemorot	Semunduk
Maximum distance for cut & carry (km)	84	55	32	40
	(64-100)	(45-70)	(0.5-50)	(2-60)
Hours/day/household for dry season CC	11	11	6	6
	(8-14)	(5-14)	(3-12)	(2-12)
No. months CC	3	3	5	6
	(2-3)	(2-4)	(1-12)	(1-12)
Hours/day/household providing water	0.8	0.7	0.5	0.7
	(0.5-1.0)	(0.1-1.0)	(0-1.0)	(0.5-2.0)

Forage availability for cattle becomes extremely scarce in all of the sub-sub-villages, particularly in the dry season (August-October), and households spend a considerable amount of time each day procuring feedstuffs and, to a lesser extent, water for their cattle. Cut and carry forages typically include local grasses between November-March, grasses and shrubs (sesbania, gamal, lantoro) between March to June, and shrubs and straws (peanut, soybean) from July-October. Although not shown, the cost of hiring transport for feeds from outside the village area (usually other villages in northern Central Lombok or East Lombok) is typically one of the largest cash outlays made by the households, second only to purchases of cattle. Despite the high cost of transporting in feedstuffs, this material is typically crop residues and straws (e.g. rice straw) of relatively low nutritional value. At the time of undertaking the baseline assessments, relatively few households actually conserved crops residues and straws from rainy season crops for feeding cattle later in the dry season.

On the basis of the exploratory work undertaken with the 4 sub-sub-villages, the project team subsequently identified 20 households to be considered for further selection as best-bet case studies.

As noted above, the general structure of the households and farming systems in both Sulsel and central Sumbawa are similar to southern Central Lombok and the process for selecting target communities and best-bet cases studies was essentially similar. There are, of course some basic differences between the sites including (for example) terrain, rainfall and availability of irrigation water that may favour late rainy season cropping in some communities (e.g. Lompo Tengga sub-village in Barru Regency, Sulsel) moreso than others that are less endowed (e.g. SPA kampung, Dompu Regency, central Sumbawa). Community and household data of a similar nature to that presented before is contained in the relevant sections of Appendix 1 and 2 (the original benchmark summaries for Barru and SPA).

11.5 Appendix E. Fact sheets

Using forage banks to provide quality year round forage close to kandangs

Jeff Corfield, CSIRO Sustainable Ecosystems, Australia

What is a forage bank?

Forage banks are plots of high producing grass and legume forages specially grown to provide high quality cut and carry feed for sapi. Forage banks are often in backyards or land close to household or kandangs. They are called "forage banks" because forage grown is often saved as standing or conserved forage for feeding in dry season or periods of feed shortage.

Forage banks

- Use perennial grasses such as elephant grass, *Setaria* and *Brachiaria, Mulato, Paspalum, perennial* herbaceous legumes such as *Stylo*, *Clitoria* and *Centrosema* and tree legumes such as gamal and lamtoro to produce large amounts of high quality forage for year round use.

- Are harvested regularly during the wet season and early dry season then often left as standing forage or cut and dried as conserved forage for dry season use when other forage is limited.

Forage banks situated close to backyard or communal kandangs:

- Provide easy access to high quality forage close to where sapi are kept.
- Are close to sources of sapi manure to provide good compost for improved forage growth.
- Save much time and labour in gathering cut and carry forage from the field.
- Improve sapi condition and growth by having easy access to high quality forage

CSIRO

Australian Government
Australian Centre for International Agricultural Research

Further information
contact: Firstname Lastname
phone: (00) 0000 0000
email: firstname.lastname@csiro.au
web: insert specific divisional url
www.csiro.au

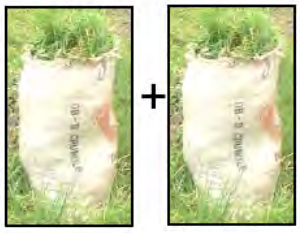
How many sapi will my forage bank feed?

Jeff Corfield, CSIRO Sustainable Ecosystems, Australia

When planning forage banks it is important to balance the expected yearly forage production with the forage requirements of your sapi to work out how many sapi you can feed and for how long. **THIS IS CALLED FORAGE BUDGETING**.

Here are some simple rules of thumb to remember

One adult sapi cow needs 30-45 kg of fresh forage each day depending on the time of year.



This translates to around 12 tonnes of fresh forage for one sapi cow for one year

Some forages can produce up to 120 tonnes of fresh forage per ha per year over several harvests.

This translates to around 12 tonnes of fresh forage produced from a forage bank of 0.1 ha (30m X 33m)

Therefore to provide enough forage to support one sapi cow entirely for one year you will need a forage bank of around 0.1 ha or 30m X 33m in size

1 year

1 ha

CSIRO

Australian Government
Australian Centre for International Agricultural Research

How much forage for my sapi?

Jeff Corfield, CSIRO Sustainable Ecosystems, Australia

Forages are un-processed grasses, herbaceous legumes, shrub or tree legumes used for feeding sapi.

The amount of fresh forage a sapi needs each day may change depending on five key things: the age, size and activity of the sapi, the season and the type of forage.

Age and size of the sapi

Smaller, younger sapi needs less food compared to a larger, older sapi. However younger sapi need higher quality food to grow and develop. Include at least 10-20% legume in young sapi diet for good growth.

Time of year (season)

In the wet season, there is more moisture in fresh forage, so you need more fresh forage to provide the desired 3% of body weight in equivalent dry feed. B both soil moisture and forage quality decline in rumput champur, over the dry season.

Type of forage

Is your forage pasture, cut and carry rumput champur, tree legumes, crop residue? Forage types vary in palatability, leafiness, greenness and nutritive value. Do you know which forages are the most nutritious?

Activity of sapi

If a sapi cow is lactating, ploughing and pregnant, she will need more and higher quality food to replace extra energy used and produce milk, than a dry cow. Provide additional good quality forage to lactating cows – at least 10-20% legume in diet.

In general a sapi needs to eat 12-15% of its body weight in fresh forage or about 3% of body weight in dry forage each day to maintain condition and grow.

EXAMPLE OF FORAGE CALCULATION

A a sapi cow weighs 250 kgs 12% of her weight is 30 kg.

It is wet season and she is pregnant and lactating, so she needs at least 30 kg of forage to maintain good condition.

This forage could be
- 30 kg good quality rumput champur
- 10 kg gamal + 20 kg rumput champur
- 15 kg lamtoro + 15 kg rumput gaja
- or any combination

Which do you think is the best combination for this sapi?

CSIRO
Australian Government
Australian Centre for International Agricultural Research
Further information
contact: Firstname Lastname
phone: (00) 0000 0000
email: firstname.lastname@csiro.au
web: insert specific divisional url
www.csiro.au

How much water for my sapi?

Jeff Corfield, CSIRO Sustainable Ecosystems, Australia

Water is essential for all animals and plants to survive, grow and reproduce. Sapi need water to produce muscle, blood, milk and other body fluids and to digest food and excrete waste. An adequate supply of fresh water is essential for sapi health, growth and development.

Adult sapi require about 12-15% of their body weight in water each day – or around 30-40 litres for a 300kg sapi. However, the actual amount of water required depends on six key things: the size, age, sex and activity of the sapi, the time of year and type of forage supplied.

Age, size and sex of the sapi

Young sapi require less water overall, but need a higher % of body weight in daily water intake than older sapi. Pregnant cows require more water per day than male or dry female sapi.

Time of year (season) and forage type

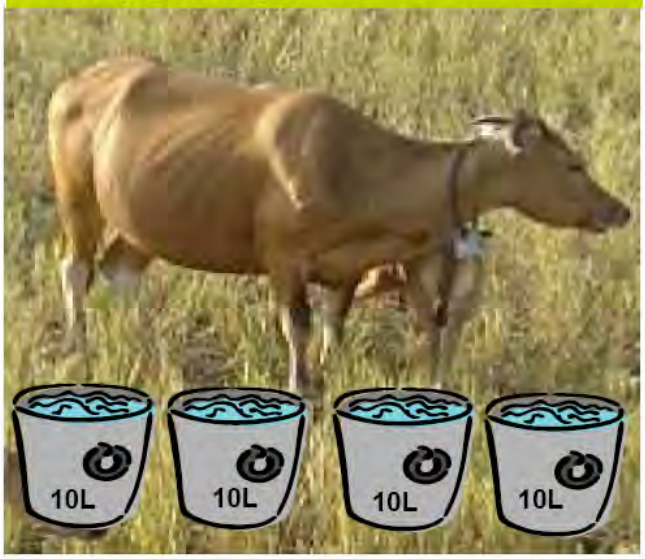
Sapi require more water during the hottest months (late dry season). In the rainy season sapi get some of their water needs from fresh green forage. However, if feed is mainly dry forage you need to supply most of the sapi's daily water needs directly.

Activity of sapi

Sapi used for draught activities (like ploughing) require additional water to replace fluid lost while working.

Lactating sapi cows require more water than equivalent size dry sapi cows. Add 5-10 litres more water per day for lactating cows to ensure good milk production for calves.

A 250kg lactating sapi cow on mainly dry feed needs 35-45L of fresh water per day in the late dry season to produce sufficient milk to feed a healthy growing calf.



A similar 250kg non-lactating sapi on mainly fresh green forage in the wet season needs 20-25 L of fresh water per day for maintenance

CSIRO
Australian Government
Australian Centre for International Agricultural Research
Further information
www.csiro.au

Options to improve water supply for sapi

Jeff Corfield, CSIRO Sustainable Ecosystems, Australia

Options to improve sapi water supply

Often the amount of water supplied each day to sapi is restricted by the distance required to carry it and limited on-farm sources of fresh water. When sapi (especially lactating sapi cows) have insufficient water, they are not able to digest forage easily, grow or produce enough milk for calves.

Here are some examples of using recycled household water, water captured from household roofs or in wells to increase sapi water supply. You might wish to try one of these options.

Simple backyard cement ponds or tanks which hold 100-500 litres of recycled household water can provide sapi with a regular supply of water that they can access easily. Only relatively clean recycled washing or kitchen water should be used for this purpose.

Capture rainfall run-off from house roofs with some simple bamboo or plastic guttering and piping and store in larger plastic lined or concrete tanks. Such permanent storages can provide water for both the household and sapi needs in most years.

Construct concrete or plastic lined wells or small earthen dams in suitable land types and locations close to household or backyard kandangs. Such permanent storages can provide water for both household and sapi needs in most years.

Simple cement backyard water storages to supply re-cycled household grey water to sapi at SPA village, Sumbawa, NTB

Concrete storage tank to hold water captured from house roof at Mertak village, Lombok

Concrete well to supply water for household and sapi, at Mertak, village , Lombok

CSIRO

Australian Government
Australian Centre for International Agricultural Research

Using tree legumes to provide high quality forage in the dry season

Jeff Corfield, CSIRO Sustainable Ecosystems, Australia

Tree legumes include shrubs and trees such as:

Lamtoro (*Leucaena leucacephala*
Turi (*Sesbania grandiflora*)
Gamal *(Gliricidia sepium)*

Tree legumes have high levels of protein essential for good sapi growth. If managed well they can produce green leaf year round and provide high quality cut and carry in the dry season when other cut and carry sources are limited.

Tree legumes can be easily grown as:

✓Living fences along roadsides or around paddocks or backyards

✓Hedges or rows on bunds or in pasture areas

✓ Plantations on upland hillsides

Tree legumes are usually fed as fresh cut and carry forage. However leaves of tree legumes such as lamtoro, turi and gamal can also be conserved as hay or leaf meal for use as high quality dry season supplements.

Feeding tree legumes to your sapi will improve:
✓sapi condition and performance
✓ milk production for sapi cows
✓ growth rates for young sapi.

❖ Even 10-20% tree legumes in your cut and carry will make a big difference to sapi performance in the dry season.

Lamtoro (*Leucaena leucacephala*

Turi (*Sesbania grandiflora)*

Gamal *(Gliricidia sepium)*

CSIRO

Australian Government
Australian Centre for International Agricultural Research

Further information
contact: Firstname Lastname
phone: (00) 0000 0000
email: firstname.lastname@csiro.au
web: insert specific divisional url
www.csiro.au

Establishing and managing tree legumes for forage production

Jeff Corfield, CSIRO Sustainable Ecosystems, Australia

Lamtoro, turi and gamal can all be established from seed. Seed can be collected from mature trees and stored for planting later. Seed can be planted directly into prepared seedbeds or in poly bags or nursery seed boxes for planting out later in the field. Keep seedlings free of weed competition for best results.

Gamal is most easily established from cuttings (poles) planted directly in the ground to form "living fences" or hedge rows

Manage gamal and lamtoro for quality, not just quantity.
Keep hedges to around 1.2-1.5m high and harvest new growth at around 3m high.

CSIRO

Australian Government
Australian Centre for International Agricultural Research

Further information
www.csiro.au

11.6 Appendix F. Best bet village and farmer summaries

This section provides summary details of individual village and best bet farmer activities and outcomes. Individual farmer summaries are preceded by brief summaries for the relevant village. Each farmer summary includes:

- Dot point notes from original best bet farmer interviews including list of main constraints to livestock production
- A best bet calendar showing existing farming system and suggested best bet activities to address identified constraints
- A summary table containing notes on progress, outcomes and impacts
- A set of figures (labelled a, b, c, and d) showing the main forage and cattle weight monitoring trends with appropriate comments.

The basic figure set is similar for most of the best bet farmers, except where specific additional or alternative examples (mainly those used in the main report) are appropriate.

Notes on data used for figures

Forage data

Though both cut and carry and grazing related data was collected during monitoring, only the cut and carry data summaries are provided for individual farmers as grazing data is more difficult to relate directly to individual animal or farm performance. Moreover, the focus of this project is improving dry season cut and carry forage supply and quality, when available grazing is usually limited. However, where village scale impacts on grazing time and areas used are relevant they have been included in the village level summaries that precede the individual farmer summaries.

Cut and carry forage monitoring was generally conducted as 1-2 day snapshot surveys every 2-3 months of amount and composition of forage fed by farmers. Other data, including estimates of forage residue and % leaf, were also collected but these proved less reliable and so are not presented here for details of forage and cattle monitoring program)

Calculation of cut and carry dry matter

In most cases sub-samples for dry matter determination were taken during forage monitoring. However at some sites this was not done consistently and so estimates of dry matter content, based on previous knowledge of seasonal dry matter trends for each feed type had to be used in order to calculate the amount of dry matter being fed.

Calculation of dry matter per adult animal equivalent (AAE)

We used the following rule of thumb equivalents to calculate AAE's based on body weight and the allowance of 3% of body weight in dry matter for maintenance and growth.

- One adult sapi cow or bull <250kg = 1 AAE
- One sapi (male or female) between 150-250 kg = 2/3 AAE
- One sapi (male or female) between 50-150 kg = 1/2 AAE

In many situations it was very difficult to determine just which animals a farmer was feeding on occasions (due to insufficient information from farmer or recording of information) In such cases the best available estimates were used based on on-going knowledge of farmer practice. Therefore such data should be treated as "best estimates" rather than as accurate actualmeasures.

Cattle liveweight data

It was common across all sites for farmers to leave certain animals out of the regular weighing sessions, for various reasons, including their location in different areas at time of weighing, sickness, or for reasons unknown. Animals, especially males were also sold, swapped or share farmed leading to high turn-over in some villages. The high turnover of young males was in fact one measure of the success of the best bet forage and animal management measures, though this ironically made it more difficult to then measure impacts directly via animal performance. This led to very patch cattle liveweight data sets for many villages.

This compounded the already existing problem of small animal numbers per farmer for assessment of best bet impacts. The liveweight trend graphs constructed thus represent the best available data sets, but often contained few animals with consistent data for sufficiently long periods. Other data on body condition, reproductive state, girth and height measurements was collected at each weighing occasion but they are not presented here for sake of space.

The relative infrequency of forage and cattle monitoring, especially at SPA and in some Sulsel villages, compounded this problem as animals, especially males would be sold after only a few moths intensive kandang feeding – often the result of successfully applying best bet technologies. As will be seen in the figures presented, not every farmer had both cows and young males at the same time and so in places there is only one graph for the class of animal held and consistently presented for weighing during the study. In some cases it was easier to present male cattle trends for individual animals because the high turnover precluded calculation of consistent means and standard errors over a reasonable time period.

Village by village best bet implementation breakdowns

A total of 142 best bet options were identified for the 40 farmers involved across 9 sub-villages during the original best bet farmer interviews. Of these 85 were implemented by farmers during the period November 2005 to February 2008 (excluding stock water improvement options). Of the original 40 best bet farmers, only one completely dropped out (pak Nunding, Lomotengah, Sulawesi Selatan) while we gained an additional best bet farmer (Ramli) at SPA village in mid 2006.Table 1 summarises the details of best bets activities identified and implemented at each study village during the period November 2005 to November 2007.

Best bet activities in the three Barru sub-villages (Lompotengah, Harapan and Pattapa) and SPA sub-village, Sumbawa commenced at the beginning of wet season 2005-06. Most of these sub-villages had previously been involved in the earlier 124 and 125 projects which provided an array of biophysical and socio-economic benchmark data from which many of the IAT modelling scenarios were derived. By contrast the sub-villages at Desa Pattalikang (Gowa Regency) and Desa Mertak (South Lombok) had no previous history of involvement and thus required a year of benchmarking prior to commencement of best bet activities in wet season 2006-07. Thus the “old villages had three seasons of best bet activity while the “new” villages had only to seasons of best bets. The following notes provide more detail on the best bet implementation process and outcomes for each study sub-village and best bet farmer.

Table 1: Number of best bet activities identified and implemented across all sites

District/ Village	No. of farmers	New forage introduction		Better use of existing forages		Crop residue conservation		Preferential feeding / early weaning	
		Identified	Started	Identified	Started	Identified	Started	Identified	Started
Barru									
Harapan	5	3	3	4	2	6	2	3	2
Pattapa	5	4	2	3	1	4	0	5	1
Lompotengah	5	4	2	5	2	4	0	2	2
Total	15	11	7	12	5	14	2	10	2
Pattalikang									
Lemoa	5	8	5	2	1	2	1	2	1
Manyampa	5	8	6	4	2	2	0	2	1
Total	10	16	11	5	3	3	1	4	1
Mertak									
Barremontong	1	2	2	1	1	1	0	1	0
Kelekuh	4	12	8	6	5	4	1	3	2
Semunduk	5	7	4	4	2	1	0	1	0
Total	10	22	17	11	8	6	1	5	2
Dompu									
SPA	6	4	6	6	6	9	4	4	5
Grand total	41	53	41	34	22	32	8	23	12

11.6.1 Barru sub-villages

Five best bet farmers were selected in the three chosen sub-villages (Harapan, Lompotengah and Pattapa). Table 1 details the best bet activities originally identified for each farmer and those initially implemented in year 1. In some cases farmers added additional best bet activities to their originally identified options (especially forage introduction and management and early weaning / preferential feeding best bets) as part of the adaptive management process.

11.6.2 Harapan sub-village

A total of 17 potential best bet activities were identified of which 12 were commenced. Identified best bet activities were fairly evenly distributed across all four categories with most activity in year 1 (2005-06) focussing on better use of existing forages such as Gliricidia and elephant grass and introduction of new forages (table 2).

Table 2: Best bet activities identified for case study farmers in Harapan village 2005-07

Village / farmer	New forage introduction		Better use of existing forages (tree legs and EG)		Crop residue conservation incl. rice straw ammoniation)		Preferential feeding / early weaning	
Harapan	Identified	Started	Identified	Started	Identified	Started	Identified	Started
Hassanuddin	1	1	1	0	1	0	1	0
Mohammad	1	0	1	1	2	1	1	1
La Matta	1	1	1	1	1	0	1	1
Sudding	0	1*	1	1	1	1	0	0
Cerrang	0	1*	1	0	1	1	0	0
Total	3	4*	5	3	6	3	3	2

** Some farmers adopted best bet practices after observer fellow best bet farmers*

Whilst one farmer (Mohammad) tried rice straw ammoniation in 2006 no others attempted this and Mohammad himself did not persist with this option. Two farmers (Cerrang and Sudding) expanded their conservation of peanut straw in 2006 and 2007. Two farmers (La Matta and Hassanuddin) successfully established introduced forages in theier backyards and upland in 2005-06 while two more farmers (Cerrang and Sudding) established upland forage banks in year 2 (2006-07) using material sourced directly from La Matta or from the project. Of forages tried, grasses such as Brachiaria decumbens, Bothriochloa insculpta cv hatch and Bracharia x cv Mulato have been the most successful to date in terms of establishment, persistence and production.. Forage legumes such as Stylosanthes guyanensis and Centrosema pascourum have declined with time in these backyard forage banks, probably due to competition from sown grasses.

Three farmers (Mohammad, La Matta and Sudding) have expanded and improved management of existing elephant grass forage banks while Mohammad has significantly expanded the planting and use of Gliricidia hedges for dry season forage. To date La Matta is the only best bet farmer to fully embrace early weaning though several farmers including Mohammad and Sudding are preferentially feeding young male cattle in backyard kandangs with higher quality forage at certain times.

Best bet farmer: Pak La Matta, Dusun Harapan, Barru, Sulawesi

Main points from original interview notes

- Currently has 2 cattle. Wants to increase number but is feed limited, especially late in dry.
- No free grazing and upland area fenced.

- Rice straw fed to stock without improvement. Has small structure to house rice straw. Opportunity for ammoniation.
- Opportunity to improve feed quality in upland area (currently native 'pasture + elephant grass). Establish mixed pasture sward (Stylo guyanensis + Brachiaria humidicola). Banks of cut and carry perennial grasses (Pennisetum purpureum, Panicum maximum). Banks of Gliricidia. Sward best established in step by step manner – small area at a time. Suggest the area to be sown be cleared of weed in November and then sown directly in early December once there is adequate soil moisture. Little cultivation is required.
- Demonstrate and compare a number of land preparation methods (slash and burn vs slash and herbicide vs hand weeding).
- Current mating cycle not too bad. Could bring back a little.
- Opportunity for preferential feeding.

Major constraints to cattle production

- Availability of high quality forage in late dry and early wet
- Free communal grazing of upland by other farmers during wet restricts opportunities for forage bank development in upland
- Limited amount of crop residue available for feeding in late dry season
- Poor dry season animal performance

Calendar of existing farming system and suggested best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Lowland	0.3ha (adjacent to Muhammad)	Food crop	Rice					Peanut						
		Grazing						Tethered (shorter period on peanut covered ground)						
		Cut and Carry												
Upland / Backyard	0.5ha	Food crop												
		Grazing	Tethered											
		Cut and Carry	Establish introduced forage grass and legume forage bank. Elephant grass and Gliricidia around boundary.for cut&carry											
Cattle breeding			Weaning and preferential feeding					Calving			Mating			
Off-farm residue / cut and carry														
Conserved feed (period of use)			Peanut					Ammoniated rice straw						
Peak labour periods			Rice planting				Harvest + prep./planting				Harvest			Rice prep.

Summary of best bet progress to February 2008

Farmer: La Matta, Harapan	Actual best bet	Commenced	2006 progress	2007 progress
Best bet 1	New grasses and legumes for backyard	2005-2006 wet	Very good	Good - expanding
Best bet 2	More tree legumes and EG for upland	2005-06-wet	Good EG fair gamal	Good EG fair gamal
Best bet 3	Rice straw ammoniation	April 2006	Not done	Not done
Best bet 4	Early weaning / preferential feeding	2006-07	Not yet tried	Now doing both
Overall assessment	Excellent establishment and growth of Brachiaria decumbens and Bothriochloa insculpta. Stylo guyanensis established patchily and while still there has remained a minor contribution. Large expansion of EG and is now managing this well to promote higher leaf proportion, as recommended following advice by Jeff in Feb 2007. Some planting of Gliricidia hedges along fences but little on old bunds. No progress on ammoniation as yet – logistically too difficult and now sufficient forage anyway Now doing both early weaning and preferential feeding.			
Farmer attitudes	Farmer very happy and enthusiastic about new forages and feeding / animal management advice – keen to adopt whole package and expand his forage Needs more encouragement re planting and use of tree legumes and better management of EG, especially in wet season			
Direct impacts	Some indication of improvement in on cow performance throughout year, but especially through dry season compared to average of Harapan best bet farmers (figure 1). Backyard forage banks of new grasses plus elephant grass now supplying all forage needs for 2 cows + 2 young males year round with new forages contributing around 1100kg of additional dry matter in 2006 alone (figure 2). Farmer says cattle condition much improved through use of best bet practices improved forages, early weaning / preferential feeding). Traders now seek out his cattle and market price for his cattle have improved. He sold 5 cattle in July 2007 to buy a motor bike (Rp 10 million) and another 3 head since (for Rp 10 million). He no longer has cattle deaths due to accidents grazing in mountain upland Less labour spent shifting cattle for tether grazing and gathering cut and carry. Before spent up to 5 hrs/day – now whole family spends less than 1 hour/day.			
Indirect impacts	Better feed management and appreciation of value of higher leaf content grasses and legumes in feed mix Better appreciation of value of preferential feeding of young stock and early weaning (though not yet tried). Pak La Matta's has already influenced other farmers in Harapan (Sudding and Cerrang) , Barru and beyond to adopt improved forage technologies			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

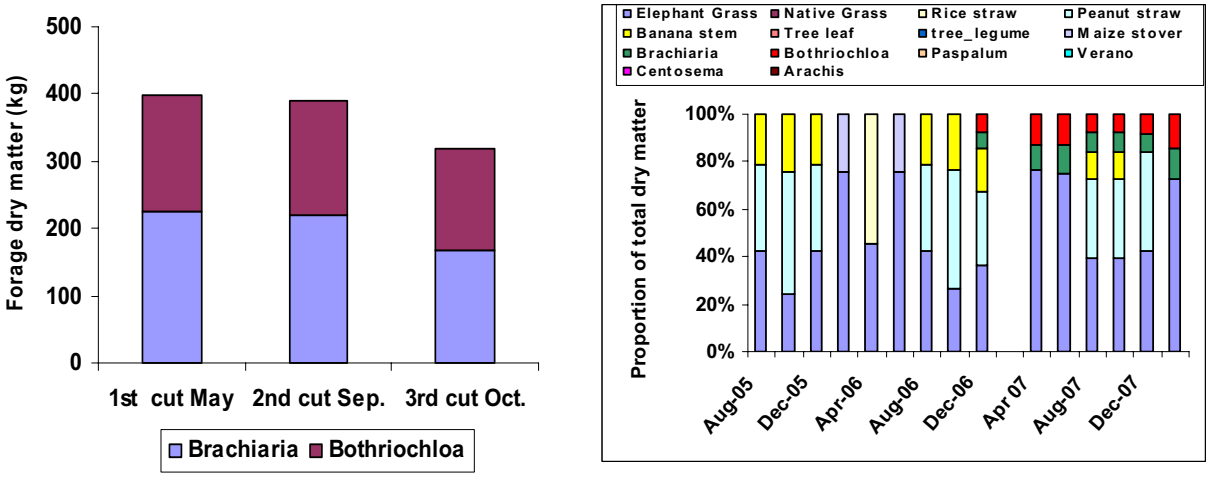


Figure 1: a. Potential contribution from La Matta's 0.6ha forage bank of Brachiaria decumbens and Bothriochloa insculpta during 2006 from three harvests between May and October 2006 and 1b. seasonal trends in cut and carry forage composition forage provided by pak La Matta between Aug. 2005 and March 2008. Note that although significant forage was available from May 2006 its use in cut and carry forage was not recorded until August 2006 and then as less than 10% of total cut and carry offered through late 2006. This was because the farmer chose to hold his forage bank in reserve for later use and also planting material for further expansion in 2006-07. However total dry matter offered was more than adequate for maintenance and growth throughout2006/07.

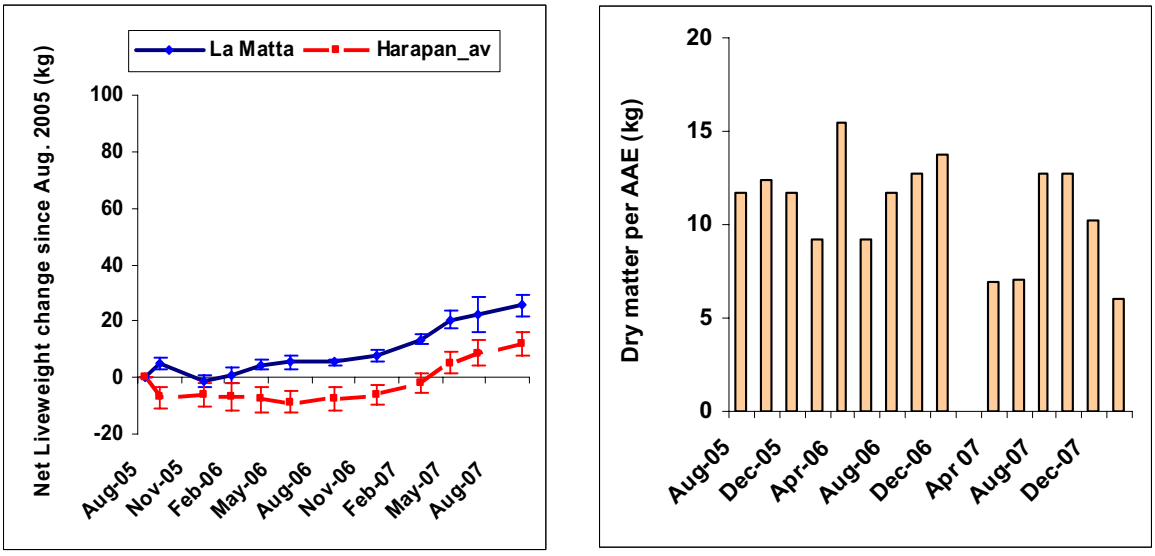


Figure 2: a. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by La Matta between August 2005 and October 2007. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. b. Comparison of liveweight trends of mature cows for Pak Lamatta vs the average for all other Harapan best bet farmers for the study period August 2005 to August 2007. Data are means and standard errors. Note that La Matta's cattle begin to trend up in liveweight from late wet season 2006 when forage best bet activities began to contribute significantly to total forage supply

Best bet farmer: Pak Mohammad, Dusun Harapan, Barru, Sulawesi

Main points from original interview notes

- Currently has 9 cattle (3 breeding cows + mix of bulls and cows of various ages). Typically one calf per year per cow. No calves for last 2 years due to poor feed supply/quality and perhaps a health issue.
- Wants to increase cattle number but constrained by feed availability (especially late dry). Labour not a problem
- Upland might benefit from increased legume content. Communally grazed
- Rice straw burnt or thrown away. No storage seen as limitation. Ammoniation an option.
- Calving times not too bad. Could push back a little. Consider preferential feeding of weaners
- Neighbours cattle free graze upland area and 'steal' forages (elephant grass). Fencing unsuccessful to date.

Major constraints to cattle production

- Availability of high quality forage in late dry and early wet
- Free communal grazing of upland by other farmers during wet
- Amount of conserved forage (peanut straw) available for feeding in dry season and preferential feeding

Calendar of existing farming system and suggested best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Lowland	0.6ha	Food crop	Rice					Other crop legumes (cowpea, mungbean, soybean)						
		Grazing										Tethered grazing		
		Cut and Carry	Sesbania on bunds											
Upland	1.4ha	Food crop	Maize											
		Grazing	Tethered									Free grazing		
		Cut and Carry	Perennial forage 'garden' fenced with Gliricidia to control stock. Introduce more legumes into upland to complement elephant grass (elephant grass Arachis)											
Backyard	0.17ha	Grazing												
		Cut and Carry												
Cattle breeding			Weaning and preferential feeding					Calving			Mating			
Off-farm residue / cut and carry												Peanut from neighbour		
Conserved feed (period of use)			Ammoniate rice straw and conserve. Save peanut residue for weaners and late dry.											
Peak labour periods			Rice planting				Harvest + prep./planting				Harvest			Rice prep.

The project will provide Rp to build a rice shelter just below lowland area

Summary of best bet progress to February 2008

Farmer: Mohammad, Harapan	**Actual best bet**	**Commenced**	**2006 progress**	**2007 Progress**
Best bet 1	More EG and Gliricidia for upland areas	2005-2006 wet	good	Good – expanding
Best bet 2	Sesbania for crop terrace bunds	2005-06-wet	Poor - abandoned	Abandoned
Best bet 3	Rice straw ammoniation	April 2006	Partly successful	None
Best bet 4	Early weaning / preferential feeding	2006-07	none	Some pref feeding
Best bet 5	Other 2nd crops to peanuts on lowland	Not yet tried	none	Tried pigeon pea in small plot
Overall assessment	Farmer has significantly expanded both EG area and Gliricidia fences both in upland and area next to cropping terraces. Farmer grew some Sesbania seedlings but planted them in upland where they performed poorly. Farmer built crop residue conservation storage shed and did ammoniation but technique less successful, though he fed conserved rice straw in dry season supplement. Farmer successfully preferential feeding with mix of EG and Gliricidia.			
Farmer attitudes	Farmer very enthusiastic especially about using Gliricidia and EG for preferential feeding He is now the local “gamal guru” He will also continue current best bet technologies and try early weaning / preferential feeding			
Direct impacts	Farmer says his cattle condition has improved since feeding EG and gamal Some apparent impact on cattle performance from dry season 2007 compared with 2006. Mohammad’s cows performing similar to Harapan best bet farmer average while his young males grew faster than Harapan best bet average through 2007 especially. He says cattle prices have also improved. He has only sold 1 male sapi during project but sold 2 just at beginning of project (so no impact from project here) Less labour spent shifting cattle for tether grazing – more C/C to upland kandangs close to EG and Gliricidia			
Indirect impacts	Better cattle and feed management and appreciation of value of legumes in feed mix Appreciation of value of preferential feeding of young stock and early weaning (though not yet tried). Pak Muhammad’s position as village head should influence other Harapan villages to adopt technologies			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

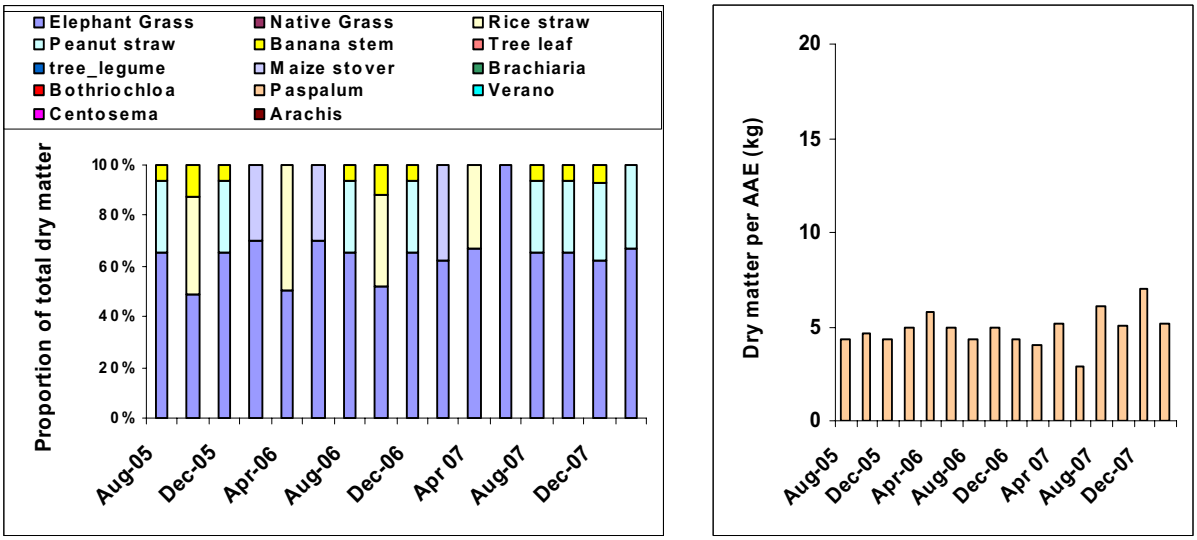


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Mohammad between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5 kg dry matter per day for maintenance and growth.

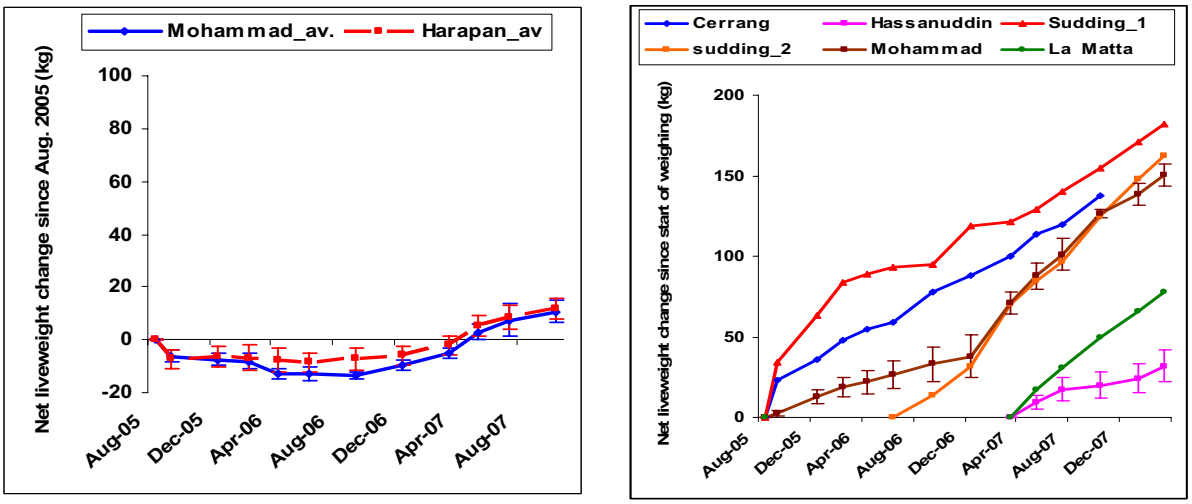


Figure 2: a. Comparison of liveweight trends of a. mature cows for Pak Mohammad vs. the average for Harapan best bet farmers for the study period August 2005 to October 2007. Note that Mohammad's cattle are about average for Harapan best bet farmers. Data are net liveweight change since August 2005 (means and standard errors. b. Comparison of net liveweight change for young male cattle. Data are means and standard errors for change since start of weighing. Note that Mohammad's male cattle gained at slightly faster rate than most other Harapan best bet male cattle after Dec. 2006.

Best bet farmer: Pak Sudding, Dusun Harapan, Barru, Sulawesi

Main points from original interview notes

- Has 11 cattle including 3 cows. Had 20 once but many died from cold!!. Feels that current number is less risky – doesn't want to increase number.
- Already doing much of best-bets. Has plenty of feed and practices seasonal mating.
- Interested in using ammoniated rice straw (currently burns all of his rice)

- Preferential feeding of calves of interest. Currently feeds cow and calf the same amount and composition. Perhaps need to monitor LWG for a while first to see how the calves and other cattle are going and then consider preferential feeding or increasing amount fed (not sure whether he is feeding enough). Free grazing limits however
- Could consider increasing amount of Gliricidia and elephant grass (ie. cut and carry types) in upland area to enable preservation of peanut straw until later in the dry season.
- Peanut stored under house

Major constraints to cattle production

- Availability of high quality forage especially in late dry
- Cattle ill-thrift in changeover from wet to dry

Calendar of existing farming system and suggested best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Lowland	1ha	Food crop	Rice						Peanut					
		Grazing						Free grazing						
		Cut and Carry												
Upland / Backyard	2.5ha	Food crop			Peanut/ maize intercrop (1ha)									
		Grazing	Tethered until rice harvest – supplemented with Elephant grass + peanut residue						Free grazing					Tethered
		Cut and Carry	Expand cut and carry species area (elephant grass & Gliricidia)											
Cattle breeding			Weaning					Calving			Mating			Weaning
Off-farm residue / cut and carry														
Conserved feed (period of use)					Introduce ammoniated rice straw									
			Lowland peanut					Upland peanut						Lowland peanut
Peak labour periods			Rice planting				Harvest + prep./planting				Harvest			Rice prep.

Summary of best bet progress to February 2008

Farmer: Sudding, Harapan	Actual best bet	Commenced	2006 progress	2007 Progress
Best bet 1	Grasses and legumes for upland terraces	2005-2006 wet	Little (only EG)	Good - expanding
Best bet 2	Rice straw ammoniation	April 2006	None	none
Best bet 3	Early weaning / preferential feeding	2006-07	None	none yet

Overall assessment	Forage planting delayed until 06-07 season but good establishment and growth of Mulato Brachiaria, purple panic, Stylo 184 and Clitoria achieved in upland area as part of a planned 1ha forage bank expansion of elephant grass and new forages. Has now attempted all best bet options except for ammoniation attempted He has implemented similar EG management to Cerrang and La Matta. Has planted more Gliricidia and is feeding it to his cattle – they really like it. Plans to expand upland forage banks to 2ha and shift all his cattle operations there
Farmer attitudes	Farmer very enthusiastic about new forages. This farmer is on his way to making cattle a major income generating enterprise
Direct impacts	New forage grasses and legumes only small area as yet so little measurable impact on animal production or household income to date. However elephant grass now contributing significantly to cattle diets. He says his cattle condition and performance has improved since early weaning / preferential feeding and kandang feeding of improved forages. Had 13 cattle (mixed age and sex) but sold 6 last August for RP 17 million. He says his remaining 6 cattle now in better condition than the previous 13 were before project involvement. However cattle weighing data shows his cows are actually performing at around the Harapan best bet farmer average while his young males are growing faster than the Harapan best bet farmer average. Amount of dry matter given per AAE per day is the main constraint to improved cattle growth rates at present – farmer needs more education He says calving interval now back to 12 months due to EW.
Indirect impacts	Better appreciation of role and value of higher quality grass and legume cut and carry forages in feed mix Better appreciation of value of preferential feeding of young stock and early weaning though still a way to go re understanding cattle nutritional needs.

Relevant graphical summaries of best bet impacts on forage use and cattle performance

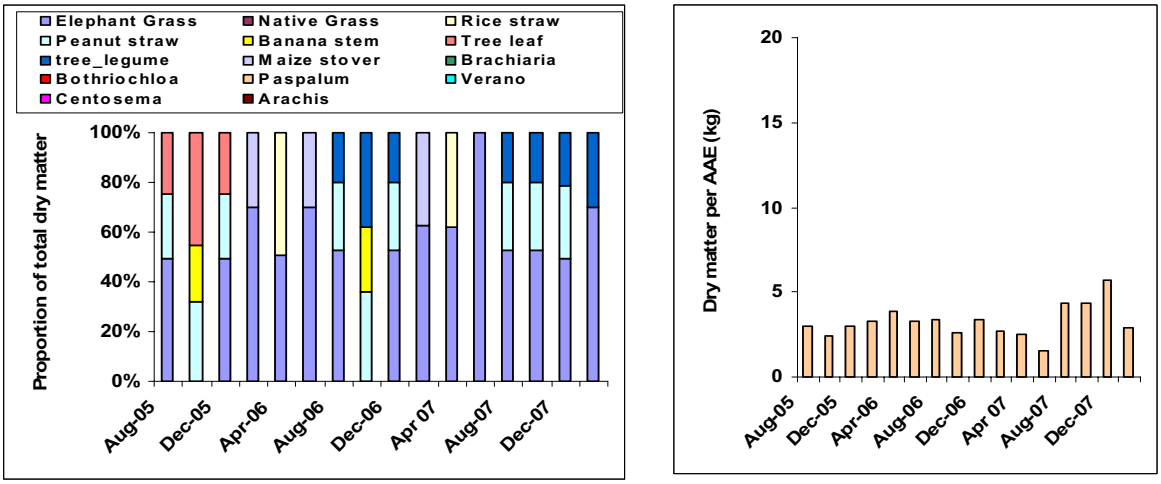


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Sudding between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Sudding's cattle are receiving below maintenance dry matter throughout the year from cut and carry forage. However he also grazes his cattle especially during the wet season.

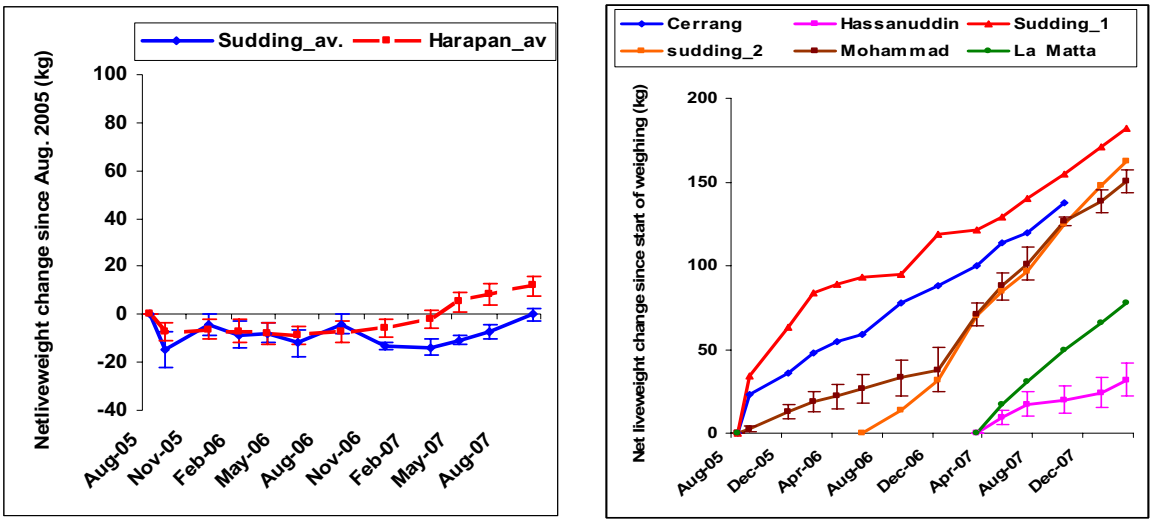


Figure 2: a. Comparison of liveweight trends of mature cows for Pak Sudding vs. the average for Harapan best bet farmers for the study period August 2005 to October 2007. Data are means and standard errors. Note that Mohammad's cattle are about average for Harapan best bet farmers. Data are mean net liveweight change since August 2005 and standard errors. The graph indicates pak Sudding's cows are doing slightly worse than Harapan best bet farmer average throughout the year. b. Comparison of net liveweight change for young male cattle at Harapan. Data are means and standard errors for change since start of weighing. Note that Sudding's male cattle gained at slightly faster rate than most other Harapan best bet male cattle except those of Mohammad.

Best bet farmer: Pak Hassanuddin, Dusun Harapan, Barru, Sulawesi

Main points from original interview notes

- Wants to expand Elephant grass production in upland area (ie 1ha parcel). Needs more stock to justify developing other 2 upland parcels (0.5ha each).
- Has 3 cattle (2 cows + 1 calf). Wants to increase cattle nos. but needs to sell females for Rp.
- Needs to increase feed supply to expand numbers.
- Keen to try improving already conserved rice straw via ammoniation. Also needs to build structure to house rice straw.
- Scope for seasonal mating here. Not getting one calf per year and calving date too late. Has good access to neighbours bull. Also preferential feeding.
- The upland area that backs directly onto house is terraced. Suggest demonstration with Gliricidia along every 2nd bund (to reduce shading) with a perennial cut and carry grass along other bunds. Plant Arachis along flat of terrace. This would enable saving of peanut residue until later in dry.

Major constraints to cattle production

- Availability of high quality forage especially in late dry /early wet
- Current calving spread and late season calving – increased feed demand to maintain cow calf condition in late dry/early wet

Calendar of existing farming system and suggested best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Lowland	1ha	Food crop	Rice					Peanut (residue stored in lowland area)						
		Grazing										Tethered (supplemented with peanut residue)		
		Cut and Carry												
Upland / Backyard	4 separate parcels. 2 undeveloped parcels of 0.5ha. Other 2 parcels developed.	Food crop			Intercrop peanut/maize (some years)									
		Grazing	Tethered grazing of 1ha native 'pasture' (supplemented by elephant grass + peanut)											
		Cut and Carry	Use 1ha terraced upland area behind house to establish mix of tree legumes + perennial grass on bunds + Arachis inbetween. Complement 0.1ha E.G											
Cattle breeding							Calving			Mating				Weaning and preferential feeding
Off-farm residue / cut and carry														
Conserved feed (period of use)								Ammoniated rice straw				Lowland peanut		
Peak labour periods			Rice planting and preparation			Harvest & prep. plant					Peanut harvest			Rice planting / prep.

Summary of best bet progress to February 2008

Farmer: Hasanuddin, Harapan	**Actual Best Bet**	**Commenced**	**2006 progress**	**2007 progress**
Best bet 1	Grasses and legumes for upland terraces	05-06 wet	Very good	Steady, little expansion
Best bet 2	More tree legumes and EG for upland area	05-06-wet	Fair-good	Steady, little expansion
Best bet 3	Rice straw ammoniation	Not yet	none	none
Best bet 4	Early weaning / preferential feeding	Not yet	none	none
Overall assessment	Good establishment and growth of Brachiaria, Arachis and Centro pascourum in year 1 though Centro now gone. Some expansion of tree legumes but more required especially Gliricidia – little feeding of tree legumes as yet. No progress on rice straw ammoniation. Farmer says he tried pref feeding but too difficult to separate stock classes and too much labour. Not keen on early weaning Grasses N deficient and rank - farmer not feeding his improved grasses and tree legumes – too busy with crops, too labour intensive. Not grazed them as alternative as fearful cattle would damage them.			
Farmer attitudes	Farmer still enthusiastic about new forages but lacks the knowledge or will to use them as recommended to improve cattle nutrition at critical times			

Direct impacts	Sown grasses providing significant forage for farmer's cattle, but little used until 2007-08 and this contribution mainly from Brachiaria decumbens Elephant grass making a significant contribution to cut and carry Little measurable impact on new forages on cattle performance in late dry because farmer not using his forage bank – tether grazing volunteer grasses instead - despite abundance of forage His cow and calves were in poor condition at Nov. 2007 inspection when farmer said he was too busy to provide cut and carry from forage bank. However cattle weighing data indicates a marked improvement in dry season cow condition in 2006 over 2007 so the setback in Nov 2007 may have been temporary due to lack of time for c/c or ill-health (parasites?) His male cattle (not preferentially fed) are not performing as well as the average for Harapan best bet cattle.
Indirect impacts	Hard to assess, because farmer not managing or feeding his new forages as recommended Farmer says he does not have sufficient labour during crop preparation to harvest his forage bank for C/C but his animal condition is suffering in comparison with La Matta's cattle who have access to a similar forage bank

Relevant graphical summaries of best bet impacts on forage use and cattle performance

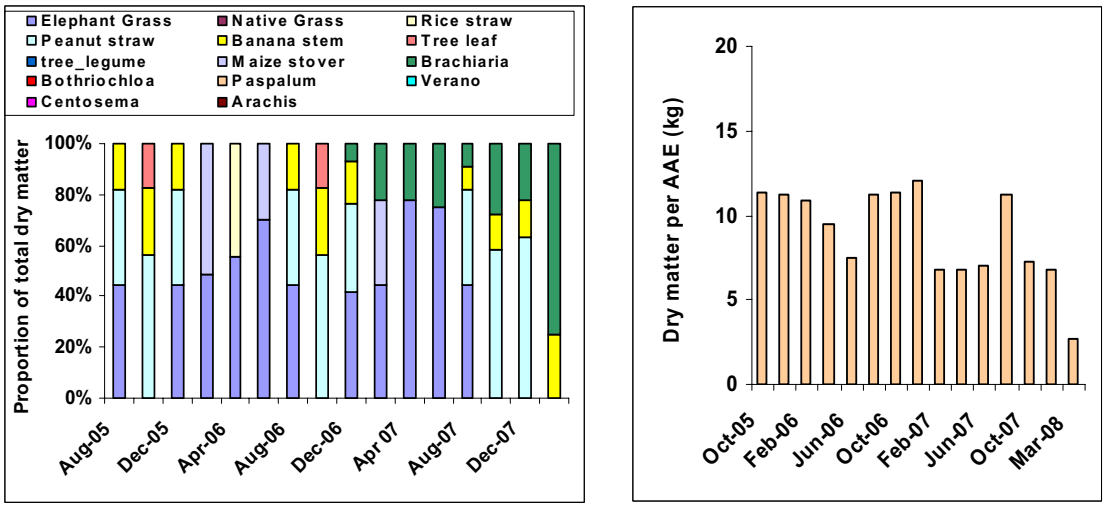


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Hassanuddin between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Hassanuddin's cattle are receiving around maintenance dry matter levels throughout the year from cut and carry forage, including significant percentages of elephant grass and peanut straw, in addition to grazing his cattle especially during the wet season. In spite of this his cows and calves were in poor condition in November 2007 when he was tether grazing rather than providing cut and carry while doing land preparation for cropping.

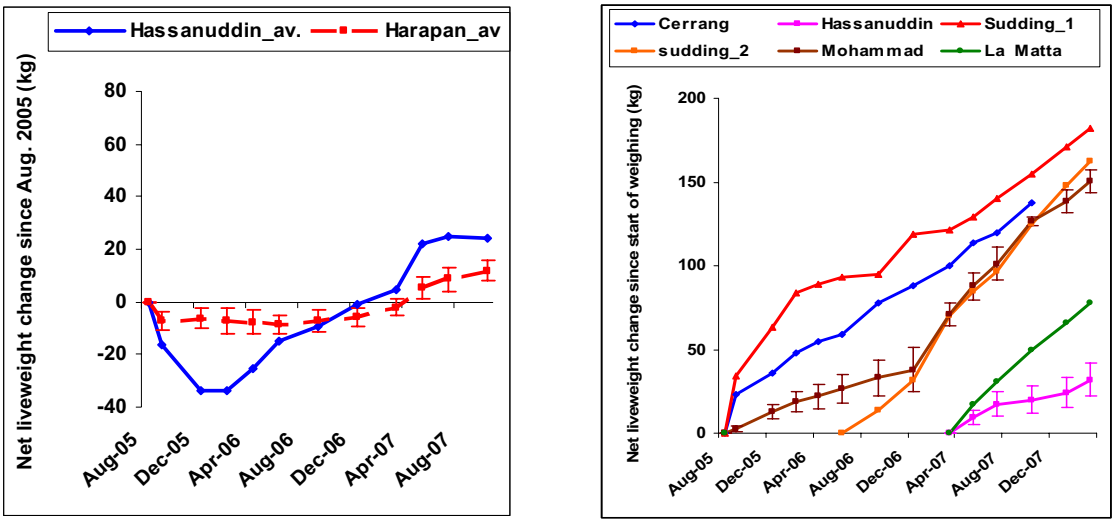


Figure 2: a. Comparison of liveweight trends of mature cows for Pak Sudding vs. the average for Harapan best bet farmers for the study period August 2005 to October 2007. Data are means and standard errors. Note that Mohammad's cattle are about average for Harapan best bet farmers. Data are mean net liveweight change since August 2005 and standard errors. Pak Hassanuddin's cows show an improvement over through 2007 compared their poor performance in 2006, though liveweights again flatten out and fall slightly in late 2007 in line with observed poorer condition in November 2007. b. Comparison of net liveweight change for young male cattle at Harapan. Data are means and standard errors for change since start of weighing. Note that Hassanuddin's male cattle gained at a much slower rate than most other Harapan best bet male cattle though data are only for a short period. Hassanuddin did not preferentially feed his young males.

Best bet farmer: Pak Cerrang, Dusun Harapan, Barru, Sulawesi

Main points from original interview notes

- Tethered grazing on lowland in September to avoid neighbours crop.
- Has 4 cattle. 1 cow + younger mix.
- This might be a good site for demonstration of different elephant grass cultural practices. Different N rates. Different cutting intervals and heights. Use for model improvement.
- Could demonstrate rice ammoniation. Cerrangs' lowland area directly behind house – easy to provide rice straw for ammoniation. Needs a structure to house rice straw.
- As this property borders La Matta property could conduct demo's to complement proposed activities on La Matta property. Could also share rice straw facility and material. Rice straw currently burnt.
- Potential for preferential feeding.

Major constraints to cattle production

- Availability of high quality forage especially in late dry /early wet

Calendar of existing farming system and suggested best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Lowland	0.4ha	Food crop	Rice											
		Grazing									Tethered	Free (no supplementary feed)		
		Cut and Carry												
Upland / B'yard	2 separate parcels. 0.4ha each.	Food crop												
		Grazing	Tethered Upland 1 (0.2ha) – 'pasture'					Free Upland 2 (0.4ha) – 'pasture'						
		Cut and Carry	Expand area under Elephant grass. Trial different cultural practices for elephant grass											
Cattle breeding			Weaning					Calving			Mating			
Off-farm residue / cut and carry									Peanut from share cropping activity (no charge)					
Conserved feed (period of use)			Complement peanut straw with ammoniated rice straw.											
Peak labour periods			Rice planting and preparation				Rice harvest							Rice prep.

Summary of best bet progress to February 2008

Farmer: Cerrang, Harapan	**Actual best bet**	**Commenced**	**2006 progress**	**2007 progress**
Best bet 1	Better management of EG and more Gliricidia in upland area	05-06 wet	slow	some progress
Best bet 2	Rice straw ammoniation	not yet	none	none
Best bet 3	Grasses and legumes for upland terraces	06-07 wet	not yet planted	fair - good
Overall assessment	New forage introduction delayed until 06-07 season after farmer observed La Matta experience. However good establishment and growth since Has increased EG planting Has also established an upland forage bank using material obtained from neighbouring farmer pak La Matta, plus Setaria, Mulato and Panicum from Pattalikang. He has also started early weaning / preferential feeding on his own bat (not part of originally suggested best bets as no cows at time) and is conserving peanut straw for feeding back in late dry season. However he has not yet increased tree legume planting and use – because he says his cattle don't like gamal – also no promotion from local team. Has not attempted rice straw ammoniation.			
Farmer attitudes	Farmer still enthusiastic intends expanding forage bank area. Farmer says all best bets he tried worked well for him and he will continue and expand them.			

Direct impacts	New forage grasses and legumes only small area as yet so little measurable impact on animal production or household income to date. However elephant grass comprises a significant proportion of the cut and carry diet now. However, farmer says that since early weaning / preferential feeding his calving interval is back to <12 months and both cow and calf condition better. Cattle growth rates also better and prices for his cattle have increased. Cerrang's cow liveweight performance slightly higher than Harapan average for 2006-07 but falling away in late dry by comparison. His male cattle performance about Harapan best bet average. He sold 1 cow in 2007 for Rp 3 million. 2 Years ago only 4 cattle, now 7, due to increased forage supply.
Indirect impacts	Better appreciation of role and value of higher quality grass and legume cut and carry forages in feed mix Better appreciation of value of preferential feeding of young stock and early weaning (though not yet tried).

Relevant graphical summaries of best bet impacts on forage use and cattle performance

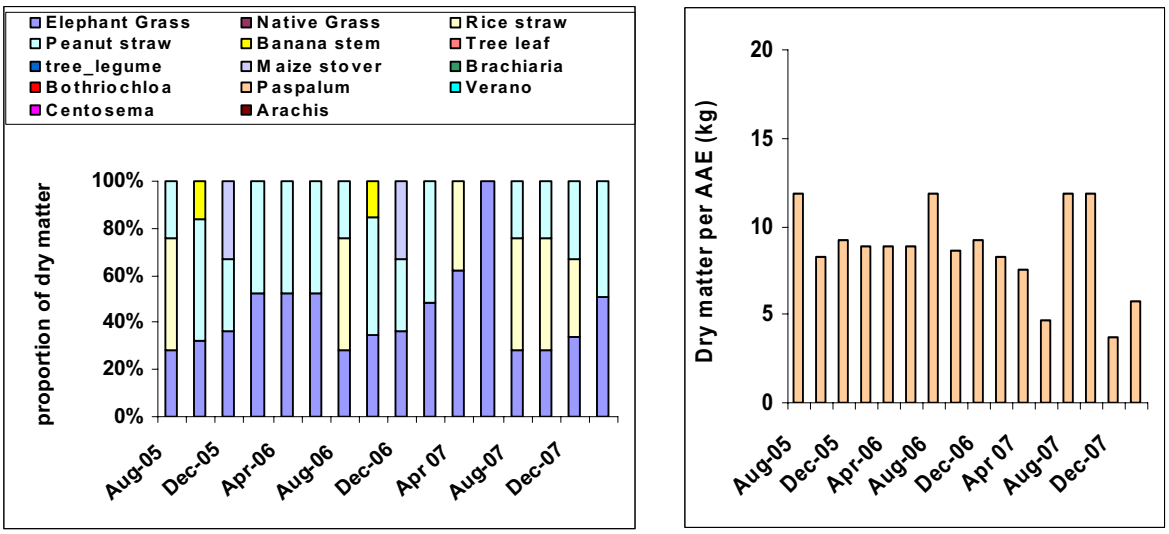


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Cerrang between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Cerrang's cattle are receiving around maintenance dry matter levels throughout the year from cut and carry forage though levels drop in late 2007, due to more cattle. Farmer also does some grazing especially during the wet season. There is no documented impact of new forages as yet but he is feeding significant percentages of elephant grass

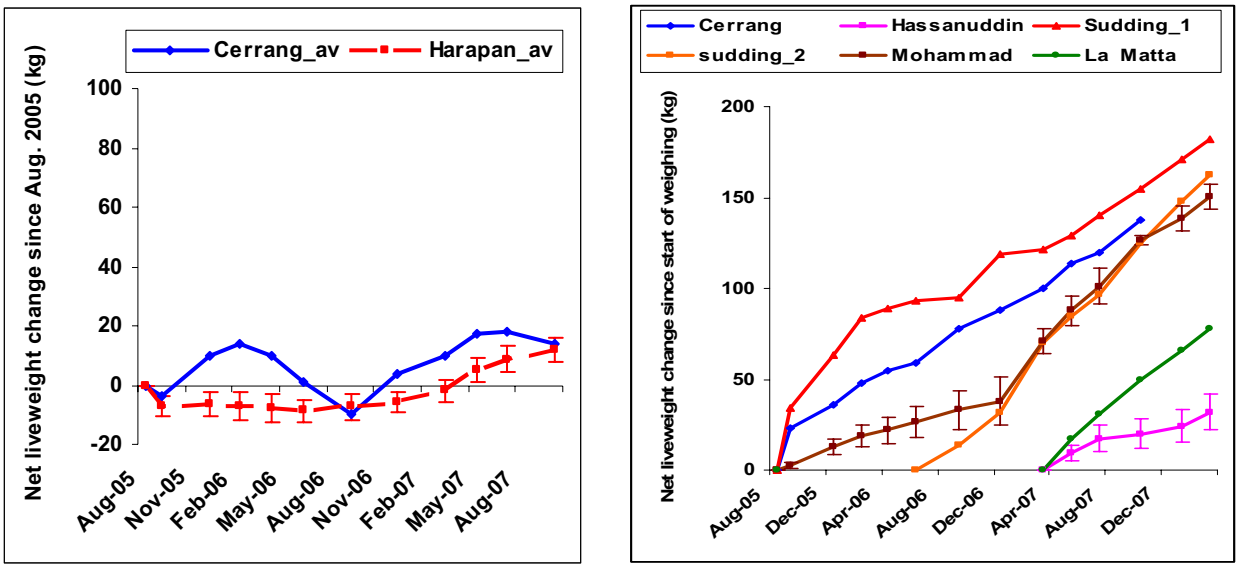


Figure 2: a. Comparison of liveweight trends of mature cows for Pak Cerrang vs. the average for Harapan best bet farmers for the study period August 2005 to October 2007. Data are means and standard errors. Note that Cerrang's one cow is doing better than the average for Harapan best bet farmers especially over the wet season periods of 2006 and 2007, though the graph shows a small continuous loss through dry season 2006 and a fall in late dry 2007 compared to Harapan best bet average. b. Comparison of net liveweight change for young male cattle at Harapan. Data are means and standard errors for change since start of weighing. Cerrang's male cattle gained at a around average for most Harapan best bet male cattle until sold in Nov. 2007.

11.6.3 Pattapa sub-village

A total of 12 separate best bet options were identified with Pattapa best bet farmers of which 7 have been implemented to some extent (table 3)

Table 3: Best bet activities identified for case study farmers in Pattapa village 2005-07

Village / farmer	New forage introduction		Better use of existing forages (tree legs and EG)		Crop residue conservation (inc. rice straw ammoniation)		Preferential feeding / early weaning	
Pattapa	Identified	started	Identified	started	Identified	started	Identified	Started
Bakka	1	1	0	0	1	0	0	1
Syamsuddin	1	1	1	1	1	0	0	1
Muhammad	1	0	1	0	1	0	0	1
Sahabuddin	1	0	1	0	1	0	1	1
Cipe	0	0	0	0	0	0	1	0
Total	4	2	3	1	3	0	2	4

However included in these are preferential feeding activities for young male cattle in backyard kandangs using elephant grass, which commenced in late 2006 largely as response to the Barru field day rather than the direct impact of participation in the best bet program. Of the original best bets identified, forage introduction was only attempted on 2 of the 4 sites originally identified (the upland of pak Syamsuddin and an exclosed area of heavily grazed, degraded upland belonging to pak Bakka) in the 2005-06 wet season. Though rice straw ammoniation was identified as an option for 4 of the 5 farmers, none was attempted. Again the reasons given included logistics of carting and storing rice straw and later reduced need due to adoption of elephant grass cut an carry production and feeding since 2006.

The original new forage plantings in pak Sysmsuddin's upland were hampered by injury to the farmer in late 2005 which delayed planting until end of wet 2006. Some replanting has occurred since and the hillside gorage bank of Clitoria, elephant grass and Gliricidia is now producing good forage. A second round of new forage introductions for use in backyard forage banks was undertaken at the farmer's request in the 2006-07 wet season. These have been largely unsuccessful, partly due to dry conditions and less suitable heavily shaded conditions in backyard orchard (kubun) areas.

As at February 2008 all Pattapa best bet farmers are now separating their male cattle from the communal grazing herd to fatten in backyard kandangs, using mainly elephant grass grown in backyards or cultivated upland areas previously considered too poor anything but communal grazing. About half of these farmers commence this practice in late 2006 while the remaining farmers adopted the practice during 2007-08.

Best bet farmer: Pak Bakka, Dusun Pattapa, Barru, Sulawesi

Main points from original interview notes

- Labour and rainfall constrain second crop on lowland. Large area of rice means longer process time post-harvest by which time to late to sow second crop (i.e. too dry).
- Upland is communally grazed (currently over-grazed and in poor condition). 10ha in total in this area communally grazed by ~100 cattle. Needs periodic resting.
- Bakka has 12 head of cattle in total.
- Establishment of forage biomass requires fencing to exclude free ranging stock. Suggestion to set up demonstration plot of what could be achieved. Set up exclosure to see what would grow naturally in the absence of grazing. Establish forage sward/garden inside fenced area demonstrating best-bet species. Small area initially to build up confidence and then, if successful adoption will happen naturally.
- Opportunity to set up a rotational grazing system involving various parcels of fenced-off communal grazing areas.
- Upland area also adjacent to lowland fields – interested in using rice for feed (place in racks for direct feeding).

Major constraints to cattle production

- Lack of forage quantity and quality all year round – due to overgrazing and degradation of upland communally grazed land
- Lack of alternative forage supply options (fodder banks or conserved forages)
- Lack of animal management – extensive grazing – low input / low output system

Calendar of existing farming system and suggested best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Lowland	7ha	Food crop	Rice											
		Grazing						Free graze						
		Cut and Carry												
Upland / Backyard	2ha	Food crop												
		Grazing	Establish forage sward/ inside fenced area. Consider rotational grazing around fenced communal grazing fields (ie. periodic resting of each)											
		Cut and Carry												
Cattle breeding			Free ranging stock. Natural, uncontrolled mating. No opportunity for seasonal mating, preferential feeding.											
Off-farm residue / cut and carry														
Conserved feed (period of use)								Rice straw conservation / ammoniation						
Peak labour periods			Rice plant				Rice harvest							Rice preparation

Summary of best bet progress to February 2008

Farmer: Bakka, Pattapa	**Actual best bet**	**Commenced**	**2006 progress**	**2007 progress**
Best bet 1	Perennial pasture grasses and legumes for fenced upland rehabilitation area	05-06 wet	Slow due to communal grazing	none – exposed to communal grazing
Best bet 2	Rice straw ammoniation	Not yet	none	none
Best bet 3	Forage grasses and legumes for backyard forage bank	06-07 wet	not yet attempted	fair - small area, patchy emergence and growth
Overall assessment	Original upland exclosure had poor-fair establishment on lower slopes but inability to exclude communal grazing prevented recovery of this area. No progress on ammoniation option. Farmer planted selected grasses and legumes in backyard in 06-07. Of these Clitoria performed the best, but contribution of new forages very small compared to EG. He also has established about 1ha of EG in 3 parcels in upland. He fertilises his EG with urea and superphosphate every 15 days during growing season. Farmer now focussing on backyard EG production and preferential feeding of young male cattle			
Farmer attitudes	Initially very poor and disinterested. However renewed interest in animal management and cut and carry preferential feeding since attending 2006 Barru field day			
Direct impacts	Exclosure area compromised by failure to exclude communal heavy grazing. Backyard sown forages too small area to have direct impact. Backyard EG production supporting preferential feeding of young male weaners in backyard kandang His cows are performing about average for Pattapa best bets while his young males are doing slightly better than Pattapa average though little liveweight data available.			

Indirect impacts	Exposure to full package of forage/animal feeding technologies at Barru field day sparked renewed interest in using cut & carry forages for preferential feeding of young male cattle. This has led to fencing and clearing of shrub covered degraded upland and planting of EG forage banks in both backyards and upland areas. This offers scope to move farmers into a two tired system of grazing cows on improved and fenced upland paddocks and preferentially feeding young male calves in backyard kandangs.

Relevant graphical summaries of best bet impacts on forage use and cattle performance

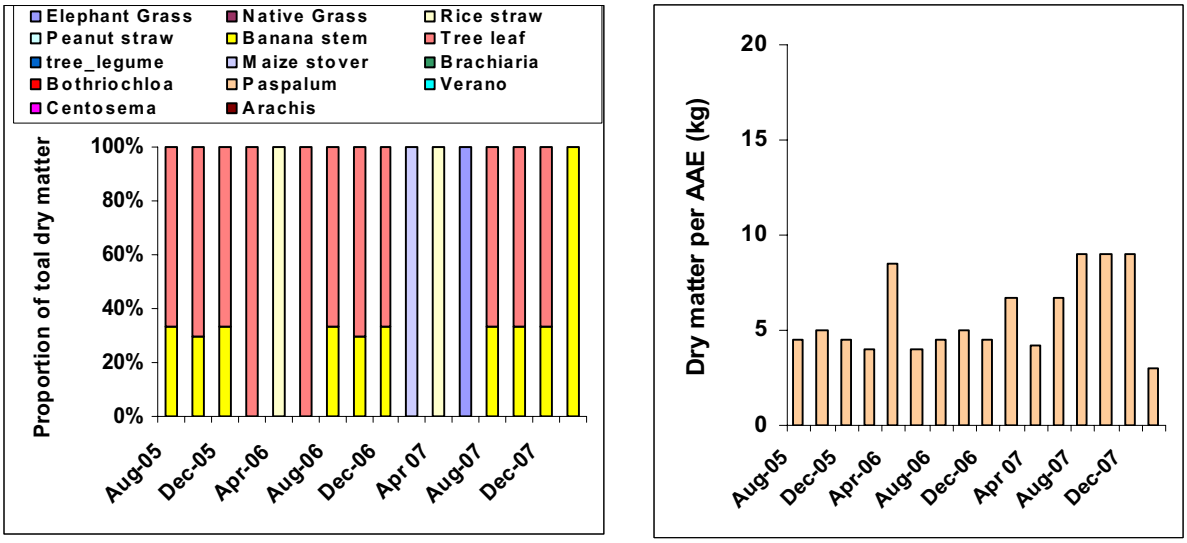


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Bakka, Pattapa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. Note that even though farmer says elephant grass being fed from mid-2006 it was only recorded once in cut and carry monitoring in mid 2007. Dry matter per AAE generally below maintenance though improving during 2007. Unsure from records just which animals receiving cut and carry as cows mostly free grazed in upland.

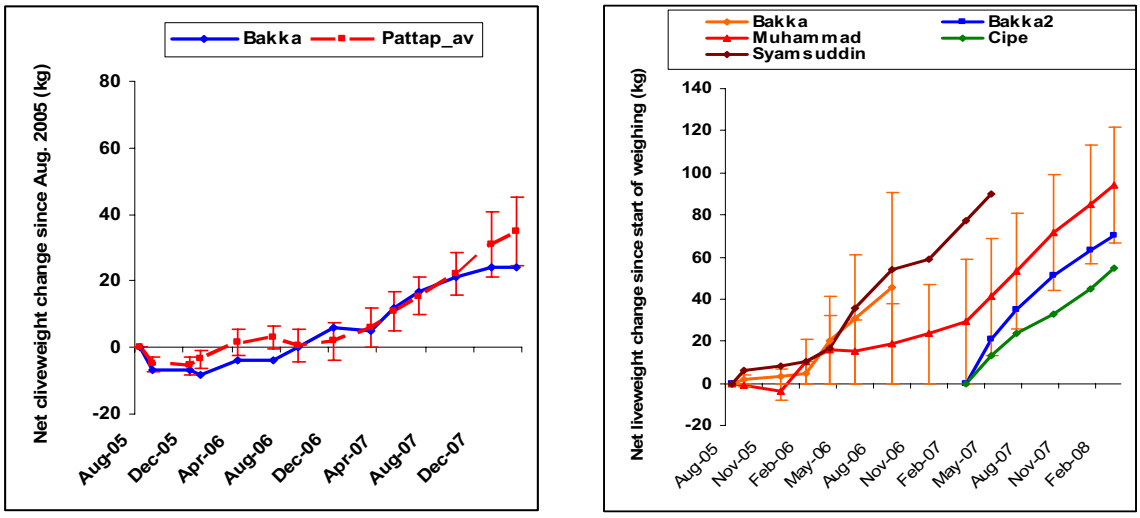


Figure 2: a. Comparison of liveweight trends of mature cows for Pak Bakka vs. the average for Pattapa best bet farmers for the study period August 2005 to October 2007. Data are means and standard errors. Note that Bakka's one cow is doing about average for Pattapa best bet farmers and that cow liveweight appears to have improved through dry season 2007 compared to 2006, though error bars show considerable variation between animals. b. Comparison of net liveweight change for young male cattle at Pattapa. Data are means and

standard errors for change since start of weighing. Bakka's male cattle gained at a similar rate to other Pattapa best bet male cattle. Note also the sharp improvement in growth rate from late 2006 coinciding with adoption of preferential feeding of young males with elephant grass. However the error bars indicate considerable variation between individual animals

Best bet farmer: Pak Muhammad, Dusun Pattapa, Barru, Sulawesi

Main points from original interview notes

- Opportunity for rice ammoniation and conservation
- Opportunity for more perennial cut and carry forage in upland cocoa area. Cattle taken there often and could add to Gliricidia with elephant grass etc.
- Opportunity for cut and carry perennials in 0.2ha unused roadside upland block (elephant grass and Gliricidia). E.G might not persist throughout all of dry but would provide valuable feed for early to mid part of dry. Would bulk up over wet when cattle confined to other upland areas.
- Has 9 cattle including 3 cows. Wants to increase cow number but limited by labour and feed.
- Labour tied up moving and chasing cattle. Use of 0.2ha block will provide more feed closer to house to reduce labour demand. The farmer thinks there is enough labour to collect cut and carry from the 0.2ha parcel.

Major constraints to cattle production

- Availability of high quality forage especially in late dry and wet season
- Availability of labour to produce and feed additional forage

Calendar of existing farming system and suggested best bet options to meet constraints

<table>
<tr><td>Land type</td><td>Area(ha)</td><td></td><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>S</td><td>O</td><td>N</td><td>D</td></tr>
<tr><td rowspan="3">Lowland</td><td rowspan="3">2 parcels of 0.5 and 0.4ha.</td><td>Food crop</td><td colspan="5">Rice</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Grazing</td><td></td><td></td><td></td><td></td><td></td><td colspan="8">Free grazing of crop residue + roadside</td></tr>
<tr><td>Cut and Carry</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Upland / Backyard</td><td rowspan="4">3 parcels. One parcel of 0.2ha is unused roadside block.</td><td>Food crop</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Grazing</td><td colspan="5">Free grazing of 1ha 'pasture'</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Cut and Carry</td><td colspan="5">Gliricidia to supplement 'pasture' (sourced from Gliricidia fence and shading strips in cocoa field ?ha). elephant grass fodder bank / Arachis as understorey</td><td colspan="8">Gliricidia to supplement lowland grazing</td></tr>
<tr><td colspan="13">Introduce forage garden into unused roadside block (0.2ha) to provide additional feed during dry.</td></tr>
<tr><td colspan="3">Cattle breeding</td><td colspan="13">Free ranging stock. Natural, uncontrolled mating. No opportunity for seasonal mating, preferential feeding.</td></tr>
<tr><td colspan="3">Off-farm residue / cut and carry</td><td colspan="13">Some peanut residue used primarily for animal control (ie cattle movement) rather than as feed supplement.</td></tr>
<tr><td colspan="3">Conserved feed (period of use)</td><td></td><td></td><td></td><td></td><td></td><td colspan="8">Introduce ammoniated rice straw</td></tr>
<tr><td colspan="3">Peak labour periods</td><td>Rice plant</td><td></td><td></td><td></td><td>Rice harvest</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Rice prep.</td></tr>
</table>

Summary of best bet progress to February 200

Farmer: Muhammad Pattapa	Actual Best Bet	Commenced	2006 progress	2007 progress
Best bet 1	Grasses and legumes on small upland plot	Started 2006-07 wet	poor	poor
Best bet 2	Better use of EG an tree legumes on upland	Started mid 2006	OK	OK
Best bet 3	Rice straw ammoniation	Did not start	none	none
Overall assessment	Farmer did not persist with any of the originally identified best bets However farmer has commenced preferentially feeding EG to young male weaner calves following visit to Barru field day in 2006 He planted new forages in backyard in 2006-07 season. Also took Setaria from Pattalikang (Barru field day) Forages in upland cocoa block not successful as cattle keep knocking down fence and eating young forages and EG. Backyard new forage plots failed as seedlings destroyed by chickens. Not interested in ammoniation as too much labour involved. Also has Gliricidia fences in backyard and is feeding mix of EG + Gliricidia to young male cattle in backyard kandang similar to Bakka. He feeds rice straw in morning and EG/gamal in afternoon.			
Farmer attitudes	Initially very poor and disinterested. However renewed interest in animal management and cut and carry preferential feeding since attending 2006 Barru field day			
Direct impacts	Not much as farmer did not proceed with any of our best bet options He says his cattle growth rates are now much better now he uses EG + gamal in kandang feeding system though liveweight data shows his cows and young males performing about average for Pattapa best bet farmers – which is not that good.. Has not yet sold any cattle from his kandang system but has one 2 year old male currently in kandang and expects to get at least RP 4 million but thinks it is worth around RP 5.5 million. Farmer says his cattle now easier to sell because of better condition and traders now come to him and demand to buy his cattle.			
Indirect impacts	Exposure to full package of forage/animal feeding technologies at Barru field day sparked renewed interest by farmer in using cut & carry forages such as EG for preferential feeding of young male cattle, though have not seen Muhammad's EG or cattle kandang as yet. This offers scope to move farmers such as Muhommad into a two tired system of grazing cows on improved and fenced upland paddocks and preferentially feeding young male calves in backyard kandangs.			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

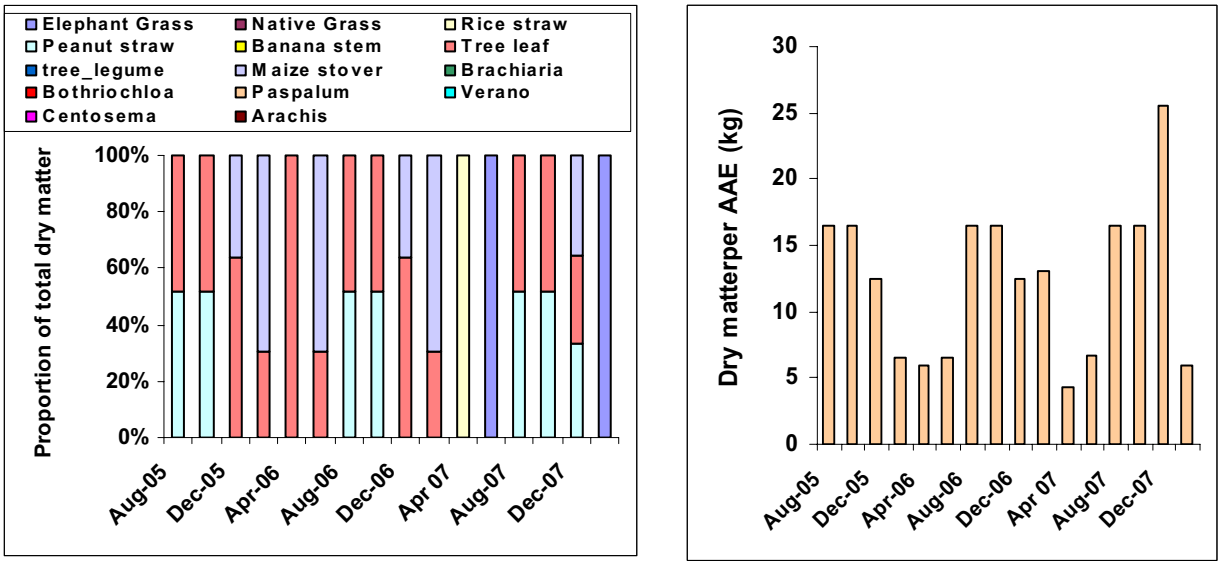


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Muhammad, Pattapa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. Dry matter offered up and down, peaking in late dry each year and mostly consisting of peanut straw and tree leaves until beginning of elephant grass supplementation of males especially in 2007.

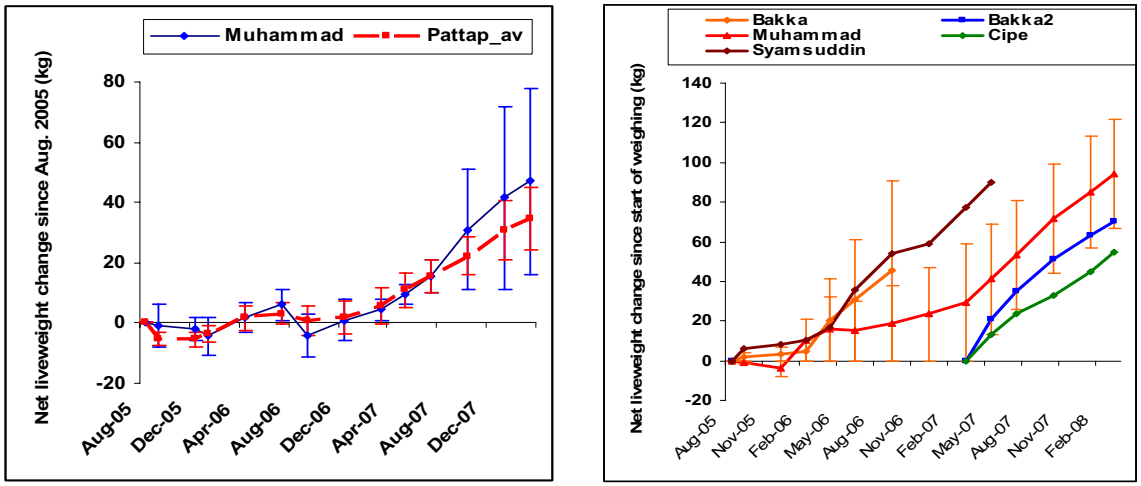


Figure 2: a. Comparison of liveweight trends of mature cows for Pak Muhammad vs. the average for Pattapa best bet farmers for the study period August 2005 to October 2007. Data are means and standard errors. Note that Muhammad's one cow is doing slightly (but not significantly) below average for Pattapa best bet farmers in dry season 2007 though cow liveweight in general appears to have improved through dry season 2007 compared to 2006. However error bars show considerable variation between animals. b. Comparison of net liveweight change for young male cattle at Pattapa. Data are means and standard errors for change since start of weighing. Muhammad's male cattle gained at a faster rate to other Pattapa best bet male cattle. From mid 2006 though error bars indicate considerable variation between individual animals and data is only for a few months until animals sold.

Best bet farmer: Pak Sahabuddin, Dusun Pattapa, Barru, Sulawesi

Main points from original interview notes

- Doesn't conserve or feed mung bean residue (reckons stock don't like woody stem!!.). Too dry for peanut as second lowland crop.
- Interested in replacing mung bean with single purpose cattle forage crop. Would need to be annual to fit in with rice. Mix of Stylo and Centrosema may be an option.
- Cattle tethered at night. Doesn't graze own upland because poor quality and used as communal grazing area by other farmers.
- Interested in fenced off forage sward idea to be trialled on Bakka's property. Would like to watch first before investing in the technology.
- Also interested in rice straw as supplementary feed for cattle tethered around house. Wants to make storage facility. Rice available when peanut residue not available.
- Has 6 cattle including 2 cows.

Major constraints to cattle production

- Availability of high quality forage especially in late dry and wet season
- No way to presently utilise upland due to lack of controlled grazing

Calendar of existing farming system and suggested best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Lowland	0.3ha	Food crop	Rice (0.3ha)					Replace mungbean with annual forages such as stylo or centrosema						
		Grazing	Free graze around house. Tethered at night.											
		Cut and Carry												
Upland / Backyard	0.9ha. 2 parcels. Communal grazing area next to Bakar + 0.05ha fenced but unused.	Food crop												
		Grazing												
		Cut and Carry	Perennial tree forage + Arachis in unused, fenced 0.05ha											
Cattle breeding			Opportunity for preferential feeding given tethering.											
Off-farm residue / cut and carry												Peanut straw as supplement until runs out		
Conserved feed (period of use)								Ammoniated rice straw (until runs out)						
Peak labour periods			Rice plant				Rice harvest							Rice prep.

Summary of best bet progress to February 2008

Farmer: Sahabuddin, Pattapa	Actual best bet	Commenced	2006 progress	2007 progress
Best bet 1	Grasses & legumes for upland forage bank	Commenced 2006-07 wet	poor	poor
Best bet 2	Replace mung bean with new forage crop	Did not start	none	none

Best bet 3	Ammonated rice straw	Did not start	none	none
Best bet 4	Preferential feeding and early weaning	Started feeding young males mid 2006	Some PF	Some PF
Overall assessment	Farmer did sow new forages but not successful Did not attempt any of the other identified best bet options. However farmer has commenced preferentially feeding EG to young male weaner calves following visit to Barru field day in 2006			
Farmer attitudes	Initially very poor and disinterested. However renewed interest in animal management and cut and carry preferential feeding since attending 2006 Barru field day			
Direct impacts	Not much as farmer did not proceed with any of our best bet options He says cattle condition and growth rates now improved and traders now seeking out his cattle However his cows performing poorly in terms of liveweight compared to Pattapa average. No data available for young males			
Indirect impacts	Exposure to full package of forage/animal feeding technologies at Barru field day sparked renewed interest by farmer in using cut & carry forages such as EG for preferential feeding of young male cattle, though have not seen Sahabuddin's EG or cattle kandang yet. This offers scope to move farmers such as Sahabuddin into a two tired system of grazing cows on improved and fenced upland paddocks and preferentially feeding young male calves in backyard kandangs.			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

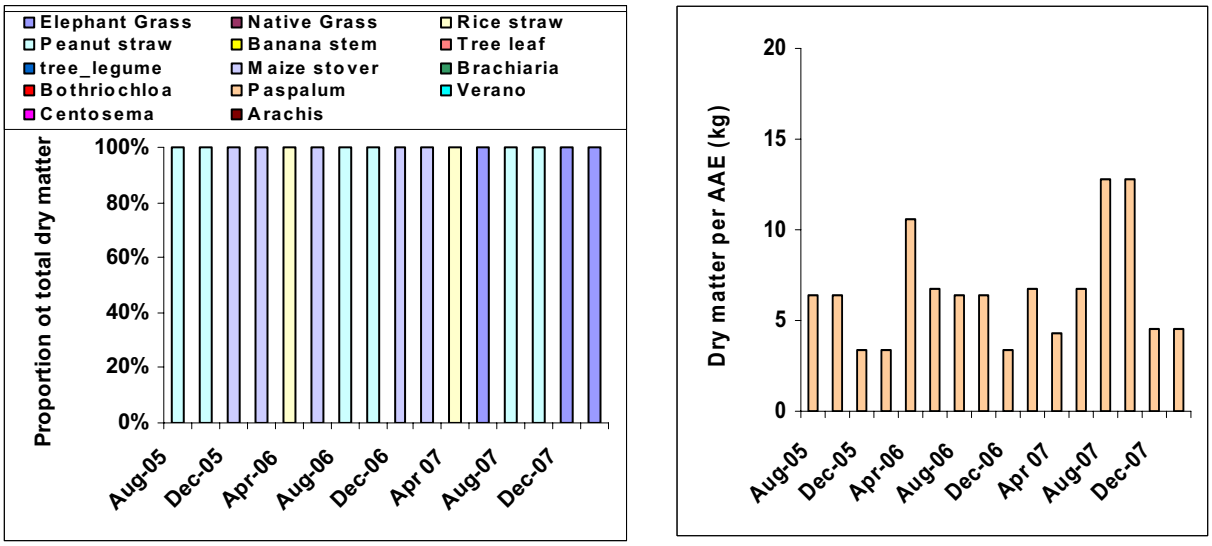


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Sahabuddin, Pattapa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. Dry matter offered up and down, peaking in late dry each year and mostly consisting of rice straw (around April each year)and small quantities of peanut straw and tree leaves until beginning of elephant grass supplementation of males especially in 2007.

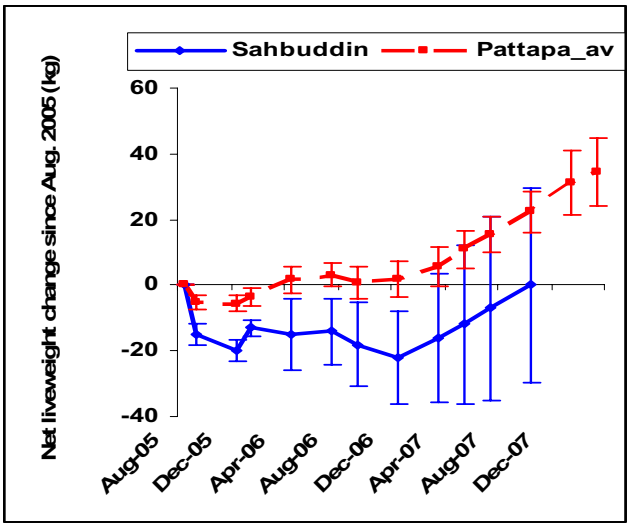


Figure 2: Comparison of liveweight trends of mature cows for Pak Sahabuddin vs. the average for Pattapa best bet farmers for the study period August 2005 to October 2007. Data are means and standard errors. Note that Sahabuddin's cows are doing well below average for Pattapa best bet farmers thoughout 2006-07, though showing a similar improvement trend through dry season 2007 compared to 2006. However error bars show considerable variation between animals. No liveweight data for male cattle exist for Sahabuddin for this period – hence no figure.

Best bet farmer: Pak Cipe, Dusun Pattapa, Barru, Sulawesi

Main points from original interview notes

- Cattle free grazing in upland only. No supplements. Upland also used for public grazing.
- Backyard not used for grazing.
- No incentive to improve upland because of communal grazing. Could participate in rotational cell grazing idea put forward in Bakka's overview.
- Has 13 cattle including 4 cows. Can't be too healthy!!.
- No point in conserving or buying in residue as animals free grazing the whole time.
- Alternatively, could use this farm as a control – how do cattle perform under 'natural' conditions?
- Not interested in rice collection and feeding as insufficient labour.

Major constraints to cattle production

- Lack of forage quantity and quality all year round – due to overgrazing and degradation of upland communally grazed land
- Lack of alternative forage supply options (fodder banks or conserved forages)

Calendar of existing farming system and suggested best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Lowland	0.4ha	Food crop	Rice											
		Grazing												
		Cut and Carry												

Upland / Backyard	0.5ha. Communal grazing upland + 0.3ha backyard	Food crop												
		Grazing	Establish forage swards inside fenced area. Consider rotational grazing around fenced communal grazing fields (ie. periodic resting of each) NOTE farmer shared this best bet demonstration with Bakka as no other options apparent											
		Cut and Carry												
Cattle breeding			Free ranging stock. Natural, uncontrolled mating. No opportunity for seasonal mating, preferential feeding.											
Off-farm residue / cut and carry														
Conserved feed (period of use)														
Peak labour periods			Rice plant				Rice harvest							Rice prep.

Summary of best bet progress to February 2008

Farmer: Cipe, Pattapa	**Actual best bet**	**Commenced**	**2006 progress**	**2007 progress**
Best bet 1	Perennial pasture grasses and legumes for fenced upland rehabilitation area	05-06 wet	Slow due to communal grazing	None – exposed to communal grazing
Overall assessment	Original upland exclosure had poor-fair establishment on lower slopes but inability to exclude communal grazing prevented recovery of this area. No other original best bets identified Has just recently followed other best bet farmers to segregate males and feed them EG – the last farmer to do so.			
Farmer attitudes	Initially very poor and disinterested and remains so. The last of the of the original 5 Pattapa best bet farmers to take up growing and feeding EG cut and carry (Feb 2008).			
Direct impacts	Exclosure area compromised by failure to exclude communal heavy grazing. Farmer says cattle now in better condition. Before would have expected around RP 3 million for a 4 YO male – now at least RP 5 million (though trader only offering RP 4 million due to age and condition). However liveweight data suggests his cows doing poorly compared to Pattapa average (which is not good either) while his young males doing about average for Pattapa.			
Indirect impacts	Farmer has finally learnt the value of growing and feeding RG to young males in backyard kandang.			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

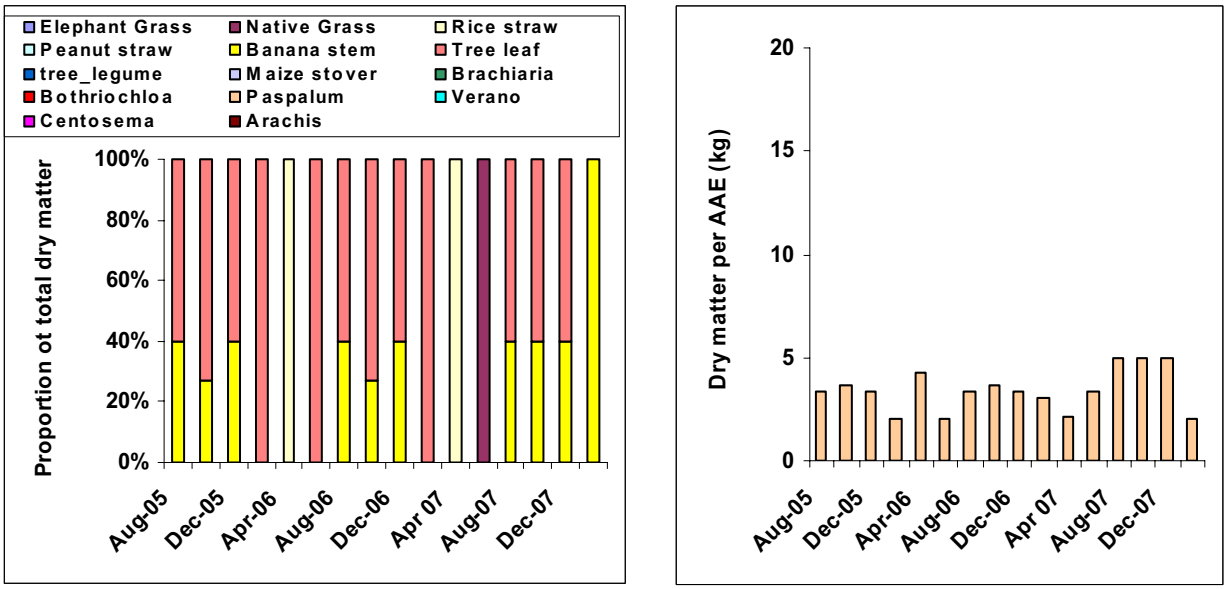


Figure 1:a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Cipe, Pattapa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The amount of cut and carry dry matter fed by pak Cipe is always wel below maintenance reflecting the fact that is essentially a free grazer who has only very recently embraced segregated feeding of elephant grass to young male cattle. The limited cut and carry he feeds is mostly tree leaves, rice straw, banana stem and native grass

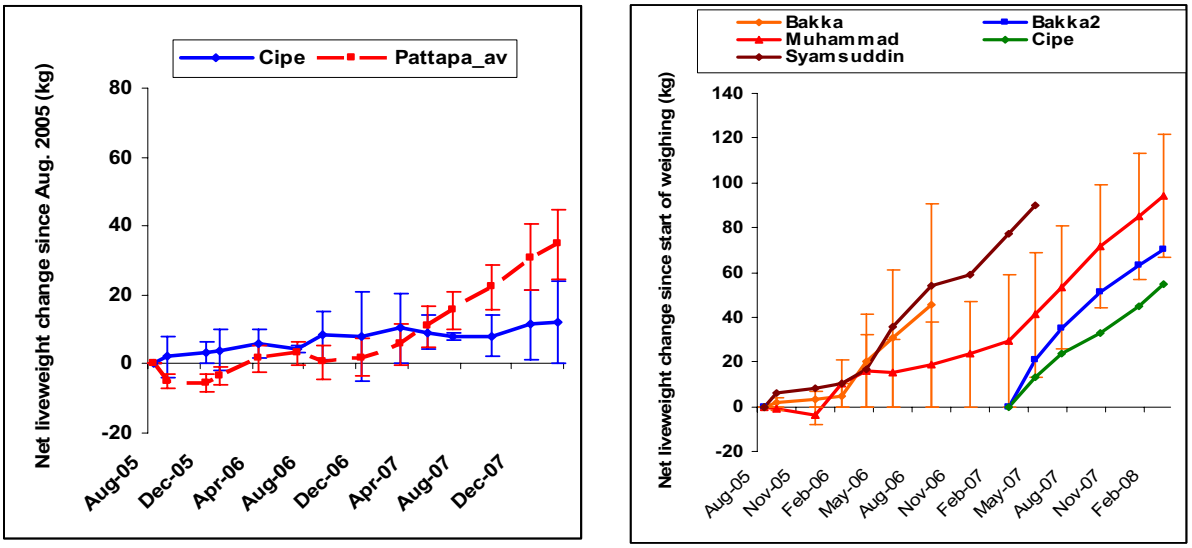


Figure 2: a. Comparison of liveweight trends of mature cows for Pak Cipe vs. the average for Pattapa best bet farmers for the study period August 2005 to October 2007. Data are means and standard errors. Note that Cipe's cows are doing well below average for Pattapa best bet farmers especially through 2007 when other farmer's cows are improving in liveweight. However error bars show considerable variation between animals. b. Comparison of net liveweight change for young male cattle at Pattapa. Data are means and standard errors for change since start of weighing. Cipe's male cattle gained at a similar rate to most other Pattapa best bet male cattle. Cipe only began separating his young males in mid 2007 and feeding them elephant grass from Feb. 2008

Best bet farmer: Pak Syamsuddin, Dusun Pattapa, Barru, Sulawesi

Main points from original interview notes

- No rice crop
- Earns primary income from cattle and off-farm as a truck driver.
- The 1ha lowland area is currently unused and covered in lantana etc. Does not grow rice. Perfect site for forage garden - mix of perennial species (suitable as no annual crop element). Would need to fence off to exclude free grazing stock. This parcel of land is in a natural drainage line with good deep soil.
- Farmer very keen to work this land up. The project will help with fencing costs.
- Has 4 cattle. Recently reduced from 6.
- Given tethering at night could consider preferential feeding of weaners.
- Interested in use of others rice (can get neighbours for free has vehicle to collect). Would build a store to house.

Major constraints to cattle production

- Availability of high quality forage especially in late dry and wet season
- Lack of grazing control to exploit use of potential forage bank development areas

Calendar of existing farming system and suggested best bet options to meet constraints

<table>
<tr><td>Land type</td><td>Area (ha)</td><td></td><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>S</td><td>O</td><td>N</td><td>D</td></tr>
<tr><td rowspan="3">Lowland</td><td rowspan="3">1ha</td><td>Food crop</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Grazing</td><td colspan="13" rowspan="2">Establish forage garden & sward on currently unused lowland area.</td></tr>
<tr><td>Cut and Carry</td></tr>
<tr><td rowspan="3">Upland / Backyard</td><td rowspan="3">5 separate parcels totalling 5ha</td><td>Food crop</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Grazing</td><td colspan="13">Free around house during day. Tethered at house at night. Doesn’t graze upland area – communally grazed by others</td></tr>
<tr><td>Cut and Carry</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Cattle breeding</td><td colspan="13">Preferential feeding of weaners in evening using plant residues and others cut and carry from new forage garden</td></tr>
<tr><td colspan="3">Off-farm residue / cut and carry</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Ammoniated rice straw (collected from other farmers)</td><td colspan="4">Peanut residue from other farmers.</td></tr>
<tr><td colspan="3">Conserved feed (period of use)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Peak labour periods</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Summary of best bet progress to February 2008

Farmer: Syamsuddin, Pattapa	Actual best bet	Commenced	2006 progress	2007 progress
Best bet 1	Grasses and legumes for upland terraces and forage bank on old cropland	05-06 wet	Poor establishment due to farmer injury	Better result for re-sown forages – should improve over next wet season
Best bet 2	Crop residue conservation	Not yet	none	none
Best bet 3	Preferential feeding and early weaning	Not yet	Not yet attempted	Not yet attempted

Overall assessment	Original planting delayed due to farmer accident Then planted late – too dry so poor establishment. Replanted in 06-07 – mixed success but should really thicken up in 07-08 wet season to provide useful forage bank. No ammoniation and no preferential feeding or early weaning yet. He has also planted EG, good Gliricidia fences and Sesbania for forage. This area has good potential for on-site feeding of forages as farmer building small caretaker house there to oversee cropping and animal management Farmer currently has no cattle (had 3 but sold them). Currently his cousin utilises his forage but he oversees management of it.
Farmer attitudes	Farmer still keen despite setbacks. Keen to expand and develop forage bank and expand cattle activities
Direct impacts	No real impacts as yet as forage bank still developing and has recently sold all his cattle (still share farms one calf). Liveweight data shows his cows doing worse than Pattapa average though his young male performed slightly better than Pattapa average especially in late 2006/early 2007 when he started feeding EG + tree legumes.
Indirect impacts	Farmer exposure to Barru field day has strengthened his interest in expanding his cattle raising and forage production activities

Relevant graphical summaries of best bet impacts on forage use and cattle performance

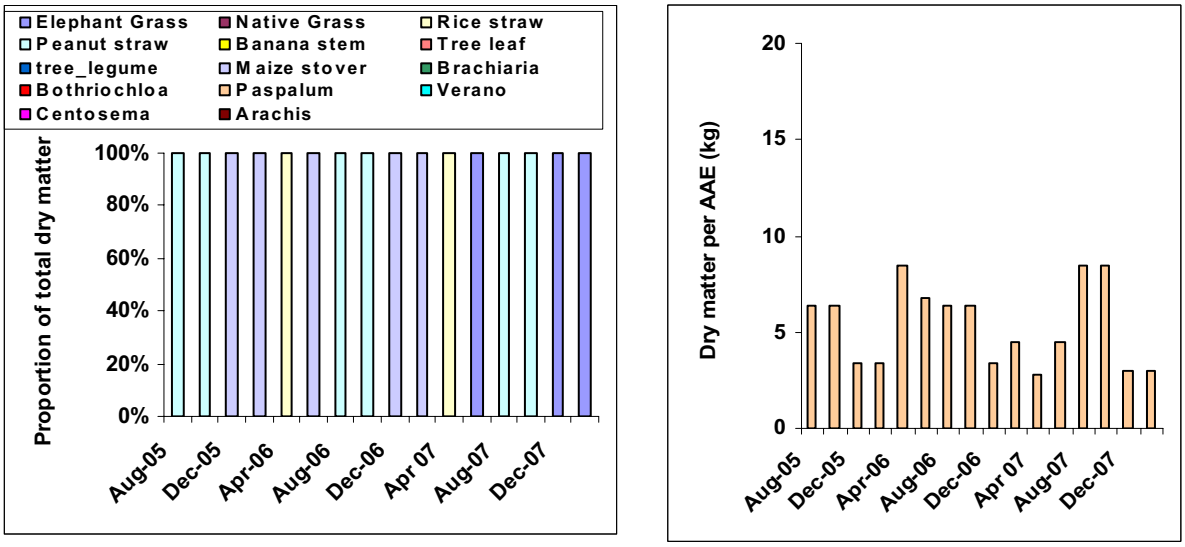


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Syamsuddin, Pattapa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. Dry matter offered up and down, generally below maintenance, peaking in late dry each year and mostly consisting of maize stover, rice straw (around April each year)and small quantities of peanut straw until beginning of elephant grass supplementation of males especially in 2007. No evidence of use of new forage bank (Clitoria + grasses) mainly due to small area and location in upland, away from backyard kandang.

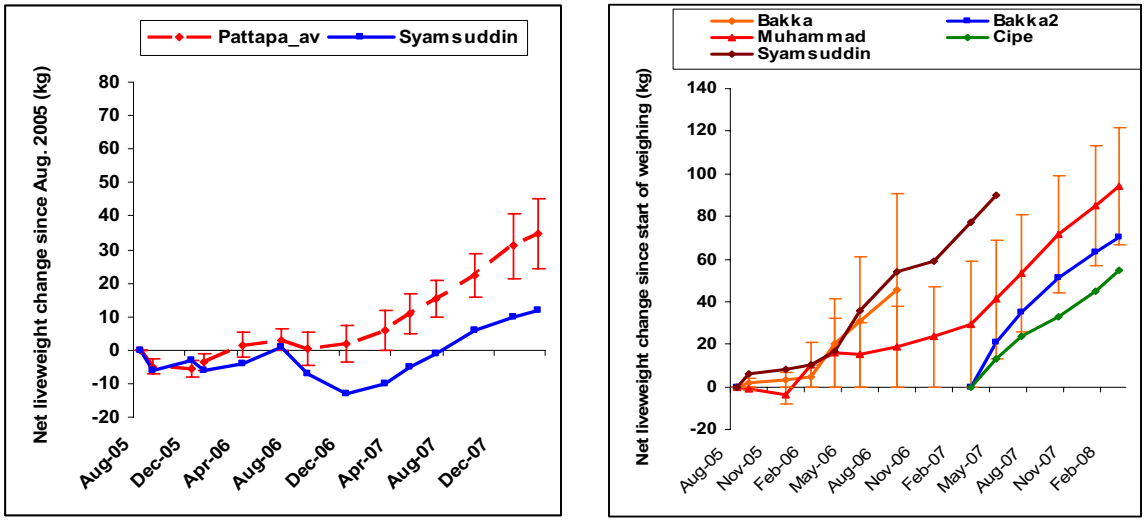


Figure 2: a. Comparison of liveweight trends of mature cows for Pak Syamsuddin vs. the average for Pattapa best bet farmers for the study period August 2005 to October 2007. Data are means and standard errors. Note that Syamsuddin's cow is doing well below average for Pattapa best bet farmers especially through 2007 when other farmer's cows are improving in liveweight. b. Comparison of net liveweight change for young male cattle at Pattapa. Data are means and standard errors for change since start of weighing. Syamsuddin's male cattle gained at a faster rate compared to most other Pattapa best bet male cattle during most of 2006 but slowed down during late dry before again growing faster through 2007 until sold mid 2007. However there is considerable variation between animals as evidenced by the standard error bars.

11.6.4 Lompotengah sub-village

A total of 19 separate best bet activities were identified with the five farmers. Of these 8 have been implemented to date with varying degrees of success (table 4).

Table 4: Best bet activities identified for case study farmers in Lompotengah 2005-07

Village / farmer	New forage introduction		Better use of existing forages (tree legs and EG)		Crop residue conservation (inc. rice straw ammoniation)		Preferential feeding / early weaning	
Lompotengah	Identified	started	Identified	started	Identified	started	Identified	Started
Jufri	1	1	1	1	1	0	1	1
Mahmud	1	1	1	1	1	0	1	1
La Emma	1	1	1	0	1	0	1	0
Nunding	1	0	1	0	0	0	1	0
Syamsuddin	1	1	1	0	1	0	1	0
Total	5	4	5	2	4	0	5	2

One farmer (Nunding) left the district but was not replaced. Two other best bet farmers (Syamsuddin and La Emma) have been virtually inactive since the early stages. While both initially tried to establish new forages these attempts failed largely due to reasons including lack of labour and/or suitable land or cattle to effectively implement and maintain these best bet activities This left just two active best bet farmers at Lompotengah for most of the period.

The highest percentage of adoption has been in the categories of new forage introduction and better use of existing forages, followed by adoption of early weaning, preferential feeding and controlled mating by two farmers (Jufri and Mahmud). Though opportunities for adoption of crop residue conservation, in particular rice straw ammoniation, were identified for all Lompotengah best bet farmers, there has been no progress towards adoptions of these options.

Of the forage introduction best bet activities, farmer Jufri's forage bank adjacent to his house and padi area has been the most successful in terms of establishment, management and contribution to cattle production. Originally planned for his upland area on well drained loamy soils, the selected forages (Verano stylo, Centrosema pascourum, Arachis pintoi, Brachiaria decumbens and Setaria sphacelata) were instead sown on poorly drained padi claysoils with limited success. A switch to better suited Clitoria ternatea and Paspalum atratum has seen this small (0.05ha) forage bank develop into a highly productive and sustainable resource of high quality cut and carry forage close to the farmer's household kandang. (see results section for impact details). While Clitoria productivity declined significantly on the original site, production of Paspalum has expanded to fill the gap. Jufri has since expanded the development of new forages into his upland area using material obtained from his existing plot, from pre-existing plots on pak Mahmud's upland and project sources.

In terms of the better use of existing forages options, both pak Jufri and pak Mahmud have expanded both the area of elephant grass and Gliricidia fences in their upland areas and built kandangs for preferential feeding in both upland and backyard areas. Jufri now has his own bull for better control of mating.

Best bet farmer: Pak Mahmud, Dusun Lompotengah, Barru, Sulawesi

Main points from original interview notes

- Has 5 cattle – 2 cow and 3 calf.
- Mahmud is head of farmer group
- Opportunity to improve preferential feeding (already adopting to some extent)
- Opportunity for seasonal mating. Problem with these farmers is access to bull. Offered to buy from project funds to be shared by all.
- Opportunity for ammoniation of rice straw to increase quality. Of particular use during change from dry to wet season (diarrhoea prior to gut flora adjustment associated with shift to young, green feed). Rice straw slows down digestion. At other times during the wet season a valuable source of energy).
- Incorporate new legumes into upland area to complement elephant grass

Major constraints to cattle production

- Availability of high quality forage in late dry and wet season. Also availability of good quality roughage/ to ameliorate gut flora changeover and associated weight loss/growth check.

Calendar of existing farming system and suggested best bet options to meet constraints

<table>
<tr><th>Land type</th><th>Area (ha)</th><th></th><th>J</th><th>F</th><th>M</th><th>A</th><th>M</th><th>J</th><th>J</th><th>A</th><th>S</th><th>O</th><th>N</th><th>D</th></tr>
<tr><td rowspan="3">Lowland</td><td rowspan="3">2 parcels of 0.25 and 0.15ha</td><td>Food crop</td><td colspan="5" rowspan="2">Rice 1</td><td colspan="5">Peanut (in upper, drier terraces)</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td colspan="5">Rice 2 (irrigated)</td></tr>
<tr><td>Grazing</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Free grazing</td></tr>
<tr><td>Cut and Carry</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Upland / Backyard</td><td rowspan="3">0.25ha</td><td>Food crop</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Grazing</td><td colspan="11">Improve quality of 'pasture' with introduction of shrubby and tree legumes</td><td></td><td></td></tr>
<tr><td>Cut and Carry</td><td colspan="11">elephant grass + introductions from last project (Setaria, Paspalum, Arachis)</td><td></td><td></td></tr>
</table>

Cattle breeding					Calve			Mate			Wean and preferentially feed	
Off-farm residue / cut and carry												
Conserved feed (period of use)	Ammoniate rice straw to improve quality											
Peak labour periods	Rice planting				Rice harvest and prep./planting of 2nd crop					Harvest		Rice prep.

Summary of best bet progress to February 2008

Farmer: Mahmud, Lompo Tengah	**Actual best bets**	**Commenced**	**2006 progress**	**2007 progress**
Best bet 1	More use of tree legumes, especially Gliricidia	05-06	good	Very good
Best bet 2	Preferential feeding and early weaning	Not yet started	none	Has now started
Best bet 3	Crop residue conservation	Not yet started	none	Some
Best bet 4	Further development of forage banks in upland area	On-going	Excellent expanding	Excellent expanding
Overall assessment	All best bet options tried working well – no failures. Did not attempt ammoniation because already has enough forage year round (EG plus new forages) and does not want to use labour to cart and store rice straw. New forages all working well – Mulato and Clitoria useful additions to new forages he already had established. Farmer has established 600m of Gliricidia and using Gliricidia from new hedges as cut and drop. Farmer has now established a backyard kandang similar to Jufri and is weaning at 7 months (154 kg LW) and feeding additional forage to calves. early weaning / preferential feeding also working well. Farmer has significantly expanded his original upland forage bank and now provides planting material for other farmers as well as setting up and managing a substantial forage nursery for the new scaleout project.			
Farmer attitudes	Farmer remains extremely keen and enthusiastic promoter of new forages within village and beyond He is both mentor and champion for best bet technologies at Desa Lomp Tengah and beyond			
Direct impacts	Forage monitoring shows farmer feeding adequate dry matter which includes significant proportions of EG plus some new forages. Few measurable direct impacts on cattle to date – can see difference in cow and calf condition. Cattle liveweight data shows Mahmud's cows not performing as well as Lompotengah average while his young males performing about average.			
Indirect impacts	Mahmud's leadership and mentoring role in promoting adoption of new forages has been a major reason for significant scaleout of 005 technologies at Pattalikang and surrounding villages Mahmud is also providing the land and expertise for development of a major regional forage nursery to serve the new scaleout project			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

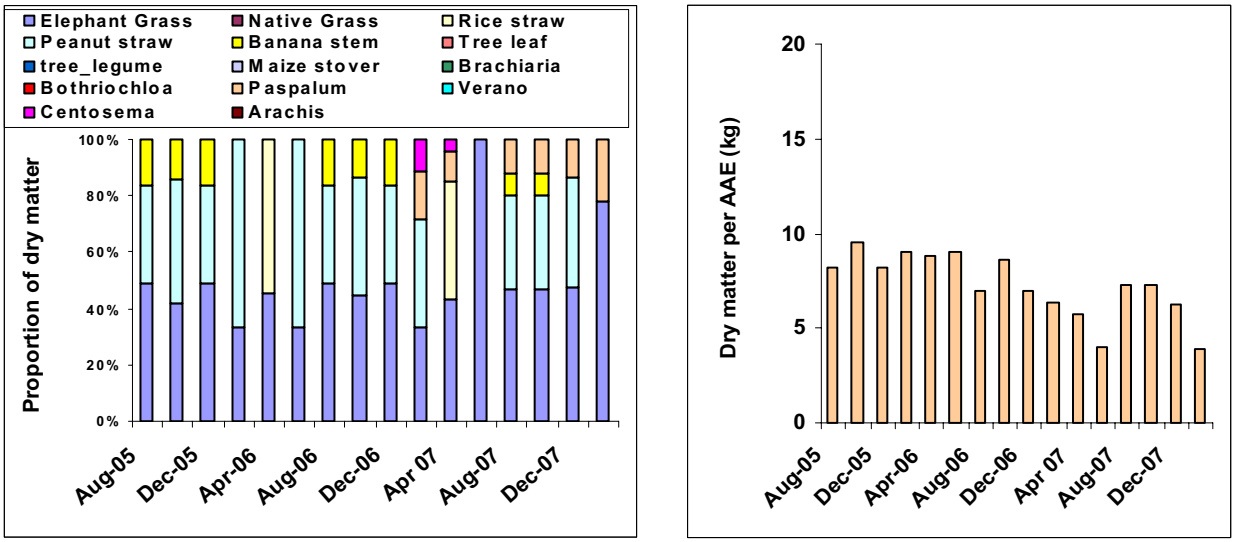


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) for pak Mahmud between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Mahmud's cattle are receiving around maintenance dry matter throughout the year from cut and carry forage. However he also grazes his cattle year round in upland area near cropland. Figure a shows the significant proportion of elephant grass and also the contribution of new forages, especially Paspalum atratum to cut and carry.

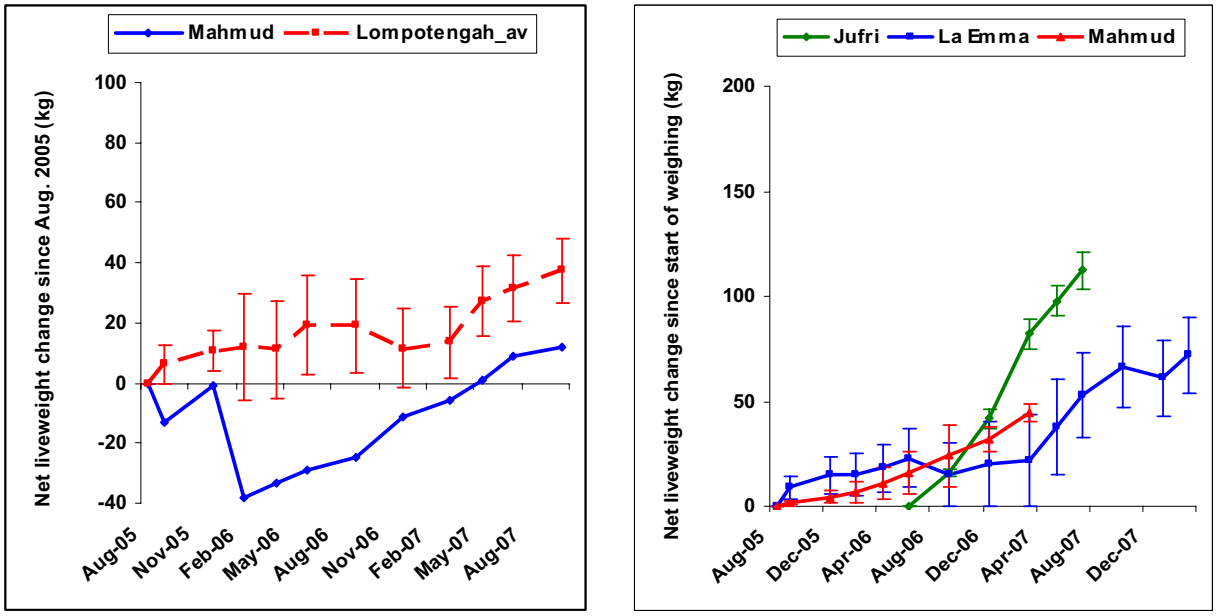


Figure 2: a. Comparison of liveweight trends of a. mature cows for Pak Mahmud vs. the average for Lompotengah best bet farmers for the study period August 2005 to October 2007. Note that Mahmud's cow is below average for Lompotengah best bet farmers. Data are net liveweight change since August 2005 (means and standard errors for cows with starting weight above 150kg).b. Comparison of net liveweight change for young male cattle at Lompotengah. Data are means and standard errors for change since start of weighing. Mahmud's male cattle gained at a similar rate to most other Lompotengah best bet male cattle except Jufri's during most of 2006-07.

Best bet farmer: Pak Jufri, Dusun Lompo Tengah, Barru, Sulawesi

Main points from original interview notes

- Has 5 cattle – 1 cow and 4 others.
- Forage availability and quality is limiting stock increase according to farmer (especially quality from July to September).
- Opportunity to improve preferential feeding
- Opportunity for seasonal mating. Problem with these farmers is access to bull but he is experienced in A.I. Offered to buy from project funds to be shared by all.
- Opportunity for ammoniation of rice straw to increase quality.
- Incorporate new legumes into upland area to complement elephant grass

Major constraints to cattle production

- Availability of high quality forage in mid-late dry. Also availability of good quality roughage/ to ameliorate gut flora changeover
- Late calving also places extra pressure on cow/calf maintenance and growth in late dry.

Calendar of existing farming system and suggested best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Lowland	0.3ha + share crops 0.2ha	Food crop	Rice 1					Peanut (in upper, drier terraces)						
								Rice 2 (irrigated)						
		Grazing						Rice stubble					Free grazing	
		Cut and Carry					Grasses from bunds							
Upland / B'yard	0.5ha upland / 0.05ha b'yard	Food crop												
		Grazing	Improve quality of 'pasture' with introduction of shrubby and tree legumes											
		Cut and Carry	Elephant grass											
Cattle breeding							Calve			Mate			Wean and preferentially feed	
Off-farm residue / cut and carry														
Conserved feed (period of use)											Ammoniate rice straw to improve quality			
Peak labour periods			Rice planting				Rice harvest and prep./planting of 2nd crop					Harvest		Rice prep.

Summary of best bet progress to February 2008

Farmer: Jufri, Lompo Tengah	Actual best bets	Commenced	2006 progress	2007 progress
Best bet 1	Grasses and legumes for upland areas	2005-06	Poor	Fair-good
Best bet 2	Grasses and legumes for lowland wet areas near backyard	2005-06	Poor initially then excellent with Clitoria	Excellent Paspalum

Best bet 3	Preferential feeding and early weaning	2006 (feeding)	Good (pref feeding)	Good (pref feeding)
Best bet 4	Crop residue conservation	Not started	none	none
Overall assessment	Original upland site not planted until 06-07. Old paddy area near house used instead in 05-06. Initial legume establishment poor – too wet but Clitoria did well in 2006. Farmer has now planted Paspalum atratum and Setaria as well. Paspalum excellent for this area, Clitoria now struggling but still there. Farmer planted Gliricidia around fences. Upland area plantings had mixed success in 06-07 but should improve. Farmer successfully preferentially feeding young cattle and has built a kandang in his upland for early weaning / preferential feeding and controlled mating – now has his own bull for this No crop residue conservation yet.			
Farmer attitudes	Farmer very enthusiastic and has embraced the whole package. His forage bank and animal management system have provided inspiration and material for up to 50 other farmers to date.			
Direct impacts	Lowland forage banks provided up to half the daily requirements for 3 young cattle in 06-07 Jufri's young male cattle grew at twice the rate (0.33 kg/head/day) from when he commenced feeding new forage, in May 2006, compared to the Lompotengah average of 0.14kg/hd/day. In other words Jufri's cattle reached the same liveweight in half the time. Farmer has turned over more than Rp 15 million in cattle sales over this period.			
Indirect impacts	Farmer's success has resulted in over 50 local farmers now adopting both introduced forage and cattle feeding technologies successfully practiced by pak Jufri.			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

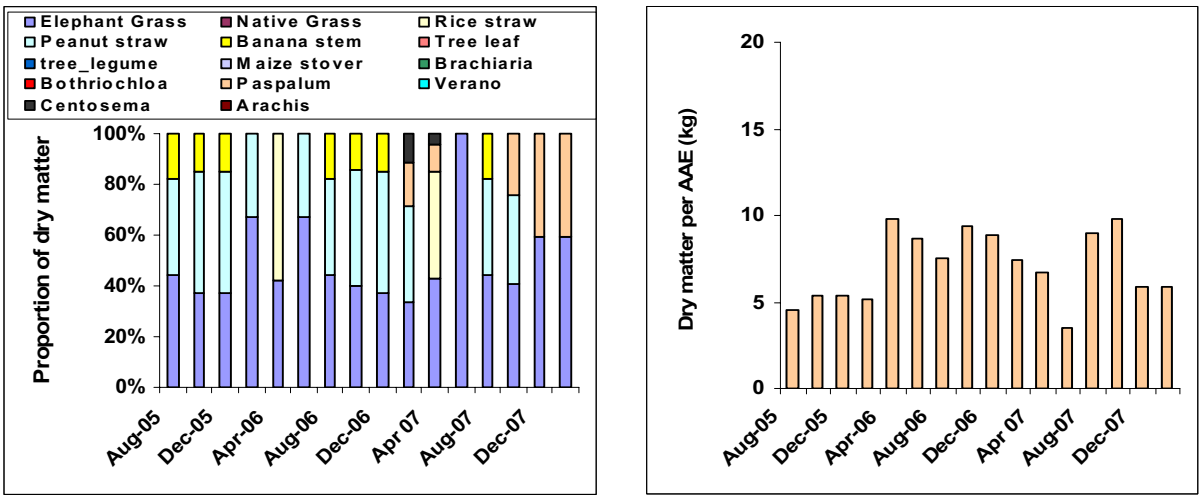


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Jufri between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Jufri's cattle are receiving around maintenance dry matter throughout the year from cut and carry forage, especially since mid 2006 on when his forage bank began to contribute. Figure a. shows the significant proportion of elephant grass and also the contribution of new forages, especially Paspalum atratum and Clitoria ternatea to cut and carry. However the forage monitoring data do not show the full extent of the contribution of this forage bank from mid 2006 due to much of the new forage being fed to young male cattle in the intervals between monitoring visits. Figure a below shows this contribution better.

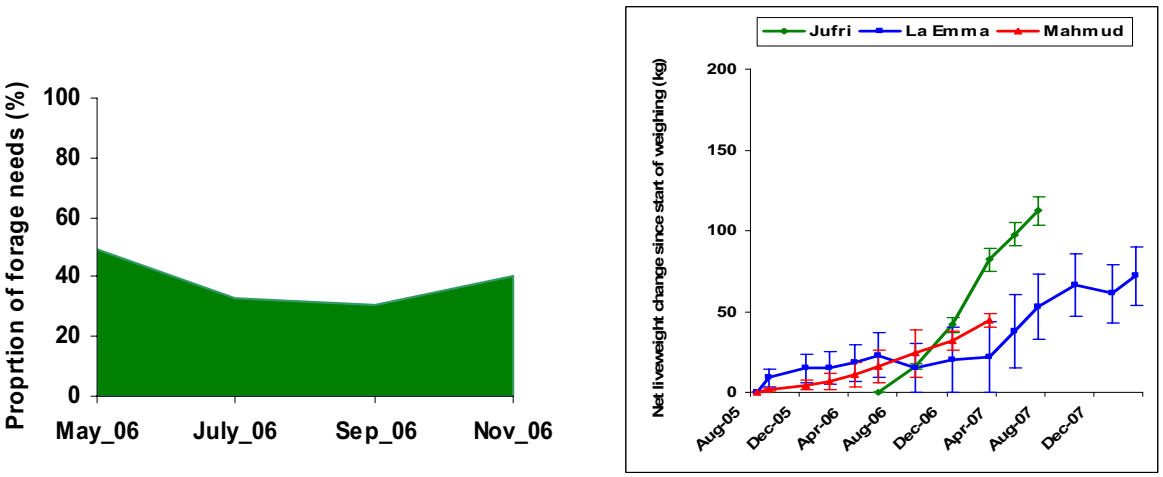


Figure 2: a. Proportion of cut and carry forage dry matter requirements for supplied from pak Jufri's 0.05ha forage bank for 3 yearling male cattle during 2006 (assuming a daily dry matter requirement of 3% of body weight for maintenance and growth. Forage was a mixture of Clitoria ternatea, Centrosema pascourum and Paspalum atratum and Seteria sphacelata which contributed around 17000kg/ha dry matter during 2006-07 or around 850kg dry matter from the 0.05ha forage bank. b. Comparison between growth rates of Jufri's yearling male cattle fed from his forage bank and average growth rates for similar young male Bali cattle at Lompotengah during 2006-07. Note that Jufri's cattle grew at twice the rate (0.33 kg/head/day) from when he commenced feeding new forage, in May 2006, compared to the Lompotengah average of 0.14kg/hd/day. In other words Jufri's cattle reached the same liveweight in half the time. Note that there is no cow liveweight data for Jufri over this period – hence no figure.

Best bet farmer: Pak Nunding, Dusun Lompotengah, Barru, Sulawesi

Main points from original interview notes

- No lowland cropping. Derives sole income from cattle.
- 5 cattle including 3 cows & 2 calves
- Sells 2 cattle per year
- Cattle keeper and breeder. Originally just bought young cattle, fattened and sold for export. This market is now a little risky and feels prospects better for breeding. Is currently doing both.
- Sells bred cattle at 1.5y.o. for fattening by other farmers. Easier to sell locally at this age.
- Buys bull at 1y.o.. Fattens the bull, uses it for mating and then sells at 3-4 y.o. Buying brings in new genes.
- Rp is constraint to increasing herd size as needs to sell to pay for living expenses etc. Can't afford not to sell females (ie to build up calving potential)
- Opportunity to introduce legumes into pasture mix to complement elephant grass Opportunity to introduce tree legume on riverbank. Legume deficient at moment.
- Opportunity to grow cattle faster via preferential feeding of weaners. Faster growth, earlier sale, better price.

Major constraints to cattle production

- Availability of high quality forage in mid-late dry to compliment EG.

- As cattle sole income and farmer wishes to switch to breeding and selling growers, availability of high quality supplements for preferential feeding of weaners

Calendar of existing farming system and suggested best bet options to meet constraints

<table>
<tr><td>Land type</td><td>Area (ha)</td><td></td><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>S</td><td>O</td><td>N</td><td>D</td></tr>
<tr><td rowspan="3">Lowland</td><td rowspan="3">0.4ha</td><td>Food crop</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Grazing</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cut and Carry</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="3">Upland / Backyard</td><td rowspan="3">2 separate parcels. 0.5ha and 1ha. 0.2ha backyard</td><td>Food crop</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Grazing</td><td colspan="12">Improve quality of ‘pasture’ with legume (sp. depending on conditions).</td></tr>
<tr><td>Cut and Carry</td><td colspan="9">Elephant grass (0.5ha along riverbank). Supplement with rice meal occasionally. Gliricidia along riverbank as additional source of legume.</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Cattle breeding</td><td></td><td></td><td></td><td></td><td colspan="2">Calve</td><td></td><td colspan="2">Mate</td><td></td><td colspan="2">Wean & preferentially feed</td></tr>
<tr><td colspan="3">Off-farm residue / cut and carry</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Conserved feed (period of use)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Peak labour periods</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

*** Farmer moved to Papua before best bet activities commenced – not replaced*

Best bet farmer: Pak Syamsuddin, Dusun Lompotengah, Barru, Sulawesi

Main points from original interview notes

- Very small land area
- Purchases rice off-farm to provide for family
- 3 cattle including 1 cow and 2 calves
- Essentially a feedlot
- Feels 5 cattle is maximum that can be supported on this area!!.
- Opportunity for ammoniated rice
- Opportunity for seasonal mating and preferential feeding
- Opportunity to incorporate legumes into upland

Major constraints to cattle production

- lack of land to grow forages or produce crop residues for conserved forage

Calendar of existing farming system and suggested best bet options to meet constraints

<table>
<tr><td>Land type</td><td>Area (ha)</td><td></td><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>S</td><td>O</td><td>N</td><td>D</td></tr>
<tr><td rowspan="3">Lowland</td><td rowspan="3">0.17ha</td><td rowspan="2">Food crop</td><td colspan="5" rowspan="2">Rice 1</td><td colspan="4">Peanut (share crop another parcel of land)</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td colspan="4">Rice 2 (0.17ha)</td></tr>
<tr><td>Grazing</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cut and Carry</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Upland / B’yard</td><td>0.1ha. Also</td><td>Food crop</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

	has access to another farmers upland 0.15ha for EG	Grazing	Improve quality of 'pasture' with introduction of legumes																				
		Cut and Carry	Elephant grass (kept separate from 'pasture' area). Tree legume introduction.																				
Cattle breeding							Calve						Mate				Wean & preferentially feed						
Off-farm residue / cut and carry																							
Conserved feed (period of use)						Ammoniate rice straw									Feed rice straw								
Peak labour periods			Rice planting				Rice harvest and prep./planting of 2nd crop								Hvt			Rice prep.					

Summary of best bet progress to February 2008

Farmer: Syamsuddin Lompo Tengah	Actual best bets	Commenced	2006 progress	2007 progress
Best bet 1	Perennial grasses and legumes for upland terraces	2005-06	Poor	poor
Best bet 2	use Gliricidia around upland area	Not started	None	None
Best bet 3	Ammoniated rice straw	Not started	None	None
Best bet 4	Controlled mating/calving / Preferential feeding	Not started	None	None
Overall assessment	Little progress on best bet options so far. Some repeated planting but all have failed because too small , not looked after and overgrazed Farmer not keen or too old to take on forage production or more animal management However now cooperating with La Emma to share land, labour and cattle to utilise best bet technologies			
Farmer attitudes	Farmer interested or did not have capacity to undertake best bets. However is now working with pak La Emma to do share land and cattle to make use of best bet technologies			
Direct impacts	Note much as little activity to date. Cattle liveweights show Syamsuddin's cows doing slightly better than Lompotengah best bet average which probably reflects the fact that he is feeding adequate amounts of dry matter year round, including significant quantities of EG and peanut straw at times.			
Indirect impacts	none as little activity as little activity to date			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

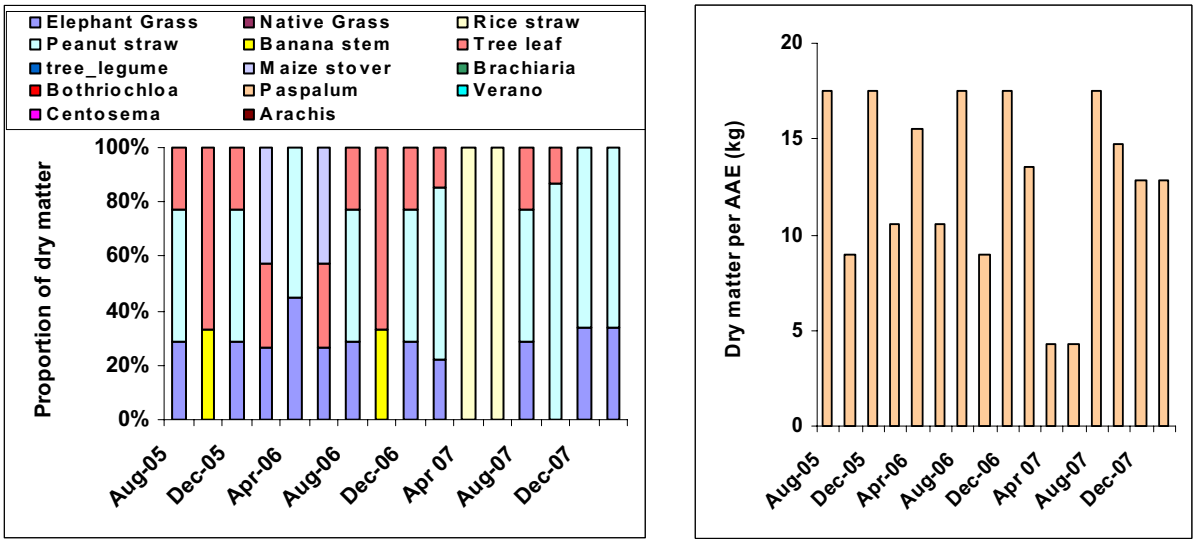


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Syamsuddin between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graphs show more than adequate supply of dry matter for most of the years though this data may not reflect the true number of cattle being fed due to farmer's vagueness about numbers at times. Cut and carry diet indicate about 20% elephant grass and s significant amount of peanut straw and maize stover at times.

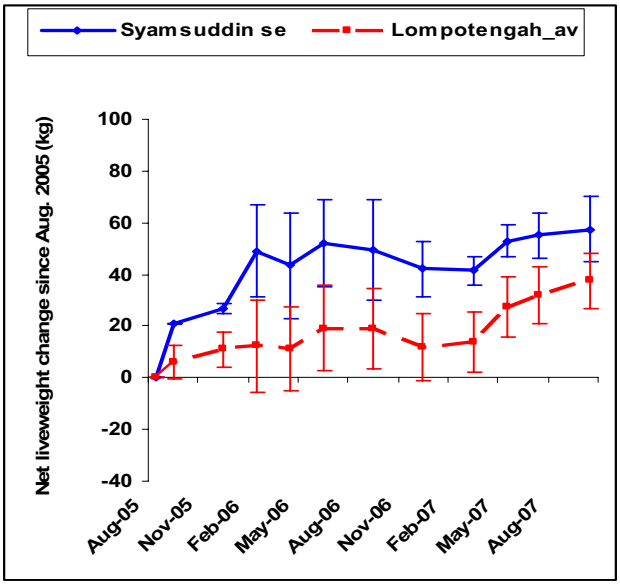


Figure 2: a. Comparison of liveweight trends of a. mature cows for Pak Syamsuddin vs. the average for Lompotengah best bet farmers for the study period August 2005 to October 2007. Syamsuddin's cows performed slightly better than below average for Lompotengah best bet farmers. Data are net liveweight change since August 2005 (means and standard errors for cows with starting weight above 150kg). Note that there is no male liveweight data available for Syamsuddin over this period – hence no figure.

Best bet farmer: Pak La Emma, Dusun Lompotengah, Barru, Sulawesi

Main points from original interview notes

- 5 cattle including 2 cows and 3 calves

- Opportunity for ammoniated rice
- Opportunity for seasonal mating and preferential feeding (could separate weaners)
- Opportunity to incorporate legumes into upland (Arachis and Stylo)
- This might be a good site for demonstration of different elephant grass cultural practices. Different N rates. Different cutting intervals and heights. Different levels of shading. Use for model improvement. Current indications are that elephant grass not being rested long enough and being cut to short (damaging growing points).
- Wants to sell one head per year.
- Labour availability would limit stock number to between 4-6. Doesn't want to increase number but wants to increase growth rate and sale weight.
- E.G needs fertilisation

Major constraints to cattle production

- Limited high quality forage in late dry season
- Labour – farmer old and wants to reduce labour load for cut&carry and thus cattle numbers
- Lack of reliable access to bull

Calendar of existing farming system and suggested best bet options to meet constraints

<table>
<tr><td>Land type</td><td>Area (ha)</td><td></td><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>S</td><td>O</td><td>N</td><td>D</td></tr>
<tr><td rowspan="3">Lowland</td><td rowspan="3">0.5ha</td><td>Food crop</td><td colspan="5">Rice 1</td><td colspan="5">Peanut (upper, drier terraces)</td><td></td><td></td></tr>
<tr><td></td><td colspan="5"></td><td colspan="5">Rice 2</td><td></td><td></td></tr>
<tr><td>Grazing</td><td colspan="5"></td><td colspan="3">Rice stubble</td><td colspan="3"></td><td colspan="2">Free grazing</td></tr>
<tr><td></td><td>Cut and Carry</td><td colspan="5"></td><td colspan="5"></td><td></td><td></td></tr>
<tr><td rowspan="3">Upland / Backyard</td><td rowspan="3">0.5ha.</td><td>Crop type</td><td colspan="5"></td><td colspan="5"></td><td></td><td></td></tr>
<tr><td>Grazing</td><td colspan="5">Introduce improved legumes</td><td colspan="3"></td><td colspan="4">Feed improved legumes</td><td></td><td></td></tr>
<tr><td>Cut and Carry</td><td colspan="9">Elephant grass cultural trial / demonstration</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Cattle breeding</td><td colspan="5"></td><td colspan="2">Calving</td><td></td><td colspan="2">Mating</td><td></td><td colspan="2">Weaning and preferential feeding</td></tr>
<tr><td colspan="3">Off-farm residue / cut and carry</td><td colspan="5"></td><td colspan="3"></td><td colspan="3"></td><td></td><td></td></tr>
<tr><td colspan="3">Conserved feed (period of use)</td><td colspan="5"></td><td colspan="3">Rice straw ammoniation</td><td colspan="3"></td><td colspan="2">Feed rice straw</td><td></td></tr>
<tr><td colspan="3">Peak labour periods</td><td colspan="2">Rice planting</td><td colspan="3"></td><td colspan="3">Rice harvest and prep./planting of 2nd crop</td><td></td><td></td><td></td><td>H'vt</td><td></td><td>Rice prep.</td></tr>
</table>

Summary of best bet progress to February 2008

Farmer: La Emma, Lompo Tengah	Actual best bets	Commenced	2006 progress	2007 progress
Best bet 1	Introduce legumes for upland	Planted 2006-07	poor	poor
Best bet 2	Improve EG utilisation and management	Started 2005-06	little	littes

Best bet 3	Ammoniated rice straw	Not started	None	None
Best bet 4	Controlled mating/calving / Preferential feeding	Not started	None	None
Overall assessment	Little progress on either best bet option so far. Some new forage planting attempted but establishment failed despite several re-plantings mainly due to poor germination (planting to deep?) and shading. Farmer also said cattle pulled out young plants Some improvement in management and use of elephant grass Farmer not keen or too old to take on forage production or more animal management However now collaborating with Syamsuddin to share land cattle an labour to utilise best bet technologies			
Farmer attitudes	Farmer not interested or did not have capacity to undertake best bets. However now collaborating with Syamsuddin to share land cattle an labour to utilise best bet technologies.			
Direct impacts	None as little activity to date. Cattle liveweight data shows La Emma's cows and young males doing below Lompotengah best bet average even though dry matter supplied seems adequate and cut and carry forage has significant amount of EG at times.			
Indirect impacts	None as little activity to date			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

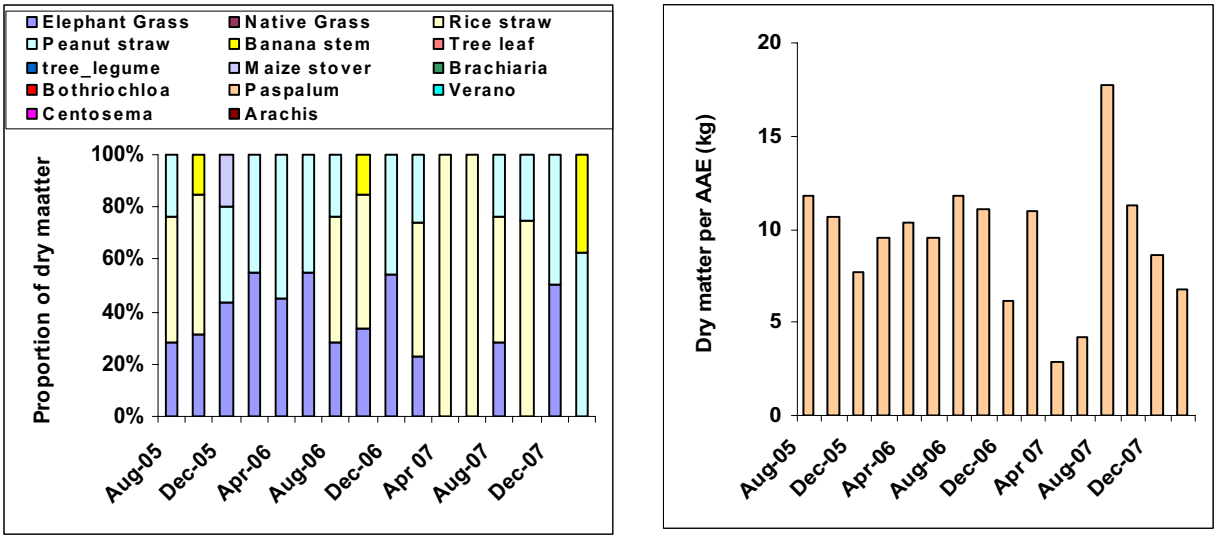


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak La Emma between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graphs show more than adequate supply of dry matter for most of the years though this data may not reflect the true number of cattle being fed due to farmer's vagueness about numbers at times. Cut and carry diet indicate about 20% elephant grass and s significant amount of rice straw, peanut straw and maize stover at times.

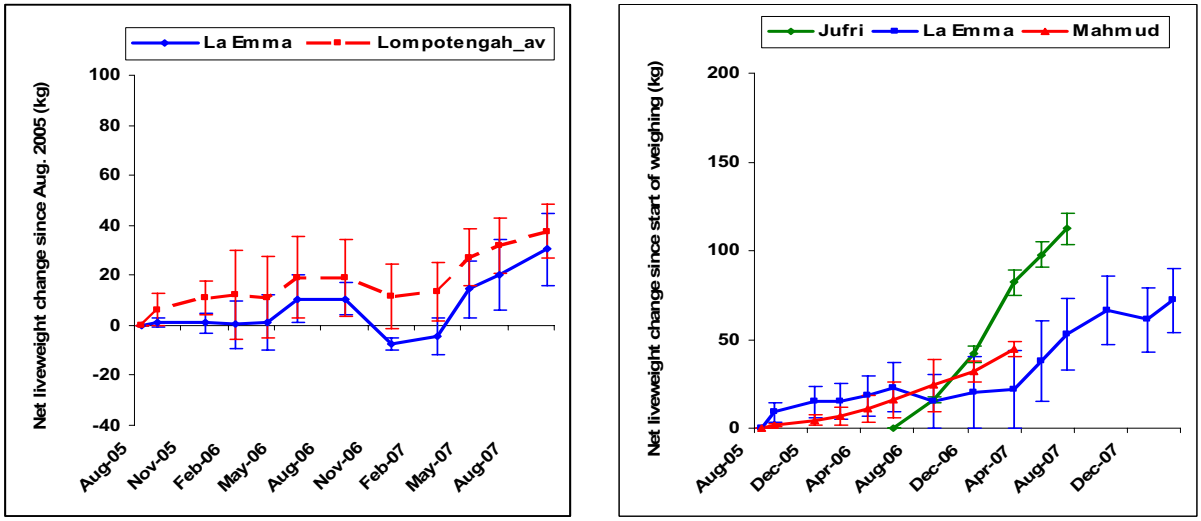


Figure 2: a. Comparison of liveweight trends of a. mature cows for Pak La Emma vs. the average for Lompotengah best bet farmers for the study period August 2005 to October 2007. Note that La Emma's cows are slightly below average for Lompotengah best bet farmers though not significantly. Data are net liveweight change since August 2005 (means and standard errors for cows with starting weight above 150kg). b. Comparison of net liveweight change for young male cattle at Lompotengah. Data are means and standard errors for change since start of weighing. La Emma's male cattle gained very little weight during most of 2006 but improved significantly through 2007.

11.6.5 B. Pattalikang villages

Five best bet farmers were selected from each of two sub-villages (Lemoa and Manyampa) in the Desa Pattalikang district of Gowa Regency between July and October 2006. Forage introduction best bet options were subsequently established in both sub-villages during wet season 2006-07. Table 4 details the best bet activities identified and implemented for each farmer and sub-village. A total 32 best bet activities were originally identified across these two sub-villages in late 2006, of which 18 were subsequently implemented by farmers. Some originally identified best bet activities and/or locations were subsequently changed as part of the adaptive learning process with farmers. Some best bet activities were also delayed or suspended due to farmer illness or change in land use for selected sites.

11.6.6 Dusun Lemoa

Of the 14 separate best bet activities identified 10 were implemented (table 4)

Table 4: Best bet activities identified and implemented in Lemoa sub village, 2005-07

Village / farmer	New forage introduction		Better use of existing forages (tree legs and EG)		Crop residue conservation (inc. rice straw ammoniation)		Preferential feeding / early weaning	
	Identified	started	Identified	started	Identified	started	Identified	Started
Lemoa								
Bella	1	1	1	1	1	0	1	0
Saiyful	3	2	1	1	0	0	1	1?
Rate	1	1	0	0	0	0	1	1?
Romo	2	1	0	0	0	0	0	0
Aming	1	1	0	0	0	0	0	0
Tot.al	8	6	2	2	1	0	3	2?

The original two forage introduction best bets of Saiyful were relocated and redesigned as backyard forage banks in consultation with the farmer, while implementation of pak Romos best bets was delayed due to farmer illness. Best bet farmer Aming joined the project in early 2007 and so implementation of forage best bet activities were slightly in his case. The biggest uptake of best bet options was in the new forage introduction category, which was the main focus in year 1 of the two year best bet program in these "new" villages, with forage supply being the main constraint to livestock production there. Of these, three farmers (Saiyful, Bella and Rate) have established significant forage banks in previously unproductive backyards or upland areas, with Bella's site being the biggest at around 0.2ha. Introduced grasses such as Paapalum, Brachiaria decumbens, Brachiaria X Mulato and Setaria sphacelata have been the most successful in terms of establishment and persistence. Legumes such as stylosanthes hamata cv verano, Stylosanthes guyanensis CIAT 184 and Clitoria ternatea established well but have been largely swamped by grasses in mixed forage bank situations at both Lemoa and Manyampa. Two farmers, (Saiyful and Bella) have improved their management and expanded use of elephant grass and Gliricidia as part of their best bet program. No farmers have yet taken up crop residue conservation options such as rice straw ammoniation at either Lemoa or Manyampa. Two Lemoa farmers at Lemoa have shown an interest in or begun preferential feeding of young male cattle though this has yet to translate into full early weaning/preferential feeding adoption.

Best bet farmer: Pak Bella, Dusun Lemoa, Gowa , Sulawesi

Main points from original interview notes

- 7 cattle – 2 x1yo, 2 calves
- Farmer only – no non-farm income
- Wants to increase cow number to 5
- Only free and tethered grazing – no cut and carry (too much labour, no forages)

Major constraints to cattle production

- currently constrained by feed, especially in dry season
- labour seen as constraint to cut and carry

Calendar of existing farming system and suggested best bet options to meet constraints

Activity/land type		J	F	M	A	M	J	J	A	S	O	N	D
Food / forage crops / grazing	LL1 (0.32ha)	Rice 1			Rice 2							Rice 1	
	LL2 (0.6ha - shared)	Rice			Maize or peanut							Rice	
	UP1 (0.75ha - near)	Cashew + native pasture + wet season maize occasionally. Gamal as perimeter fence 0.25ha forage grass and legume bank											
	UP2 (1.35ha)	Forested area											
	UP3												
Grazing management (all tethered – no free – cattle returned to BY every night)		Tethered in BY							Tethered in crop field + upland 1 & 2			Tethered in BY	
Breeding		Uncontrolled – weaning at 1yo											
On-farm C&C (30-40kg/day)		Native grass and crop residue. Cut and drop Gamal Introduced grasses and legumes + gamal and eg											
Off-farm C&C													

Conserved feed (none)				Conserve peanut straw				Feed peanut straw				
Peak labour crop												
Peak labour cattle												

Summary of best bet progress to February 2008

Farmer: Bella, Lemoa	**Actual best bet**	**Commenced**	**2006-07 Progress**	**2007-08 Progress**
Best bet 1	Legumes and grasses under cashews in UL1	06-07	excellent	excellent
Best bet 2	EG on adjacent river bank + Gliricidia fences	06-07	No EG but good gamal	No EG but good gamal
Best bet 5	Conserve crop legume residue	06-07	Not commenced	Not commenced
Overall assessment	Excellent forage bank establishment on approx 0.25ha under cashews. Planted 9 species most of which grew well. Of these he says Brachiaria decumbens, Mulato (planted later) stylo and Arachis have done best. He has since expanded his forages in year 2 – mainly grasses so far as stylos difficult to establish from cuttings and no seed harvested from year 1 plots. He cuts these forages and feeds to his cattle when they are tethered close to forage bank. Presently has 5 cattle (3 cows, 1 young bull and 1 young female). Had 2 calves but they died. He intends to expand to 10 head and expand forage banks to 2ha by renting adjacent land. Has started feeding Gliricidia now and says usually cattle graze from Gliricidia fences but he also cut and drop when feeding other forages. Farmer has already expanded area and is providing C/C to up to 7 cattle. Has good Gliricidia around area. Has not yet conserved peanut straw			
Farmer attitudes	Farmer very enthusiastic about expanding forages and using them more effectively. Farmer needs to graze or cut back his grasses prior to wet season to remove old growth.			
Direct impacts	New forages made a good contribution to 2007 cut and carry composition. Though total cut and carry dry matter fed below maintenance., farmer also does extensive tether grazing in upland. Bella's cows performing slightly better than Lemoa best bet average. No data available for his male cattle for comparison. Farmer says he does not have time to cut and feed the volume of forage produced especially during busy cropping cycle and this is evident in the dry matter provides per AAE. Farmer advised to tether graze his forage bank at these times – less labour intensive.			
Indirect impacts	Better cattle and feed management and appreciation of value of legumes in feed mix Better appreciation of value of preferential feeding of young stock and early weaning (though not yet tried).			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

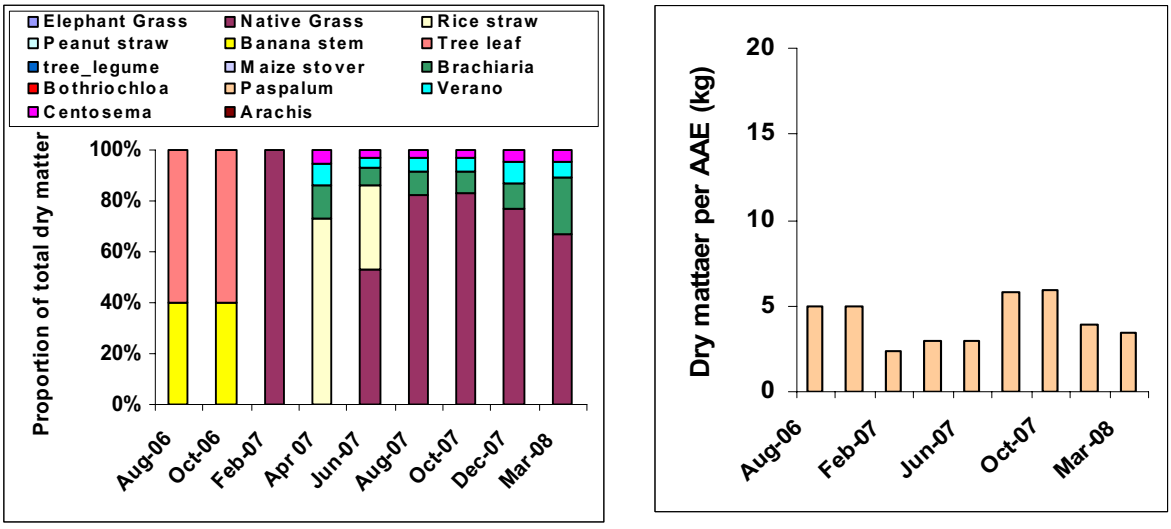


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Bella, Lemoa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Bella's cattle are receiving lower than maintenance dry matter throughout the year from cut and carry forage. However he also grazes his cattle year round in upland area near cropland and uses his forage bank and cut and carry sparingly at present. Fig. 1a shows the contribution of new forages from February 2007 on.

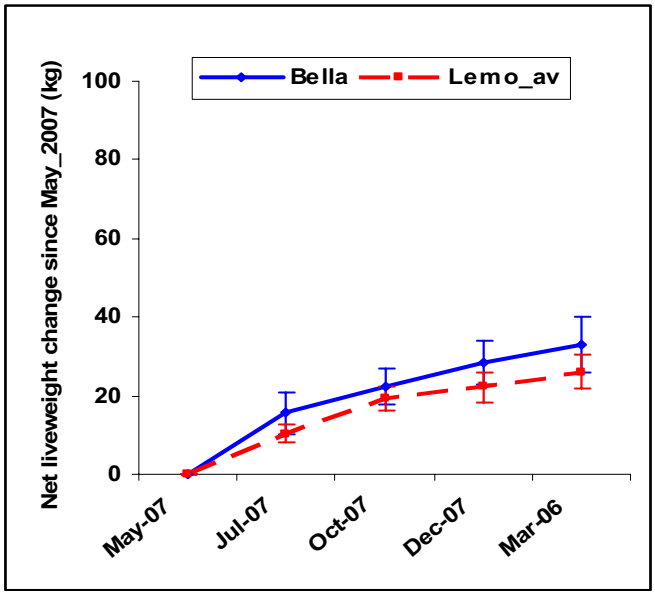


Figure 2. Comparison of liveweight trends of a. mature cows for Pak Bella vs. the average for Lemoa best bet farmers for the study period May 2007 to March 2008. Note that Bella's cows are slightly above average for Lemoa best bet farmers though not significantly. Data are net liveweight change since May 2007 (means and standard errors for cows with starting weight above 150kg).

Best bet farmer: Pak Romo, Dusun Lemoa, Gowa , Sulawesi

Main points from original interview notes

- 6 cattle – 3 cows and 3 calves (1 newborn)

- Pure farmer (used to work off-farm)
- Wants to increase cattle number and has the labour to do so.
- No cut and carry at present – purely free and tethered grazing - - forest in wet season, crop residues and village in dry

Major constraints to cattle production

- currently constrained by lack of good quality feed, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

Activity/land type		J	F	M	A	M	J	J	A	S	O	N	D
Food / forage crops / razing	LL1 (0.5ha)	Rice			Mungbean							Rice	
	LL2												
	UP1 (0.35ha)	Perennial forage bank of grasses and legumes in old rice area											
	UP2 (0.3ha)	Maize and rice			Mungbean							Maize and rice	
	UP3 (0.3ha)	Banana, cashew, cassava. Forage bank of pasture grasses, legumes and Gliricidia under cashews in up 2											
	Backyard	Forage bank of pasture grasses, legumes and Gliricidia											
Grazing management		Tethered grazing on upland / returned at night						Tethered grazing on cropping land and UL etc.				Tethered grazing on upland	
Breeding		Uncontrolled mating											
On-farm C&C (20-25kg/day)								Gamal, grass, rice straw					
Off-farm C&C													
Conserved feed					Conserve mungbean residue				Feed mungbean straw				
Peak labour crop													
Peak labour cattle													

Summary of best bet progress to February 2008

Farmer: Romo, Lemoa	Actual best bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	Forage bank in old rice bay (Clitoria +Paspalum+EG)	Did not proceed	none	none
Best bet 2	Legume and rice crop residue conservation	Did not proceed	none	none
Best bet 3	Grass and legume perennial forage bank for backyard	06-07	Late start but good	good
Overall assessment	Team decided not to proceed with forages under cashews as too similar to Bella. Team and farmer decided to establish backyard forage bank instead but farmer injury/illness delayed progress here. No progress with crop residue conservation yet He plans to separate cows and calves at end of wet season (around 7-8 months?) and preferentially feed calves with new forages. He plans to hold his cattle in the backyard and feed cut and carry in the dry season then tether graze his cows across the river in wet season. Farmer happy with everything he has achieved to present, considering he was out of action for almost 1 year. He has also tried feeding Gliricidia and has planted more in his old rice bay across river – his cattle like it.			
Farmer attitudes	Farmer still very keen despite injury and has learnt much from Saiyful next door. Plans to expand his small backyard forage bank this season			
Direct impacts	Little yet due to late start Farmer says using cut and carry (new forages plus native gasses and some Gliricidia) has resulted in improved cattle condition and performance However, he says better appetite and more healthy - though these changes still small due to predominance of cut and carry still being mature grass with some introduced forages at present Cattle liveweight trends suggest his cows did not perform as well as Lemo best bet average through 2007 but his young males did about average for Lemoa best bet farmers.			
Indirect impacts	Farmer has been working with Saiyful who is providing more planting material Farmer now interested in switching to more C/C and better animal feeding and management			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

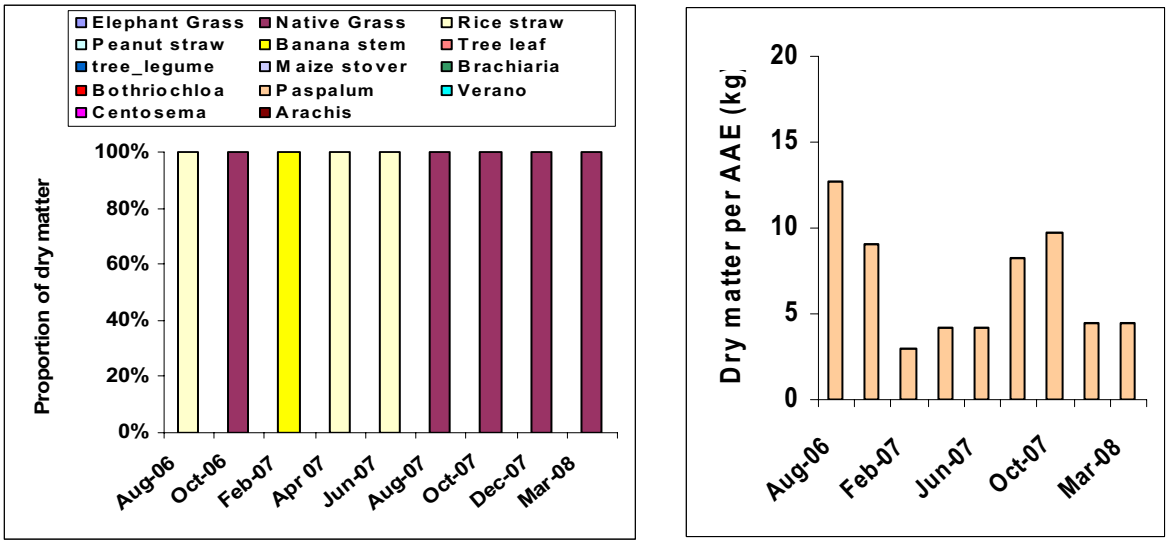


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Romo, Lemoa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and

growth. The graph shows pak Romo's cattle are receiving lower than maintenance dry matter throughout the year from cut and carry forage (apart from late dry 2006 and 2007). However he also grazes his cattle year round in upland or around village after crop harvest. His backyard forage bank is too small yet to make any significant contribution to cut and carry supply.

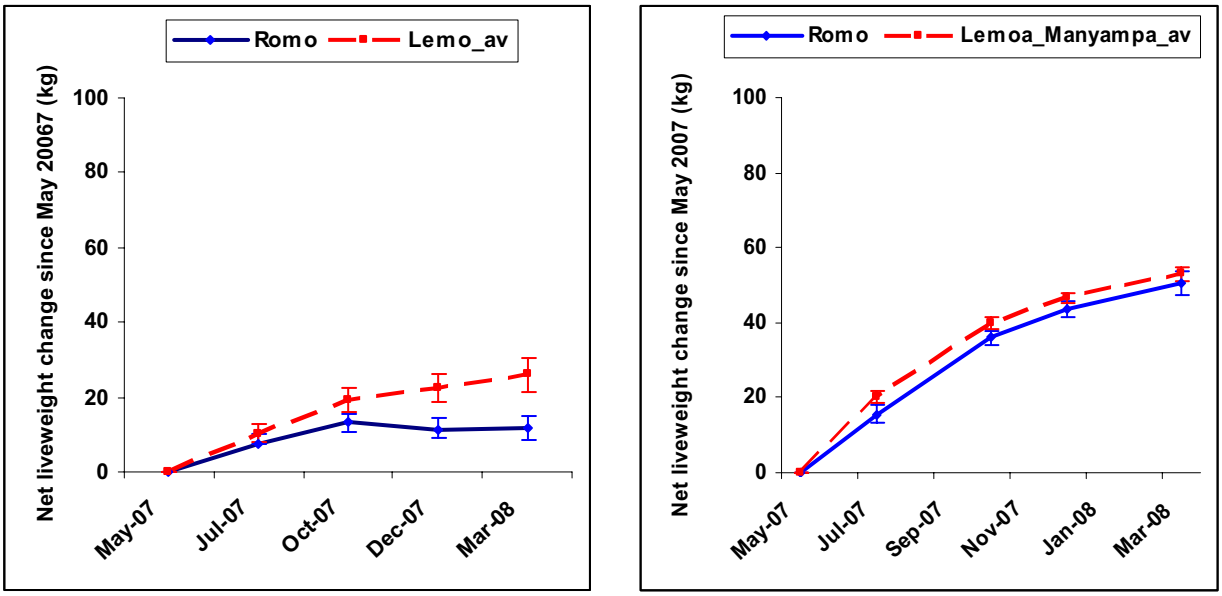


Figure 2: a. Comparison of liveweight trends of a. mature cows for Pak Romo vs. the average for Lemoa best bet farmers for the study period May 2007 to March 2008. Romo's cows are trending below average for Lemoa best bet farmers during 2007-08. Data are net liveweight change since May 2007 (means and standard errors for cows with starting weight above 150kg).b. Comparison of net liveweight change for Romo's young male cattle compared with average for Lemoa/Manyampa best bet farmers. Romo's male cattle are performing similarly to Lemoa average through 2007.

Best bet farmer: Pak Saiyful, Dusun Lemoa, Gowa , Sulawesi

Main points from original interview notes

- 5 cattle – 2 cows, 3 calves (1X1yo, 1X2yo bull), 1X 1 month old)
- Wants to increase to 10 head – has labour but lacks sufficient feed
- No non-farm income.
- Currently only tether and free grazing – no cut and carry

Major constraints to cattle production

- lack of good quality feed, especially in dry season
- distance of his upland area from household – a lot of time spent herding his cattle

Calendar of existing farming system and suggested best bet options to meet constraints

Activity/land type		J	F	M	A	M	J	J	A	S	O	N	D
Food / forage crops / grazing	LL (0.5ha? in total)	Rice			Mungbean (0.3ha / residual grazed rice straw)							Rice	
	LL2	Grasses for cropland bunds near to orchard											
	LL3												
	UP1 (1ha)	Cashew, mango, banana, cocoa, gamal perimeter fence + 'weeds' Grasses and legumes for shaded upland orchard											

	UP2												
	Backyard	Some fruit trees but no crops or forages except small area of EG. Gamal fences unused Grasses and legumes for backyard forage bank											
Grazing management		Tethered at night and day in UL						Tethered during day in upland and returned to BY at night				Tethered night and day in UL	
Breeding		Uncontrolled mating (current calves arrived in June / weans at 8-10 months)											
On-farm C&C		Cut and drop Gamal fences in upland. Elephant grass from BY also available (small amounts) Cut & carry from backyard forage bank and cropland bunds											
Off-farm C&C													
Conserved feed								Rice straw stacked (poor management)					
Peak labour crop													
Peak labour cattle													

Summary of best bet progress to February 2008

Farmer: Saiyful, Lemoa	Actual best bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	Paspalum/Setaria and Sesbania on LL bunds (area adjacent to orchard)	Did not proceed	none	Now planting in upland too
Best bet 2	Forage legumes and grasses for shaded upland orchard	Di not proceed	none	
Best bet 3	Grass and legume perennial forage bank for backyard	06-07	Excellent establishment and growth	Excellent. expanding
Overall assessment	Original suggested best bets replaced by with back yard forage bank establishment. Excellent establishment of sown grasses and legumes and farmer has also expanded area beyond that originally planned. Farmer now has more forage than he can handle and is supplying most forage needs from backyard cut and carry. However he currently not using his highly productive backyard forage bank for cut and carry or grazing (instead tether grazing his cows on native grasses in wet season) because he wants to save it as nursery for planting material to expand upland forage banks. Instead, he still uses basically the same tether grazing strategy as before, taking his cattle with him to his rice terraces each day and tethering them there during day then bringing them back each night. However, he is also feeding them with new cut and carry forages there so doesn't have to move them. He is also practising EW / PF in upland though not listed as a best bet option and did preferential feeding of a bull in 2007 in backyard kandang. He currently has 2 cows and 3 calves of mixed age and sex. Farmer also conserving surplus forage from backyard forage bank.			
Farmer attitudes	Excellent – farmer is a mentor for other farmers and is supplying forage planting material to other farmers.			
Direct impacts	Significant contribution of new forage to cut and carry forage supply in 2007 though farmer saving it for expanded plantings rather than feeding much. To date – hence little improvement in his cattle performance compared with Lemoa best bet average so far. Observable improvement in cattle management and switch to cut and carry options rather than tethered grazing			
Indirect impacts	Farmer has acquired significant skills and experience in forage propagation and management Farmer has acquired more knowledge of animal feeding and management options			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

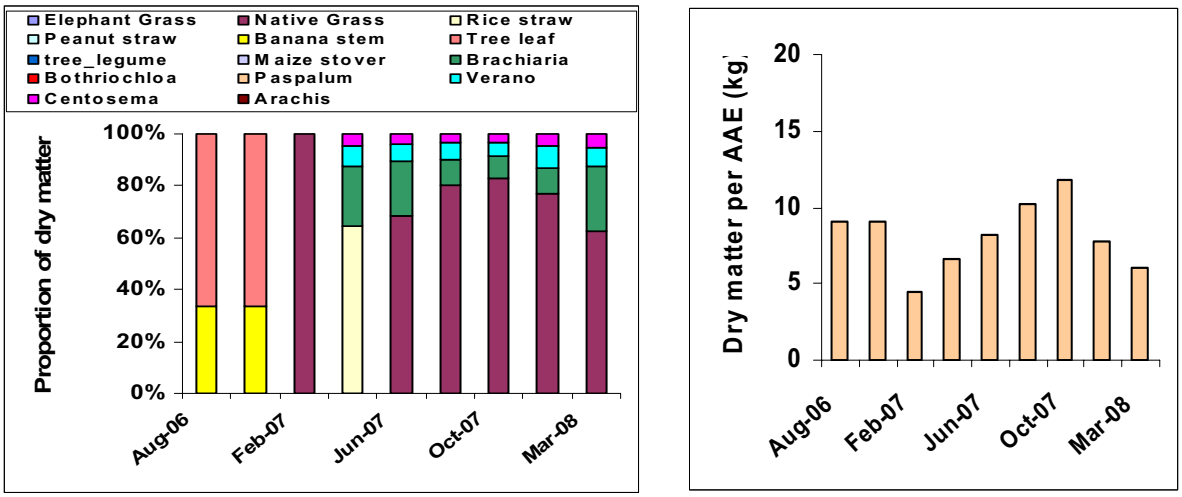


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Saiyful, Lemoa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Saiyful's cattle are receiving around the right amount of dry matter throughout the year from cut and carry forage. He also grazes his cattle (especially cows) year round in upland area near cropland and around the village after crop harvest and uses his cut and carry sparingly at present. Fig. 1a shows the contribution of new forages from around March 2007 on.

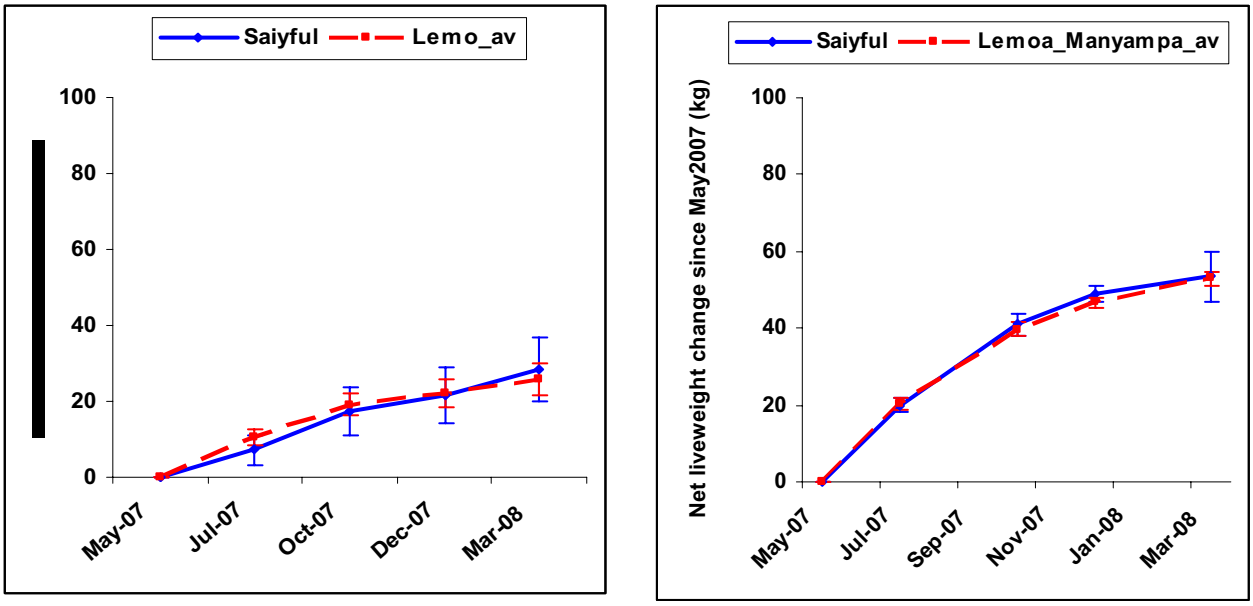


Figure 2; a Comparison of liveweight trends of a. mature cows for Pak Saiyful vs. the average for Lemoa best bet farmers for the study period May 2007 to March 2008. Saiyful's cows are trending about average for Lemoa best bet farmers during 2007-08. Data are net liveweight change since May 2007 (means and standard errors for cows with starting weight above 150kg).b. Comparison of net liveweight change for Saiyful's young male cattle compared with average for Lemoa/Manyampa best bet farmers. Saiyful's male cattle are performing similarly to Lemoa average through 2007.

Best bet farmer: Pak Rate, Dusun Lemoa, Gowa , Sulawesi

Main points from original interview notes

- Currently has 5 cattle (2 cows + 2 young male + 1 calf).
- Quality and quantity of feed is limited, all his cattle is thin/poor (score condition is 5)
- Want to increase number of 2 – 3 cows
- The labour not problems
- The cattle grazed on communal grazing (road side, upland during the rice crop standing) 0.2ha LL and 1 ha UL (terraced)
- UL – Jati (teak), Cashew + some seasonal cropping. Steep and terraced.
- Heap of Elephant grass on lower terraces.
- Available water for cattle 2 0r 3 time per day (at 10 am + 2 am and 4 pm)

Major constraints to cattle production

- lack of good quality feed, especially in dry season
- Only area available for forage development is shaded hillslopes

Calendar of existing farming system and suggested best bet options to meet constraints

Activity/land type		J	F	M	A	M	J	J	A	S	O	N	D
Food / forage crops / grazing	LL1 (0.2ha)	Rice										Rice	
	LL2												
	LL3												
	UP1 (2ha)	Mixed garden (jati wood + cashew + bananas + mango) New grasses and legumes for shaded upland terraces											
	UP2												
Grazing management		Tethered + Herded grazing on roadsides/upland/foot ball area			Free grazing on communal grazing (ricefield, bunds, upland and roadsides) and returned to cattle house at night							Tethered for bull	
Breeding		Uncontrolled mating											
On-farm C&C		Feeding of c/c forage from upland forage bank											
Off-farm C&C													
Conserved feed													
Peak labour crop				Rice harvest						Land preparation		Rice plant	
Peak labour cattle													

Summary of best bet progress to February 2008

Farmer: Rate, Lemoa	Actual best bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	Grasses and legumes for shaded upland terraces	06-07	Very good – bigger than anticipated	
Overall assessment	Excellent establishment of grasses especially Paspalum atratum and Seca stylo. Farmer has planted bigger area than originally planned. Farmer says new forages providing significant proportion of dry season forage for his cattle. Also keen to start early weaning but not started yet as father (or father in law) who he shares cattle with is sceptical of benefits. However has done some preferential feeding of male cattle using his new forages. Currently has 1 sapi cow, 1 19 month old sapi and 1 7 month old sapi calf. Also share another 2 sapi with father in law.			
Farmer attitudes	Excellent – farmer very keen to expand forage plantings and reduce tree canopy to improve growth. Says he is now preferentially feeding young animals and his cattle have improved in dry season condition.			
Direct impacts	New forages making a significant contribution to cut and carry forage supply, meaning a significant increase in available forage year round Switch from reliance on fairly poor EG to high quality improved grasses and legumes Farmer says his cattle now in better condition due to benefit of new forages. Has sold one young bull for RP 4 million a difference of RP 1.5 million more than what he might have expected previously for an animal of similar sex and age i.e. difference due to condition.since project started Catttle liveweight data shows his cows doing about average for Lemoa. No data available for young males.			
Indirect impacts	Farmer now has good understanding of value of C/C from improved grasses and legumes and preferential feeding			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

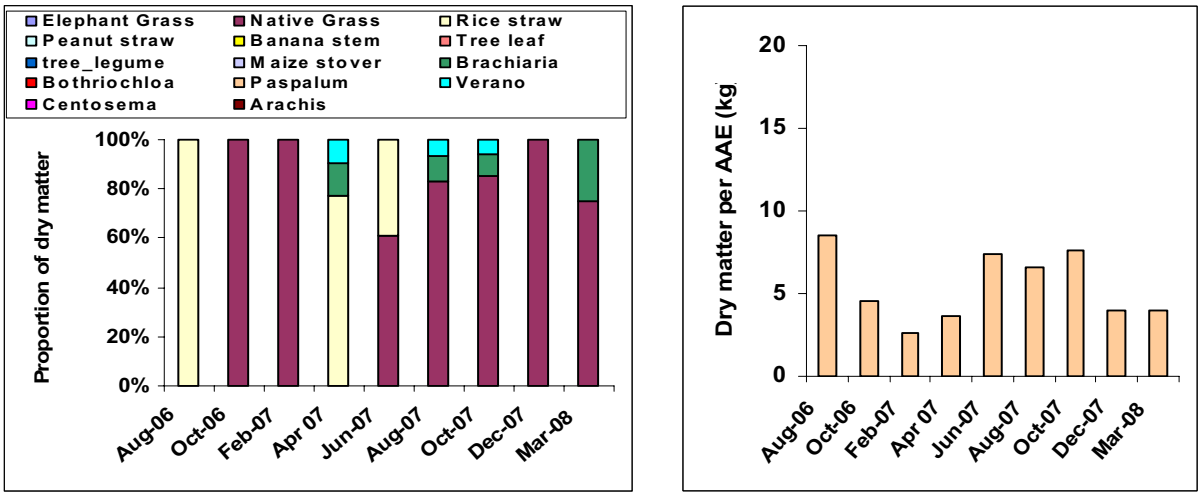


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Rate, Lemoa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Rate's cattle are receiving a little below maintenance levels of dry matter throughout the year from cut and carry forage though he also grazes his cattle (especially cows) year round in upland area near cropland and around the village after crop harvest and uses his cut and carry sparingly at present. Fig. 1a shows that he has previously relied heavily on native grass and rice straw but his new forages are now beginning to make a significant contribution.

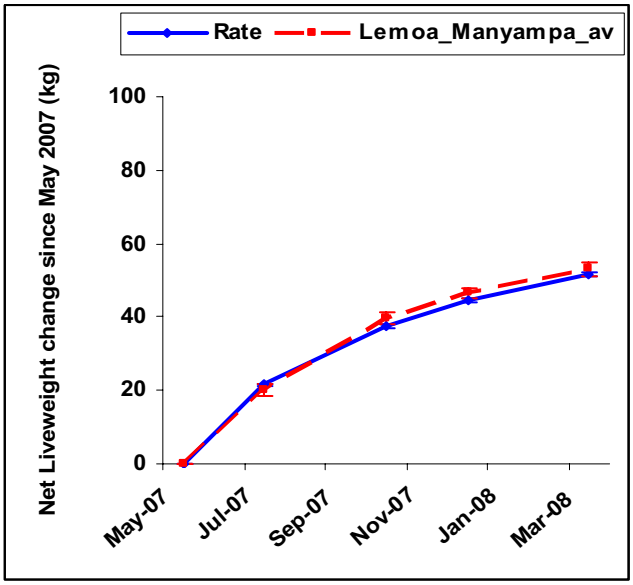


Figure 2. Comparison of net liveweight change for Rate's young male cattle compared with average for Lemoa/Manyampa best bet farmers. Rate's male cattle are performing similarly to Lemoa average through 2007.

Note: No cow data for Rate - hence nor fig for cow performance.

Best bet farmer: Pak Aming, Dusun Lemoa, Gowa , Sulawesi

Main points from original interview notes

- Shares 7 cattle with his family
- All communal grazing – tethered grazing in wet season, free grazing in field during dry
- Currently does no cut and carry feeding
- House and backyard on hillslope – backyard steep eroded sloping orchard area

Major constraints to cattle production

- lack of good quality feed, especially in dry season
- Only area available for forage development is shaded hillslopes

Calendar of existing farming system and suggested best bet options to meet constraints

Activity/land type		J F M A M J J A S O N D
Food / forage crops / grazing	LL1 (0.4ha)	Rice; Maize; Rice
	LL2 (0.3ha)	Rice; Rice
	UP1 (0.7 ha –near from house)	Cashew + Manggo + native pasture + Gamal as perimeter fence Forage bank of new grasses and legumes suitable for semi shade
	UP2 (2.0 ha)	Schrub land
Grazing management (all tethered – no free – cattle returned to UP1 every night)		Tethered in + upland 2; Tethered in + up2 (shrubland, lowland because there have harvested of rice; Tethered in + upland 2
Breeding		Uncontrolled – weaning at 1yo, calving in July - August
On-farm C&C (30-40kg/day)		Crop residues (maize) + gamal
Conserved feed (none)		
Peak labour crop		Rice; Rice

harvest planting

Peak labour cattle

Summary of best bet progress to February 2008

Farmer: Aming, Lemoa	Actual best bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	Grasses and legumes for shaded upland terraces	2007	Very good – bigger than anticipated	excellent
Overall assessment	A late starter in Feb 07. However excellent establishment and growth of sown grasses and legumes including Setaria, Brachiaria decumbens and Panicum maximum (purple panic) all growing well – Panicum best performer in shaded conditions. Stylo guyanensis 184 also doing really well. Centro pascourum OK but not as good – less suited to these conditions. Arachis growing well but slow. Farmer has fed some to his cattle. Farmer needs to cut and feed again soon forages to encourage tillering of forages – JC. Farmer says Gliricidia planting and feeding also going well – his cattle like Gliricidia.. Farmer has planted bigger area than originally planned.			
Farmer attitudes	Excellent- both he and his sons very keen to expand forages and try early weaning / preferential feeding.			
Direct impacts	Too early as yet because forage banks still small and developing. His cattle are doing about average at present for Lemoa and Manyampa best bet farmers.			
Indirect impacts	Too early as yet as farmer was a late starter.			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

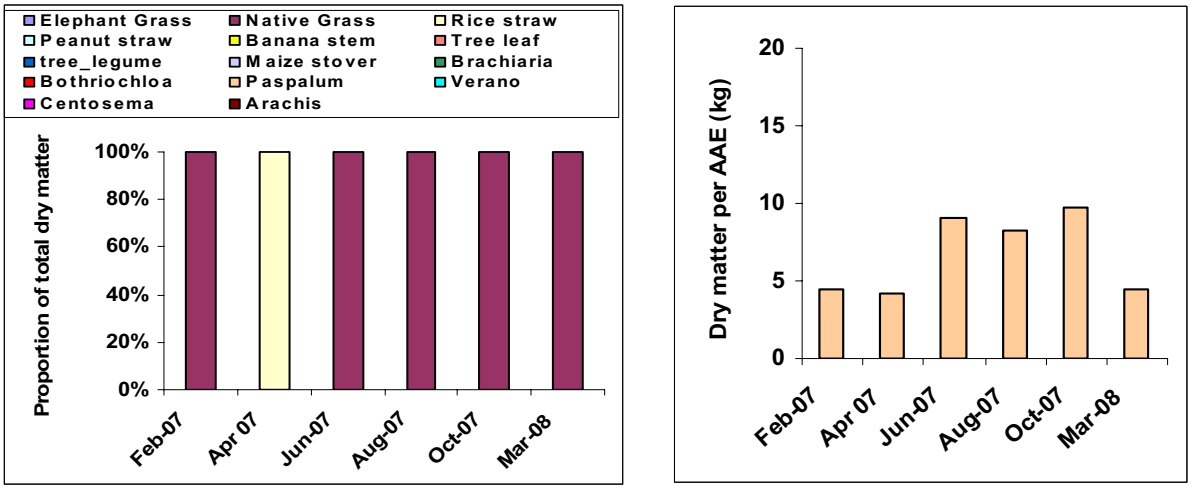


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Aming, Lemoa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Aming's cattle are receiving lower than maintenance dry matter from cut and carry forage during the wet season months (when grazing supplies most fresh forage) but adequate dry matter during the dry season, though mostly native grass and rices straw. His backyard forage bank, though displaying impressive growth, is too small yet to make any significant contribution to cut and carry supply yet, especially as farmer is keeping it for planting material to expand area.

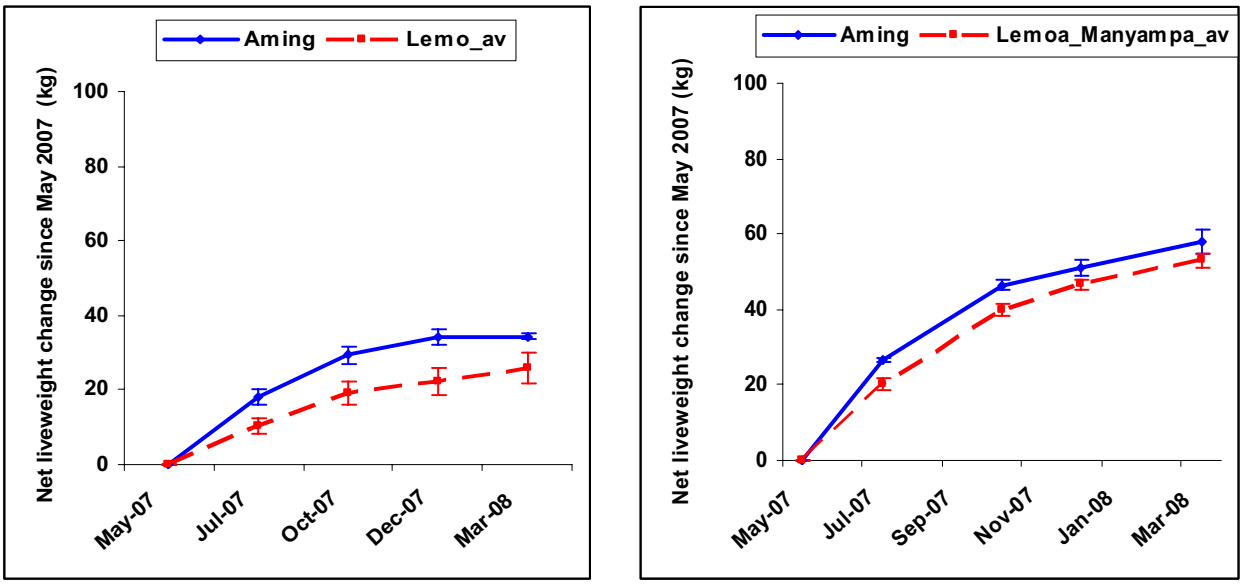


Figure 2: a. Comparison of liveweight trends of a. mature cows for Pak Aming vs. the average for Lemoa best bet farmers for the study period May 2007 to March 2008. Aming's cows are trending slightly about average for Lemoa best bet farmers during 2007-08. Data are net liveweight change since May 2007 (means and standard errors for cows with starting weight above 150kg). b. Comparison of net liveweight change for Aming's young male cattle compared with average for Lemoa/Manyampa best bet farmers. Aming's male cattle performed similarly to Lemoa average through 2007.

11.6.7 Dusun Manyampa

Of the 17 separate best bet activities originally identified nine were subsequently implemented (table 5). One forage bank site was not proceeded with as it was similar to an adjacent best bet trial, while two other sites were shifted from their original locations to new sites preferred by the farmer as part of the consultative process.

Table 5: Best bet activities identified and implemented in Manyampa sub village, 2005-07

Village / farmer	New forage introduction		Better use of existing forages (tree legs and EG)		Crop residue conservation (inc. rice straw ammoniation)		Preferential feeding / early weaning	
	Identified	started	Identified	started	Identified	started	Identified	Started
Manyampa								
Tompo	1	1	1	1	0	0	1	1
Nuru	3	2	2	0	1	0	0	0
Tango	2	1	1	0	0	0	0	0
Rumpa	2	1	0	0	1	0	0	0
Sala	1	1	1	1	0	0	0	0
Total	9	6	5	2	2	0	1	1
Grand Total	18	12	7	4	3	0	4	3?

One farmer (Tango) withdrew one site due to changer in family land use. As with Lemoa the biggest uptake of best bet options was in new forage introduction, especially for backyard or adjacent area forage banks. Two farmers (Sala and Tompo) also engaged in expansion and better use of existing forage sources such as elephant grass and Gliricidia. As with Lemoa none of the best bet farmers tried any of the crop residue conservation options suggested to date. Only one farmer (Tompo) has successfully adopted early

weaning, preferential feeding and /or controlled breeding best bet options to date in Manyampa.

Best bet farmer: Pak Tompo, Dusun Manyampa, Gowa , Sulawesi

Main points from original interview notes

9 cattle – 4 cows, 5 calves (1yo, 7mo, 4mo, 1mo, 7do)

Doesn't want to increase numbers due to labour constraint but could alleviate via more accessible feed.

Wants to increase feed quality.

No non-farm income.

Major constraints to cattle production

Lack of bull

Lack of good quality feed, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

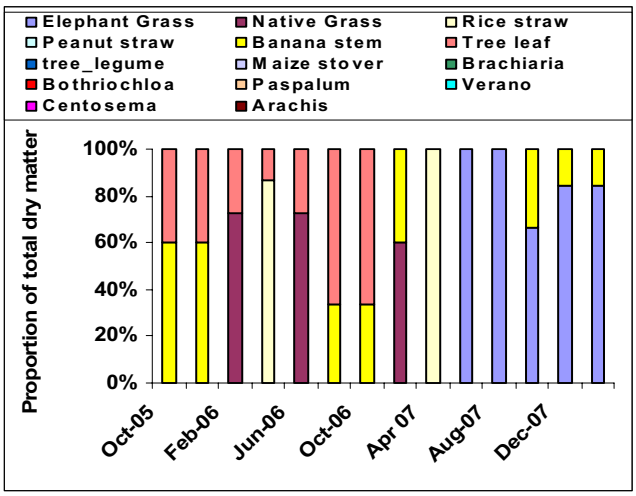
Activity/land type		J	F	M	A	M	J	J	A	S	O	N	D
Food / forage crops / grazing	LL1 (0.33ha)	Rice 1			Rice 2 (0.11ha only)							Rice 1	
	LL2 (0.18ha)	Rice			Peanut							Rice	
	LL3 (0.15ha)	Rice										Rice	
	UP1 (0.5ha)	0.03ha sweet potato. Rest is native grass. Forage bank on upper terrace of seasonal cropping area near b/y											
	UP2												
Grazing management		Free grazing in forested country (communal). Returns home at night and feeds rice bran.				Tethered grazing on cropping land and upland. Returns home at night.						Free grazing in forested country	
Breeding					Earlier Calving			Earlier Mating				Early Weaning	
On-farm C&C		Cut and drop gamal Forage from upper terrace forage bank											
Off-farm C&C													
Conserved feed													
Peak labour crop													
Peak labour cattle													

Summary of best bet progress to February 2008

Farmer: Tompo, Manyampa	Actual best bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	Forage bank for upper terrace	06-07	Slow at first but then good	excellent
Best bet 2	Preferential feeding, early weaning, controlled mating	06-07	Slow at first but then good	excellent

Overall assessment	Farmer attempted all suggested best bet options except rice straw ammoniation. Planted grasses (Brachiaria, Setaria) and legume (stylo, Centro and Clitoria) forages on upper terrace area in 2006-07 season but he became sick so couldn't look after them and they were free graze by cattle. Has since resurrected and expanded his forage bank area by planting a further 15m*15m area of EG (as originally suggested) and is feeding these forages in backyard (not in kandang –just tethered). Has been doing EW at 6 months old and PF and controlled mating since project began and also feeding gamal. Currently has 8 cattle (4 cows, 1 heifer, 3 calves – all male). He plans to continue all these and significantly expand his forage banks. He wants to expand his forages to support up to 10 cattle and would like to get a bull of his own to better implement controlled mating (currently he has to take his cows a long way to get mated)
Farmer attitudes	There was an initial misunderstanding about expectations that project would provide village with a bull for controlled mating, which affected farmer's initial enthusiasm to participate. However farmer has since enthusiastically embraced all best bet options including early weaning, preferential feeding and controlled mating, though latter is difficult due to lack of bull close by.
Direct impacts	Before project he spent much time tether and free grazing his cattle but now just 3 full bags of cut and carry Brachiaria from an area smaller than Rumpa's provides the same amount of forage – big labour saving . However forage monitoring suggests he is providing less than adequate cut and carry dry matter, though this is supplemented by tethered grazing, especially for cows. early weaning / preferential feeding is working really well. He weans at 6 months (calves born May/June, weaned in December). Calves fed separately on best quality fodder (including rice bran and gamal + new forages) on tether – not in kandang. He says there is a positive response to early weaning / preferential feeding for both cows and calves and also says that he has noticed a strong relationship between cow condition and reproductive success Cattle liveweight data show that his cows are doing slightly better than Manyampa average while his young males are performing about average for Lemoa/Manyampa best bet cattle. He says he receives better prices for his cattle due to better condition. Traders now come to him and he sells when he wants (seller's market). He recently sold 2 young cattle - one 11 months old for RP 1.6 million and one 2 year old for RP 3.7 million.
Indirect impacts	Many other local farmers come to look at what he is doing with forages and cattle feeding and management but have not taken any forages. One farmer has since planted forages.

Relevant graphical summaries of best bet impacts on forage use and cattle performance



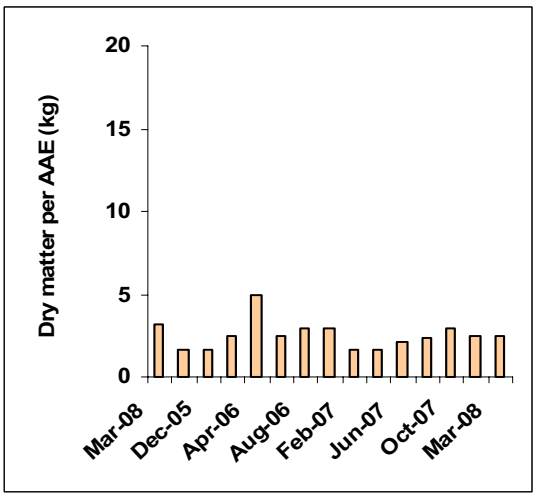


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Tompo, Manyampa between August 2005 and March 2008. An AAE of 250kg liveweight

would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Rate's cattle are receiving well below maintenance levels of dry matter throughout the year from cut and carry forage though the numbers of cattle actually being fed cut and carry may be overestimated by project team here. Farmer also grazes his cattle (especially cows) year round in upland area near cropland and around the village after crop harvest and uses his cut and carry sparingly at present. Fig. 1a shows that while he has previously relied heavily on native grass, rice straw and tree leaves prior to project he is now using significant proportion of elephant grass. His new forage banks are still too small to make make a significant contribution and farmer is saving material to expand plantings.

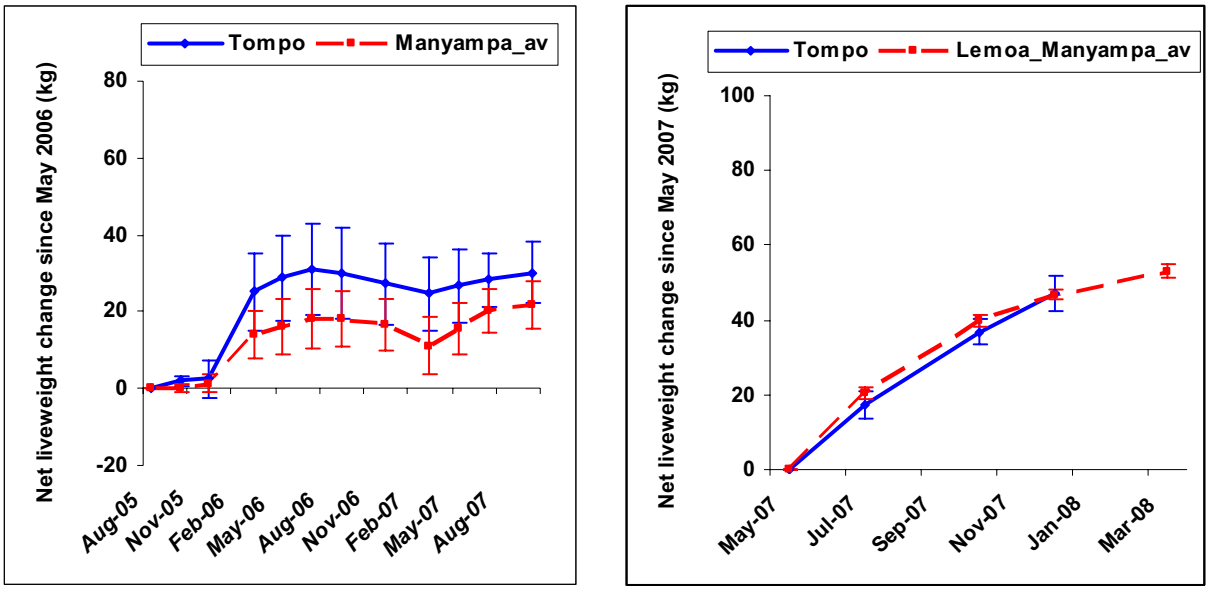


Figure 2: a. Comparison of liveweight trends of a. mature cows for Pak Tompo vs. the average for Manyampa best bet farmers for the study period May 2007 to March 2008. Tompo's cows are trending slightly about average for Manyampa best bet farmers during 2007-08 though not significantly, due to the considerable variation between animals as indicated by the error bars.. Data are net liveweight change since May 2007 (means and standard errors for cows with starting weight above 150kg). b. Comparison of net liveweight change for Tompo's young male cattle compared with average for Lemoa/Manyampa best bet farmers. Tompo's male cattle performed similarly to Lemoa/Manyampa average through 2007.

Best bet farmer: Pak Nuru, Dusun Manyampa, Gowa, Sulawesi

Main points from original interview notes

- 4 cattle – 3 cows (9yo, 2X2-3yo), 1 calf (8mo).
- Pure farmer.
- Tethered grazing in wet (forest) and free grazing around village in dry
- No cut and carry done
- Farmer has good areas of undeveloped upland and also upper terraces close to padi area
- Opportunities for forage bank development and also rice straw ammoniation

Major constraints to cattle production

- Lack of good quality feed, especially in dry season

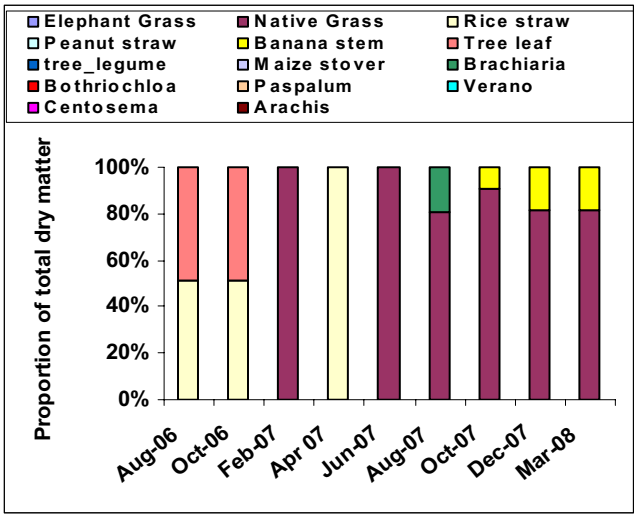
Calendar of existing farming system and suggested best bet options to meet constraints

Activity/land type		J	F	M	A	M	J	J	A	S	O	N	D
Food / forage crops / grazing	LL1 (0.22ha)	Rice										Rice	
	LL2												
	UP1 (1.0ha)	Cashews plus native pasture – several parcels Forage bank on upland orchard area adjacent to padi											
	UP2 (0.7ha)	Leased to forestry but also growing maize. Forage bank of grasses and legumes on unused upland 2 area											
	UP3												
Grazing management		Herded grazing in forests returned to by in evening				Free grazing on cropland. Returned to BY at night						Herded grazing in forests	
Breeding		Uncontrolled. Weaning at 7-9 months.											
On-farm C&C		Some cut and drop gamal in forested country											
Off-farm C&C													
Conserved feed				Ammoniate Rice straw					Feed ammoniated Rice straw				
Peak labour crop													
Peak labour cattle													

Summary of best bet progress to February 2008

Farmer: Nuru, Manyampa	**Actual best bet**	**Commenced**	**2006-07 progress**	**2007-08 progress**
Best bet 1	Perennial forage bank for unused upland area near forestry block	06-07	Fair only	Fair only – area heavily communal grazed
Best bet 2	Forage bank for upland area adjacent to rice padi	06-07	Fair-good	Fair-good
Best bet 3	Rice straw ammoniation close to daddy area	Did not attempt	none - did not attempt	none - did not attempt
Overall assessment	Patchy establishment of unused upland area – poor weed control and forages planted in small rows did not help. Farmer more interested in putting efforts into upper terrace area adjacent to padi where he planted Brachiaria, Setaria, stylo and Centro pascourum -all growing well except Centro (did not persist). Already cutting and feeding in wet season especially – cattle like them and he can see good response in cattle condition. Also cutting and feeding a little Gliricidia on paddy block – cattle eat it OK. Farmer has already expanded his original forage bank plots to lower terraces here. Good establishment here but needs to reduce shading to be more productive forage bank No progress on rice straw ammoniation yet though farmer still keen to conserve his rice straw in 2008 and is interested to try ammoniation.			
Farmer attitudes	Farmer keen but cautious about committing to much labour to build forage banks yet. Both forage bank sites have good potential and he just needs more encouragement to put the effort in.			
Direct impacts	Forage banks still too small to make significant impact on animal production – see forage monitoring figure below. Farmer cut and carry provided is well below maintenance levels but he still does extensive tethered grazing. Cattle liveweight data suggests his cattle not performing as well as Manyampa average.			
Indirect impacts	Farmer has learnt much about value of forage banks and forage propagation.			

Relevant graphical summaries of best bet impacts on forage use and cattle performance



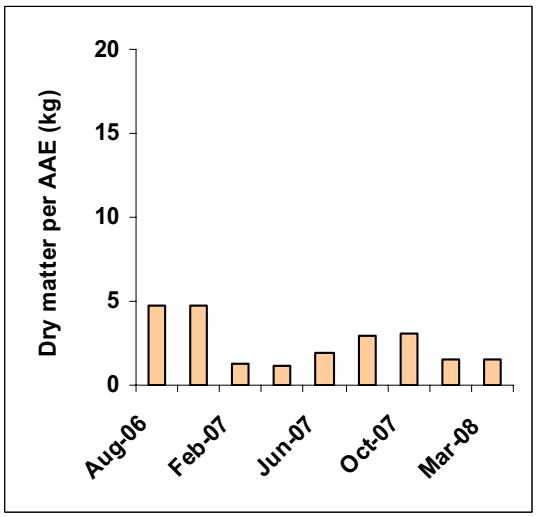
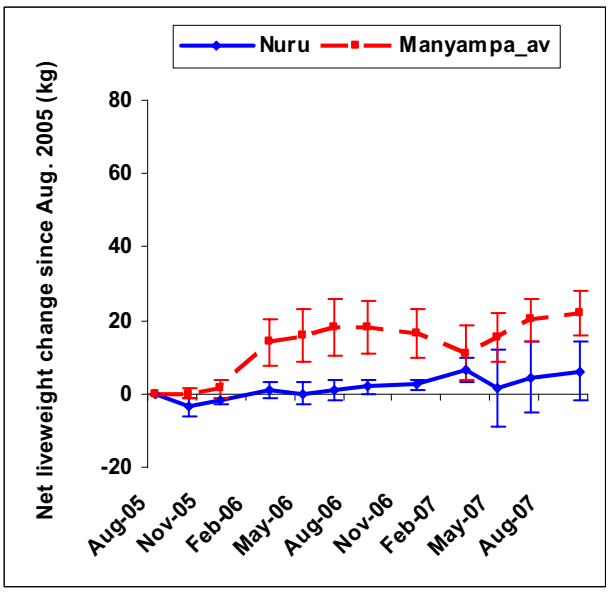


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Nuru, Manyampa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Nuru's cattle are receiving well below maintenance levels of dry matter throughout the year from cut and carry forage though he also grazes his cattle (especially cows) year round in upland area near cropland and around the village after crop harvest and uses his cut and carry sparingly at present. Fig. 1a shows that he still relies heavily on native grass, rice straw and banana stem, though his new forages are now beginning to make a small contribution in mid dry 2007.



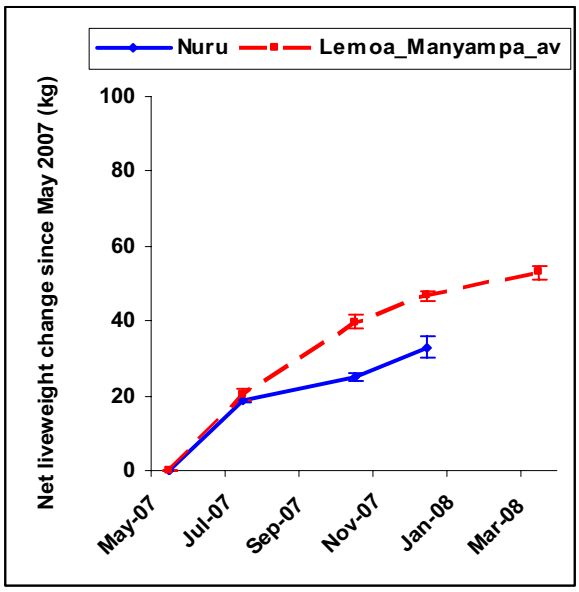


Figure 2: a. Comparison of liveweight trends of a. mature cows for Pak Nuru vs. the average for Manyampa best bet farmers for the study period May 2007 to March 2008. Nuru's cows are trending below the average for Manyampa best bet farmers during and hardly changed throughout 2006-07. However, there was considerable variation between animals as indicated by the error bars.. Data are net liveweight change since May 2007 (means and standard errors for cows with starting weight above 150kg).b. Comparison of net liveweight change for Nuru's young male cattle compared with average for Lemoa/Manyampa best bet farmers. Nuru's male cattle performed worse than the average during dry season 2007.

Best bet farmer: Pak Tango, Dusun Manyampa, Gowa, Sulawesi

Main points from original interview notes

- 5 cattle – 3 cows, 2 calves
- Wants to increase number of cows to become 6

Major constraints to cattle production

- Lack of good quality feed, especially in dry season
- Potential common improvement which might be applied
- Preferential feeding / feed management
- Improved cattle housing
- Seasonal mating
- Disease control
- Water collection (roofs and grey water recycling)
- Forage management notes (especially gamal)

Calendar of existing farming system and suggested best bet options to meet constraints

Activity/land type		J	F	M	A	M	J	J	A	S	O	N	D
Food / forage crops / grazing	LL1 (0.30ha)	Rice			Grazing area							Rice	
	LL2 (0.25ha)	Rice				Public grazing					Rice		
		Perennial forage bank in upper ll2 crooping bay											
	UP1 (0.1ha) Steep, rocky shaded area – terraced)	Native grass Improved grasses and legumes for shaded upland area											
	UP2												
	UP3												
Grazing management		Herded grazing during the year (in the wet season the cattle grazed on the upland area)											
Breeding		Un-controlled mating, calving in June to July and weaning 7 – 8 month old											
On-farm C&C													
Off-farm C&C													
Conserved feed													
Peak labour crop				Rice Harvest								Land preparation	Rice plant
Peak labour cattle		Every month give feed and water for cattle drink in dry season (July to August)											

Summary of best bet progress to February 2008

Farmer: Tango, Manyampa	Actual best bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	Grasses and legumes for shaded upland area	06/07	fair	failed
Best bet 2	Establish forage bank of Clitoria /Paspalum / EG in lowland cropping bay near house	Did not proceed	none	none
Overall assessment	Farmer decided to use lowland bay for cropping so lowland forage bank did not proceed. Forages on steep shaded upland had good early establishment but too much shade for significant production.			
Farmer attitudes	Farmer seems half hearted about participating though may engage more now other farmers have been successful			

Direct impacts	No direct impacts as farmer has done little to implement best bet recommendations Cattle liveweight data show Tango's cows not performing as well as Manyampa best bet average while forage monitoring suggests he is not providing sufficient dry matter and quality forage.
Indirect impacts	None as yet

Relevant graphical summaries of best bet impacts on forage use and cattle performance

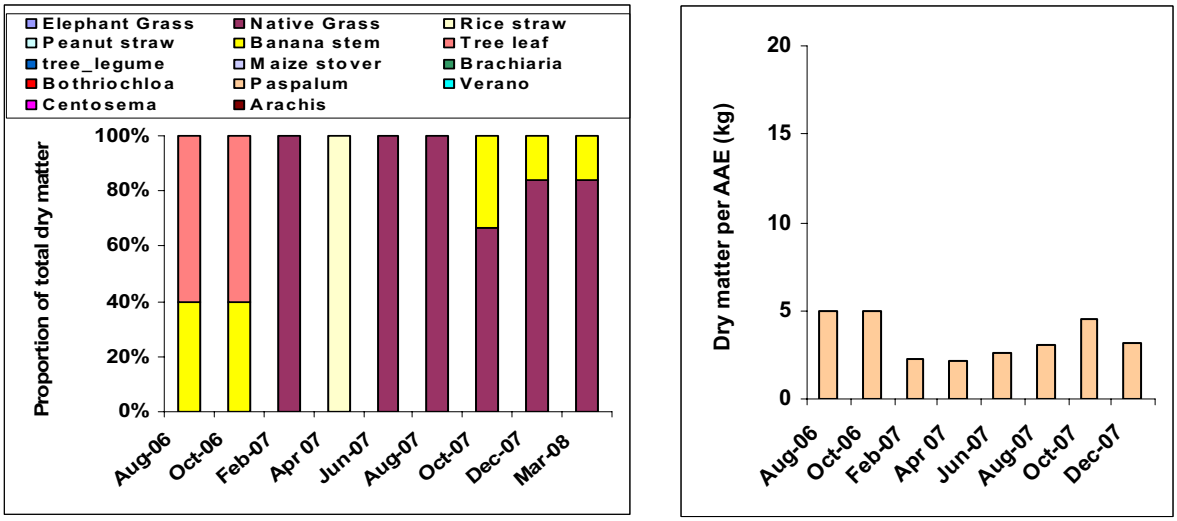


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Tango, Manyampa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Tango's cattle are receiving well below maintenance levels of dry matter throughout the year from cut and carry forage though he also grazes his cattle (especially cows) year round in upland area near cropland and around the village after crop harvest and uses his cut and carry sparingly at present. Fig. 1a shows that he still relies heavily on native grass, rice straw and banana stem fo cut and carry forage.

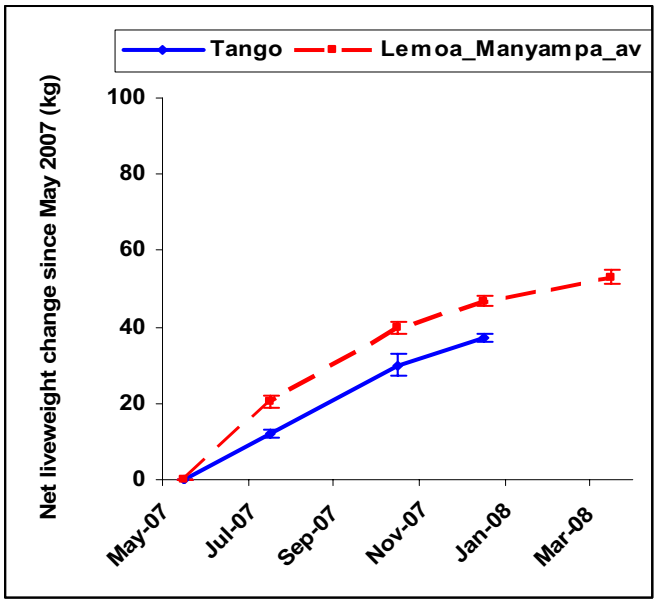


Figure 2: Comparison of net liveweight change for Tango's young male cattle compared with average for Lemoa/Manyampa best bet farmers. Tango's male cattle performed slightly worse than the average during dry season 2007. Note: no cow liveweight data available for Tango – hence no figure of cow liveweight trends.

Best bet farmer: Pak Rumpa, Dusun Manyampa, Gowa, Sulawesi

Main points from original interview notes

- 3 cattle – 2 cows + 1 young male (1 year)
- Want to increase number of cow to 6 when the feed available

Major constraints to cattle production

- Lack of good quality feed, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

Activity/land type		J	F	M	A	M	J	J	A	S	O	N	D
Food / forage crops / grazing	LL1	Rice										Rice	
	LL2	Perennial forage bank for upper cropping terrace near backyard											
	UP1 (0,2ha)	Bananas + native grass (0,20 ha) Forages for shaded orchard area											
	UP2	Perennial forage bank for upland area near paddy											
	UP3												
Grazing management		Herded grazing on the upland area			Free grazing on the ricefield, on the bunds, roadsides, upland and put in cattle house at night.								
Breeding		Un-controlled mating (natural)											
On-farm C&C													
Off-farm C&C													
Conserved feed													
Peak labour crop				Rice harvest								Land preparation	Rice plant
Peak labour cattle		During the year (in dry season too busy to provide water 2 or 3 time/day)											

Summary of best bet progress to February 2008

Farmer: Rumpa, Manyampa	**Actual best bet**	**Commenced**	**2006-07 progress**	**2007-08 progress**
Best bet 1	Forage bank for upland terrace area near padi	Team decided not to proceed	none	none
Best bet 2	Forages for shaded banana orchard area	Shifted to best bet 3 area	none	none
Best bet 3	Forage bank for upper terrace area behind backyard	06-07	Small but good	Small but good
Overall assessment	Team decided to re-focus on establishing a forage bank on upper terrace area similar to Tompo's. Farmer established small pilot area which has grown well This was established in small (10m*10m) plot with Brachiaria, Setaria, verano Stylo and Arachis in early 2007. New forages have grown well but only a small area. When he cuts it all it is enough to feed his 6 cattle for one day. He harvests the whole plot once every month over the wet season and then leaves it over the dry season – will use it if enough growth in dry. He has started feeding gamal using "cut and drop" method. He currently has 6 cattle (3 cows, 3 calves (2 male each 6 months old, 1 female) which he still tether grazes around village because he does not yet have enough new forage. No attempt yet to early weaning / preferential feeding - no info recorded on reasons. Will continue with present forage bank but says he is not really interested in expanding as he reckons he has plenty of native grasses available for tether grazing			
Farmer attitudes	Farmer keen to participate and expand forage bank area			

Direct impacts	No direct impacts as farmer has done little to implement best bet recommendations He says his cattle condition is better due to feeding these forages but later says his cattle condition is not good year round , but he doesn't really care (tidak apa apa). Though forage monitoring suggests he is feeding sufficient cut and carry dry matter (supplemented by grazing) this is generally of poor quality Cattle liveweight data suggest his cattle are performing below Manyampa/Lemoa average for best bet farmers
Indirect impacts	Farmer appreciates value of forage banks to improving cattle production

Relevant graphical summaries of best bet impacts on forage use and cattle performance

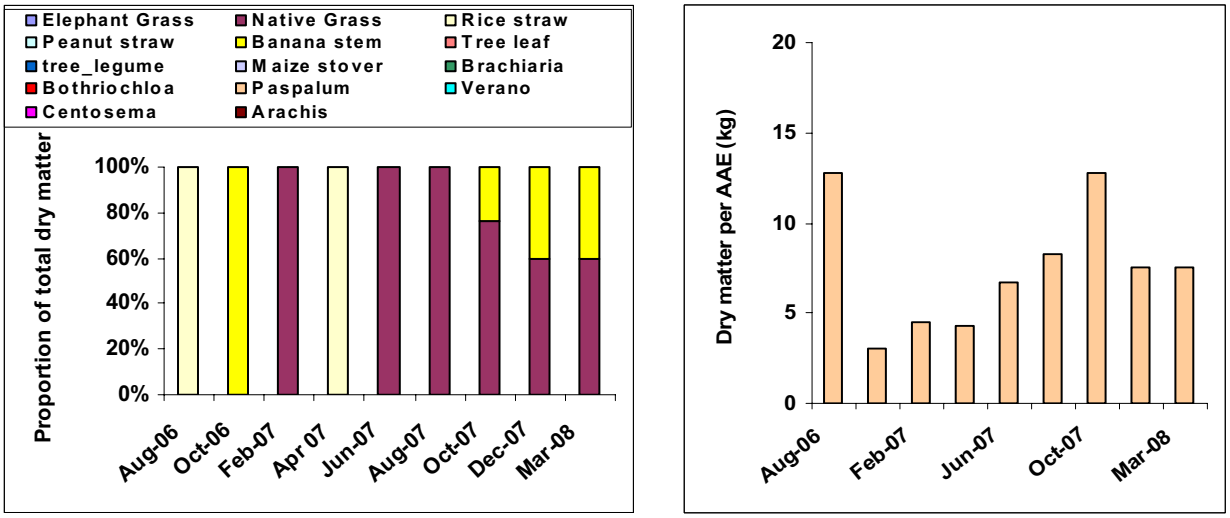


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Rumpa, Manyampa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Rumpa's cattle are receiving about maintenance levels of dry matter from cut and carry forage through the dry season especially with levels only low during wet season months when he grazes his cattle (especially cows) year in upland areas around the village after crop harvest. Fig. 1a shows that he still relies heavily on native grass, rice straw and banana stem for cut and carry forage, His small forage bank is not big enough yet to make a significant contribution to cut and carry forage especially as he is saving this material to expand his forage bank.

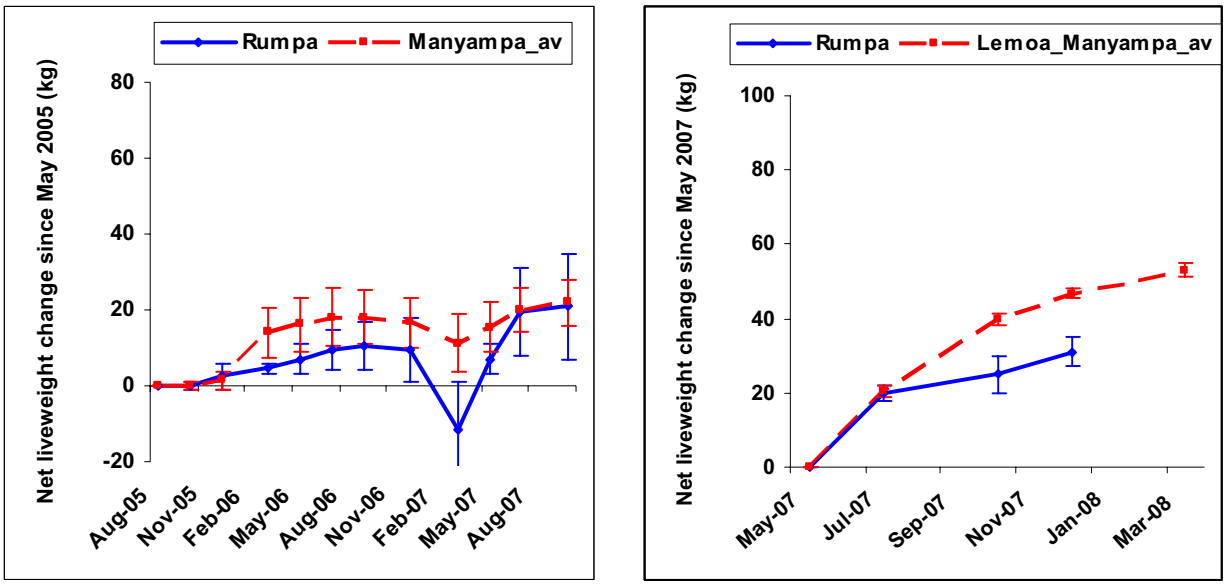


Figure 2: a. Comparison of liveweight trends of a. mature cows for Pak Rumpa vs. the average for Manyampa best bet farmers for the study period May 2007 to March 2008. Rumpa's cows are trending below the average for Manyampa best bet farmers during 2006-07 even when allowance is made for calving loss in May 2006. However, there was considerable variation between animals as indicated by the error bars.. Data are net liveweight change since May 2007 (means and standard errors for cows with starting weight above 150kg). b. Comparison of net liveweight change for Rumpa's young male cattle compared with average for Lemoa/Manyampa best bet farmers. Rumpa's male cattle performed worse than the average for Lemoa/Manyampa males during dry season 2007.

Best bet farmer: Pak Sala, Dusun Manyampa, Gowa, Sulawesi

Main points from original interview notes

- Has 12 cattle were 4 cows (2 sharing) + 2 young male (2 years) + 2 young female + 4 calves
- Does mostly upland tethered grazing in wet and free grazing around village in dry
- Wants to increase cows ownership numbers to 5 but quality and quantity feed supply during the year is problem.
- Wants to make rice ammoniation (conserved feed)
- The number of labour household about 4 people
- Upland 1 (o,5ha) so far for his house
- Upland 2 (0.6ha) is cashew
- Upland 1 and 2 used as grazing land under tree cashew in the wet season
- Upland 3 is mix garden

Major constraints to cattle production

- The lack of good quality feed, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

Activity/land type		J	F	M	A	M	J	J	A	S	O	N	D
Food / forage crops / grazing	LL1 (0.29ha)	Rice			Public grazing							Rice	
	LL2 (0.12ha)	Rice			Public grazing							Rice	
	UP1 (0,5ha)	Cashew + native grass											
	UP2 (0,6ha)	Cashew + native grass											
	UP3 (0,5ha)	Mixed garden (bananas + manggo + vegetable) and fence Gliricidia Forage bank of grasses, legumes and Gliricidia fences											
Grazing management		Herded grazing on the upland area			Free and herded grazing and tethered at night in cattle house (The cattle grazed rice strow on the field start in July to August when the grasses (native grass) have limited								
Breeding					Early Calving	Earlier Mating					Earlier Weaning		
On-farm C&C													
Off-farm C&C													
Conserved feed					Ammoniate Rice straw				Feed ammmoniated rice straw				
Peak labour crop				Rice harvest								Land prep.	Plant rice
Peak labour cattle		During the year (in dry season busy to provide water 2 or 3 time/day)											

Summary of best bet progress to February 2008

Farmer: Sala, Manyampa	**Actual best bet**	**Commenced**	**2006-07 progress**	**2007-08 progress**
Best bet 1	Forages for small upland area near household	06-07	excellent	excellent
Best bet 2	Rice straw ammoniation	Did not proceed	none	none
Best bet 3	Gliricidia fences for upland forage area	06-07	Good start	Good start
Best bet 4	Preferential feeding / early weaning	Not yet started	None to date	None to date
Overall assessment	Excellent establishment of sown grasses and legumes in small upland block. Farmer established upland forage banks of Brachiaria, Setaria, Mulato and legumes verano stylo and Clitoria and has been feeding these to his cattle, harvesting whole block 2 times already in wet season but never in dry season (leaves as forage bank). He has successfully established new Gliricidia fences around this block and is feeding it to his cattle using as “cut and fall” method (cut and let fall over on hedgerow where cattle then eat it). Started feeding gamal after visit by Jeff in Feb 2007. He did not attempt rice straw ammoniation or early weaning / preferential feeding yet. He currently has 4 cattle (2 cows, 2 young males both 7 months old). He has not yet tried EW or PF but may do it if enough new forage. Farmer very keen to expand to adjacent and more remote upland parcels.			
Farmer attitudes	Farmer very keen to learn more and expand though reluctant to embrace Gliricidia feeding or early weaning yet			
Direct impacts	Farmer says forage bank making significant contribution to improving animal condition though hard to measure as area only small and weighings infrequent. He says he has noticed a small improvement in cattle condition and growth. Forage monitoring data suggests the cut and carry dry matter provided is insufficient for maintenance though farmer still does tether grazing throughout year. No cattle liveweight data were available for Sala to compare impacts			
Indirect impacts	Farmer appreciates value of forage banks to improving cattle production			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

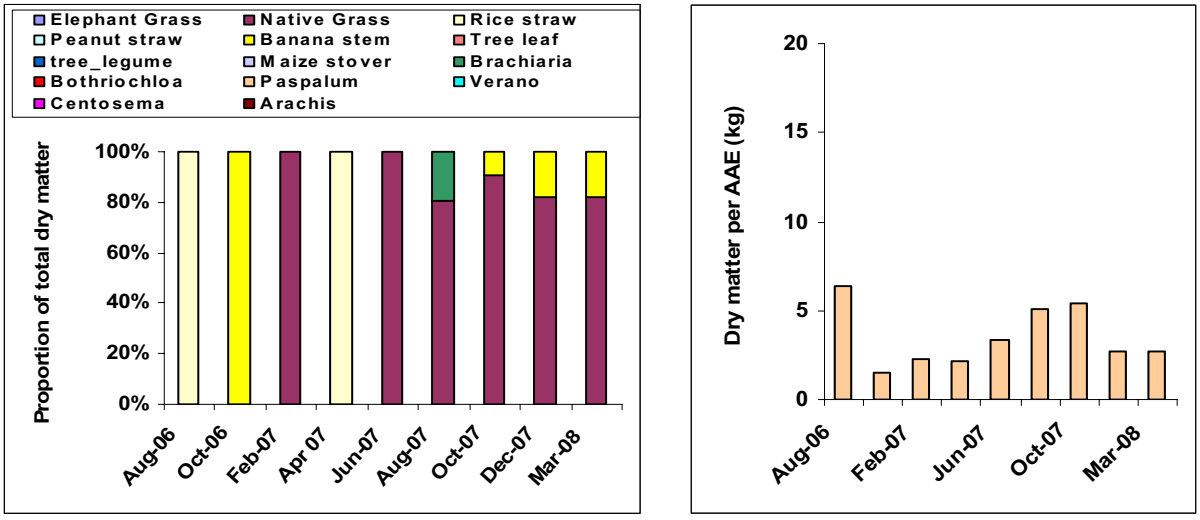


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by pak Sala, Manyampa between August 2005 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows pak Sala's cattle are receiving well below maintenance levels of dry matter throughout the year from cut and carry forage though local team may have over-estimated the number of cattle actually being fed cut and carry. He also grazes his cattle (especially cows) year round in upland area near cropland and around the village after crop harvest and uses his cut and carry sparingly at present. Fig. 1a shows that he still relies heavily on native grass, rice straw and banana stem, though his new forages are now beginning to make a small contribution in mid dry 2007.

Note: No cow or young male liveweight data available to produce figures for pak Sala.

NTB villages

Desa Mertak (Dusun Kekeku, Baremontong and Semunduk)

New sub-villages were selected within Desa Mertak in Soth Lombok during 2006. A total of 10 best bet farmers were selected from three sub-villages (Keleku, Baremontong and Semunduk) and best bet activities identified in July 2006. One best bet farmer (Aq, Leni) sold all of his cattle to buy rice and invest in a truck for caring work after the failure of the rice crop in 2007. However he has maintained his forage best bet area, which is currently being used by a relative. Another farmer, Aq. Kamil attempted only small areas of forage introduction on one of his four potential best bet options as a consequence of drought conditions in 2007. In October 2006 Indonesian project colleagues took around 20 Mertak farmers (including our 10 best bet farmers) to SPA village Sumbawa, to see first hand the impact on cattle performance of the use of tree legumes as a dry season forage source there since 2003. Establishment of forage introduction best bet activities commenced in wet season 2006-07, which turned out to be an exceptionally dry year. Table 5 details the best bet activities identified and implemented in each category at Mertak sub villages.

Table 5 Best bet activities identified and implemented in Mertak study villages – 2005-07

Village / farmer	New forage introduction		Better use of existing forages (tree legs and EG)		Crop residue conservation (inc. rice straw ammoniation)		Preferential feeding / early weaning	
	Identified	started	Identified	started	Identified	started	Identified	Started
Keluku								
Leni	1	1	1	1	0	0	0	0

Dewi	2	2	1	1	1	1	1	1
Erma	2	1	1	1	1	0	1	0
Kamil	4	1	2	1	1	0	0	0
Kusmayadi	3	3	1	1	1	0	1	1
Tot.al	12	8	6	5	4	1	3	2
Baremontong								
Mawardi	2	2	1	1	1	0	1	0
Total	2	2	1	1	1	0	1	0
Semunduk								
Sandi	2	2	1	1	0	0	0	0
Adul	2	2	1	1	1	0	1	0
Junaidi	2	2	1	0	0	0	0	0
Herman	2	1	1	0	0	0	0	0
Total	8	7	4	2	1	0	1	0
Total	22	17	11	8	6	1	5	2

Seventeen out of 22 new forage best bet options originally identified were attempted by Mertak farmers. The low rainfall and poor soil moisture conditions adversely affected new forage establishment on most Mertak best bet sites, leading to postponement or abandonment of some establishment attempts and subsequent re-establishment when rainfall conditions improved. It also le to a decision to opt for subsequent establishment of introduced grasses by vegetative tillers from plants grown in nurseries at Lingasr, Central Lombok or in farmer's backyards. Despite these early setbacks, several good stands of introduced forage were established, in particular the stylo pastures of Aq. Mawadi, Aq. Adul and Aq. Junaidi and the grass and legume forage banks of Aq. Dewi and Aq Kusmayadi.

The introduction of Brachiaria hybrid Mulato and Panicum maximum cv Simuang in 2007 led to renewed planting of grass forages from cuttings grown at UNRAM's Lingsar field station. These grasses appear far more suited to the drier conditions at Mertak than grasses previously trialled in the initial plantings.

Following their visit to SPA village in late 2006 there was great enthusiasm amongst Mertak farmers to expand use of their existing tree legume resources, in particular Gliricidia. As a result, all farmers for which expanded Gliricidia use was identified as a best bet option, subsequently commenced using this abundant resource within the Mertak village complex.

Several farmers, including Aq Mawadi, Aq. Adul, Aq, Dewi and Aq. Kusmayadi expanded their own Gliricidia plantings considerably as part of identified forage best bet options associated with creating perennial grass / tree legume forage banks or improved upland grazing systems. As with other villages, there was almost no adoption of crop residue conservation best bet options at Mertak, in particular rice straw ammoniation.

However, unlike most other villages this was mostly due to the lack of available crop residue material as a consequence of crop failure in both 2006 and 2007 growing seasons. Due to a slow start to forage best bet activities and consequent forage constraints, brought on by exceptionally dry conditions during 2007, uptake of animal management and feeding options such as early weaning / preferential feeding has been slower at Mertak.

Of five possible early weaning and feeding options identified only two have so far commenced (Aq. Kusmayadi and Aq. Dewi). The latter farmer is in fact now attempting the full range of best bet options suggested to him including expansion of Gliricidia use, existing new forage banks, early weaning, preferential feeding, controlled mating, crop

residue conservation (2008 season) and grey water recycling and run-off water harvesting for stock use.

Best bet farmer: Amaq Leni, Dusun Kelekuh, Desa Mertak, Lombok

Main points from original interview notes

- Currently has 2 cows (1 owned and one he is managing) + 3 calves (1 bull and 2 cows)
- Trucks is a large amount of forage – 3-4 trucks per month to be shared with other farmers – Praya and elsewhere. Composition varies with what is available but typically rice early in dry with some more legumes coming in later.
- Mungbean residue fed directly to stock at harvest time – not enough to conserve.
- There is minimal grazing – predominantly hand feeding

Major constraints to cattle production

- Lack of good quality local forage, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

Activity / Land type		J	F	M	A	M	J	J	A	S	O	N	D
Food crops	Lowland (1ha, 2 parcels)												
		Rice		Soybean								Rice	
	Upland (1.3ha, 3 parcels)												
		Maize / Mung bean		Soybean		Cassava		Maize / Mung bean		Soybean			
Cattle feeding strategy		Tethered in field during day, at house in evening						Tethered continuously close to house					
Calving / Weaning					Early Calving		Early Mating				Early weaning/ pref feeding		
Critical feed shortage period													
On–farm cut and carry		Grass											
		Setaria and more Sesbania on lowland bunds. Establish forage bank of grasses and legumes + Gliricidia fences on unused upland cropping terraces. Better use of existing Gliricidia on upland areas											
Off-farm residue / cut and carry		Grass etc. collected locally but off-farm						Rice, soy, mung residue + grass trucked in from Praya					Local grass etc.
Conserved feed (period of use)					Ammoniated rice straw				Feed ammoniated rice straw			Soybean	
Peak labour periods - Cattle								Feed collection and hand feeding					
Peak labour periods - Cropping		Harvesting											Preparation and sowing

Summary of best bet progress to February 2008

Farmer: Aq. Leni , Mertak	Actual Best Bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	Legumes and grasses for upland terraces	06-07 wet	Patchy but OK	OK – farmer sold cattle
Best bet 2	Establish tree legume fences in upland areas	06-07 wet	Some progress	good
Best bet 3	More Sesbania and sown grasses on lowland bunds	Not yet commenced	none	none
Best bet 5	Ammonated rice straw	Not commenced	none	no
Best bet 5	Early weaning/preferential feeding	Not commenced	none	none
Overall assessment	Farmer initially reluctant to commit land for upland forage bank but in the end established a small part of upper terrace to grasses and forage legumes – patchy establishment Farmer says all best bets tried were successful. New forage establishment in upland terraces all good – died back in dry but recovered well following wet season. Gliricidia fences grew well and feeding worked well. Says early weaning / preferential feeding worked well and he noticed a big improvement in cow condition. He sold 5 cattle and went truck driving because he needed the money due to rice crop failure, but still sharing 1 cow. His father also has 2 cows and they are currently using his forage bank and gamal. No attempt at conserved forages, some preferential feeding			
Farmer attitudes	Farmer initially not very enthusiastic but still cooperative. Has since sold his cattle (due to severe drought 2007) to buy rice and a truck for work, but very keen to resume cattle activities and will continue to embrace best bet options			
Direct impacts	Few direct measurable impacts to date due to small contribution of new forages and little effort re tree legumes – though he was feeding some Gliricidia in July 07 Farmer reduced his reliance on off-farm forage this year (reported that he had used no truckloads in 2007). He now obtains all his forages (mainly tree legumes) locally. Says his cattle condition was better in 2007 than in 2006 due to feeding tree legumes. Also saw improvement in cow condition due to early weaning – as confirmed by liveweight data However this wasn't reflected in the price he received fo his cattle in August 2007 (Rp 9.7 million for 5 head, mixed sex and ages) because he needed to sell quickly to purchase a truck for carrying			
Indirect impacts	Better appreciation of value of higher quality forages and preferential feeding of young stock and early weaning as essential part of package			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

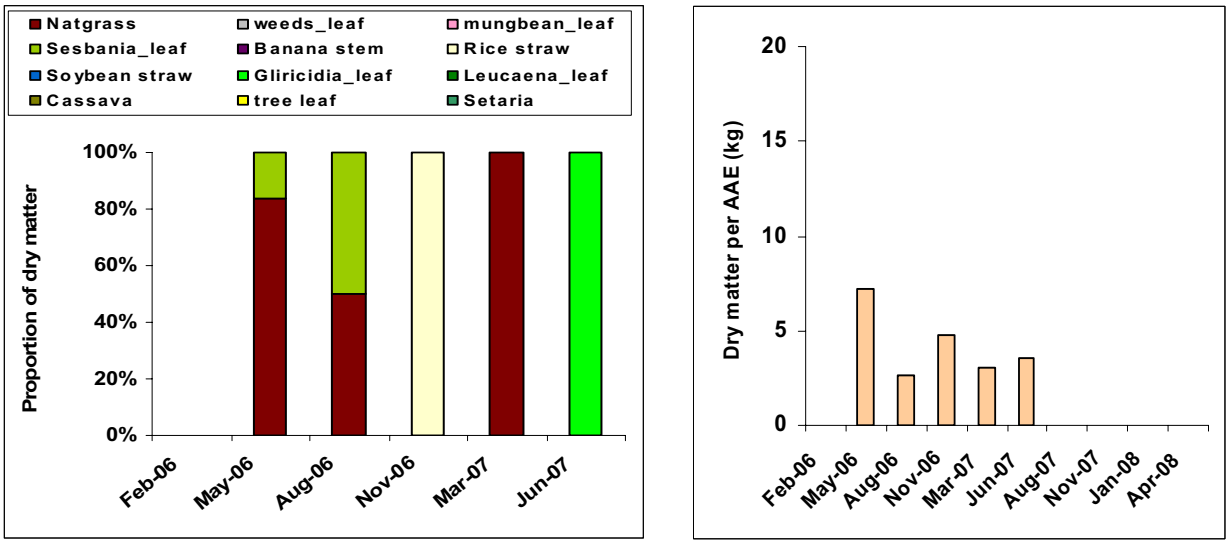


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Amaq Leni, Mertak between February 2006 and March 2008. An AAE of 250kg liveweight would

require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Aq. Leni's cattle are receiving below maintenance levels of dry matter throughout the year from cut and carry forage though local team may have over-estimated the number of cattle actually being fed cut and carry. He also grazes his cattle (especially cows) year round in upland area near cropland and around the village after crop harvest. 1a shows that he still relies heavily on native grass, rice straw and Sesbania, though he started using Gliricidia in mid 2007. His small forage bank has yet to make a significant contribution to total dry matter supply.

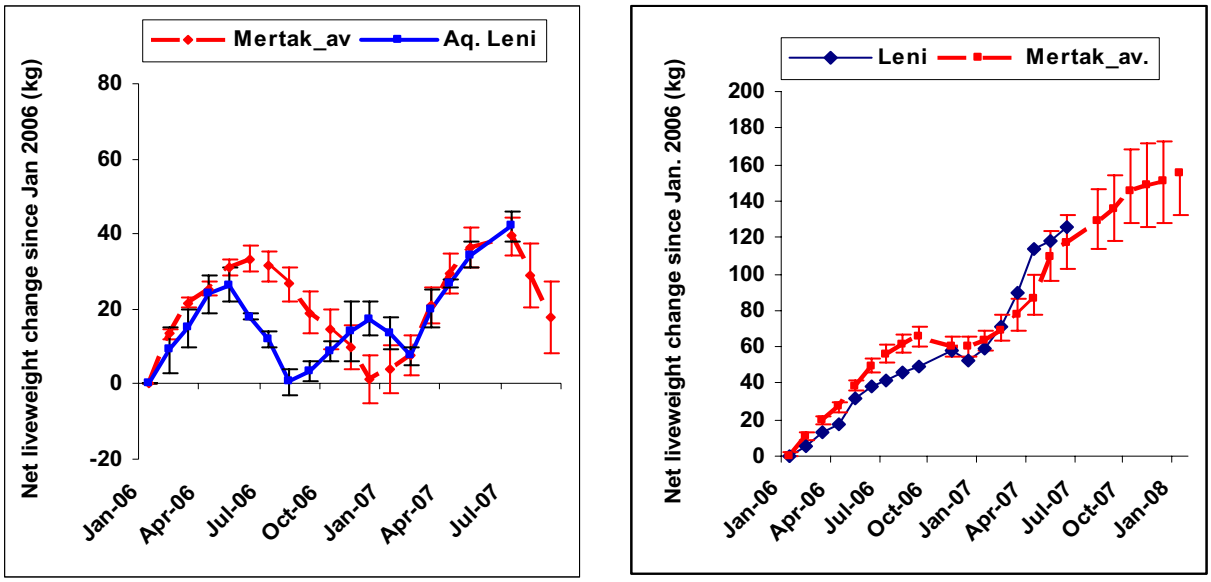


Figure 2: a. Comparison of liveweight trends of mature cows for Amaq Leni vs. the average for Mertak best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Aq. Lenis cows performed worse than best bet farmer average in 2006, losing weight earlier in the year. However they improved during 2007to Mertak average before he sold all his cattle. b. Comparison of net liveweight change for Aq. Leni's young male cattle compared with average for Mertak best bet farmers. Leni's male cattle performed similar to the average for Mertak males during 2006-07.

Best bet farmer: Mamiq Erma, Dusun Kelekuh, Desa Mertak, Lombok

Main points from original interview notes

- Currently has 2 cows + 3 calves
- Works off-farm to provide sufficient income and cover children's education in Praya
- Heavily reliant on off-farm feed sources due to small area of farm
- Rents 0.2ha of lowland area (good soil with access to irrigation on flats) to neighbour for rice production.
- Rice is currently stored in covered piles for use as feed
- Soybean residue used at harvest and not sufficient to justify conservation
- There is minimal grazing – predominantly hand feeding
- Area of lowland too small to do anything other than rice ammoniation
- Upland terraces have unmanaged Gliricidia and are eroded – could stabilise with new grasses and thicker well managed tree legumes

Major constraints to cattle production

- Lack of good quality local forage, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

Activity / Land type		J	F	M	A	M	J	J	A	S	O	N	D
Food crops	Lowland (0.05ha)												
		Rice		Soybean			Cassava					Rice	
	Upland (0.3ha)												
		Maize/ Cassava/ Soybean		Cassava								Maize/ Cassava/ Soybean	
Cattle feeding strategy		Tethered continuously close to house											
Calving / Weaning					Early calving		Early mating				Early weaning pref feeding		
Critical feed shortage period													
On–farm cut and carry		Grass			Upland terrace and backyard grasses and legumes + better use of existing Gliricidia								Grass
Off-farm residue / cut and carry		Grass etc. collected locally but off-farm								Rice, soy, mung residue + grass trucked in from Praya			Local grass etc.
Conserved feed (period of use)					Ammoniated rice straw							Feed rice straw	
Peak labour periods – Cattle										Feed collection and hand feeding			
Peak labour periods – Cropping		Harvesting											Preparation and sowing

Summary of best bet progress to February 2008

Farmer: Erma, Mertak	**Actual best bet**	**Commenced**	**2006-07 progress**	**2007-08 progress**
Best bet 1	Legumes and grasses for eroded upland terraces	Not started	none	none
Best bet 2	Establish and manage tree legume hedges on upland terrace bunds	Not started	none	none
Best bet 3	Grasses and legumes for small backyard forage bank	06-07 wet	good	Very good but washed away 2008
Best bet 5	Ammonated rice straw	Not started	none	none
Best bet 5	Early calving/weaning/preferential feeding	2007	Some pref feeding	Some pref feeding
Overall assessment	Farmer concentrated efforts on establishing backyard forages due to dry conditions in 2006-07. Has made a good start here and backyard forages should contribute significantly in coming seasons. Needs more Gliricidia fences and should try 2nd crop residue conservation. Backyard kandang well set up for early weaning / pref feeding when suitable calves available. Once backyard set up should look at restoring upland terraces for forage production			
Farmer attitudes	Farmer enthusiastic and cooperative. Keen to expand his new forages and Gliricidia resources			

Direct impacts	Few direct measurable impacts to date due to small contribution of new forages to date, but farmer now using tree legumes in feed mix. Farmer reduced his reliance on off-farm forage this year (reported that he had used no truckloads in 2007). Before project used to get large proportion of his forage from outside sources in central Lombok (several truckload/season at around RP 140,000 per load. In 2007 spent only a total of RP 270,000 on outside forage as he sourced a lot of his forage from Tree legumes within Mertak. By the end of dry season 2007 he still fed a range of forages including banana leaf and stem, coconut leaf etc. because he ran out of tree legumes by November. He plans to plant much more this year to overcome this shortage. Cattle liveweight data shows Mq. Erma's cows performing a little below Mertak best bet average during 2006 but average during 2007.
Indirect impacts	Better appreciation of value of higher quality forages and preferential feeding of young stock and early weaning as essential part of package.

Relevant graphical summaries of best bet impacts on forage use and cattle performance

Note: No forage data available for Mamiq Erma so no forage figures.

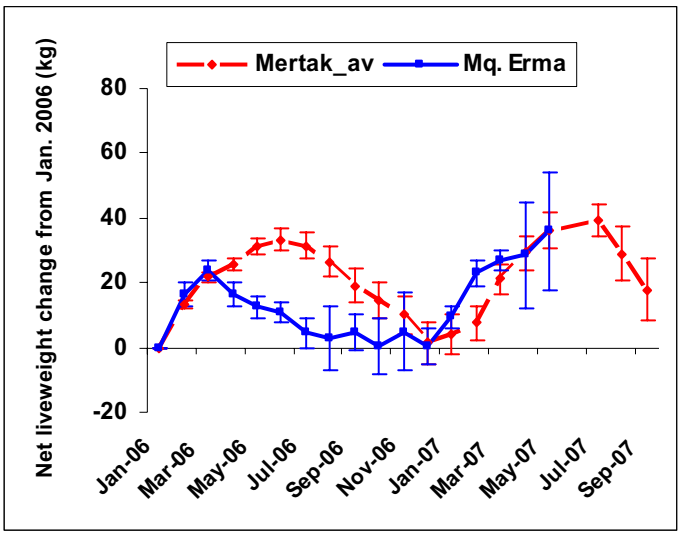


Figure 2: Comparison of liveweight trends of mature cows for Mamiq Erma vs. the average for Mertak best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Mq. Erma's cows performed worse than best bet farmer average in 2006, losing weight earlier in the year. However they improved during 2007to Mertak average, though there was considerable variation between his two cows as shown by the error bars.

Best bet farmer: Amaq Dewi, Dusun Kelekuh, Desa Mertak, Lombok

Main points from original interview notes

- Currently has 2 cows + 3 calves
- Currently does cut and carry (mainly local grass, Sesbania in dry – mainly grazing around village in wet
- Trucks in 2-3 loads/year during October from central Lombok for dry season forage
- Upper cropping terraces have potential for good forage bank and also nursery area
- Interested in using crop residues – potential for ammoniated rice straw
- Also potential for early weaning / preferential feeding

Major constraints to cattle production

- Lack of good quality local forage, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

Activity / Land type		J	F	M	A	M	J	J	A	S	O	N	D
Food crops	Lowland Rainfed (0.7ha)	Rice		Mungbean		Conserve crop residue						Rice	
	Irrigated Lowland (0.30ha)	Rice		Rice			Maize/ Mungbean					Rice	
	Upland (0.25ha)	Maize/ Mungbean/ Soybean/ Peanut		Cassava/Cotton								Maize/ Mungbean/ Soybean	
Cattle feeding strategy		Tethered continuously close to house											
Calving / Weaning					Earlier Calving			Earlier mating				Early weaning / pref feeding	
Critical feed shortage period													
On–farm cut and carry		Sesbania & Gliricidia for lowland bunds Improved grass and legumes for lowland forage bank/ nursery area More Gliricidia fences along road and around cropping areas											
Off-farm residue / cut and carry		Grass + tree legumes collected locally but off-farm									Trucked feed (mainly rice) from Praya		Local grass etc.
Conserved feed (period of use)					Conserve ammoniated rice straw		Rice (mixed with Gliricidia and Sesbania)		Feeding out ammoniated rice straw and mung bean residue				
Peak labour periods – Cattle											Feed collection		
Peak labour periods – Cropping		Harvesting									Preparation and sowing		

Summary of best bet progress to February 2008

Farmer: Aq. Dewi, Mertak	**Actual best bet**	**Commenced**	**2006-07 progress**	**2007-08 progress**
Best bet 1	Establish and manage tree legume hedges on upper and lowland areas	06-07 wet	Good progress	excellent
Best bet 2	Grasses and legumes for upper terrace nursery in lowland cropping area	06-07 wet	Fair-good	excellent
Best bet 3	Setaria and more Sesbania for lowland terrace bunds	06-07 wet	Fair-good	excellent
Best bet 5	Conserve 2nd legume crop residue	07 season	Not done 2007	Done 2008
Best bet 5	Ammonated rice straw	Not done	none	none
Best bet 6	Early weaning/ preferential feeding	2007 season	good	good

Overall assessment	Farmer very enthusiastic to adopt both forage and animal management technologies despite initial setback due to dry conditions. Farmer has put much effort into expanding his own forage nursery and tree legume fences and is actively using Gliricidia and preferentially feeding younger stock. Forage bank/nursery now has excellent stands of stylo, Mulato and Panicum maximum (purple panic) He has also set a system to use recycled household water for cattle and built a major dam near his backyard.
Farmer attitudes	Farmer enthusiastic and cooperative. Keen to expand his new forages and Gliricidia resources and get into full best bet package of forage and cattle management Has become a local mentor and champion for promoting best bet technologies
Direct impacts	Farmer says he sees definite improvement in cattle condition, due mainly to increased use of tree legumes rather than new forage bank However Cattle liveweight data shows his cows and young males performing about average for Mertak best bet farmers. Farmer reduced his reliance on off-farm forage this year (reported that he had used no truckloads in 2007). Perhaps the below maintenance levels of cut and carry dry matter provided are having an influence here.
Indirect impacts	Good appreciation of value of higher quality forages and preferential feeding of young stock and early weaning as essential part of package. Farmer sees good options for moving more into cattle and growing forages rather than unreliable rice crops

Relevant graphical summaries of best bet impacts on forage use and cattle performance

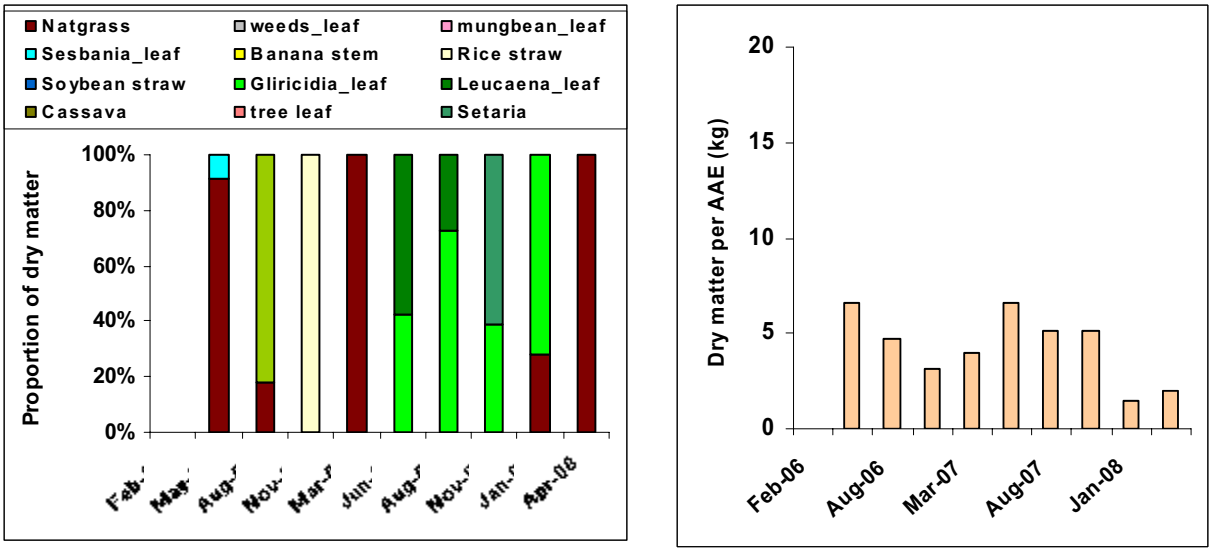
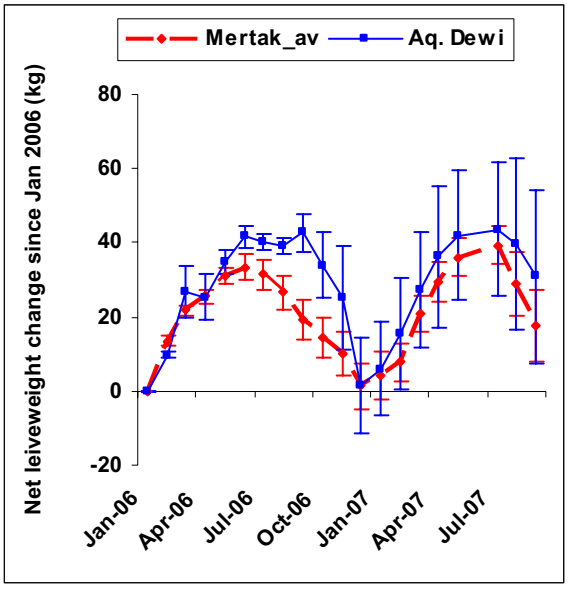


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Amaq Dewi, Mertak between February 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Aq. Dewi's cattle are receiving below maintenance levels of dry matter throughout the year from cut and carry forage though there may be some error in determining which of his animals were receiving cut and carry. He also grazes his cattle (especially cows) in upland area near cropland and around the village after crop harvest. 1a shows that he still relies heavily on native grass in wet season. In 2006 he relied heavily on rice straw in late dry but in 2007 he replaced this with tree legumes and new grasses such as Setaria. His forage bank is now making a significant contribution to total dry matter supply.



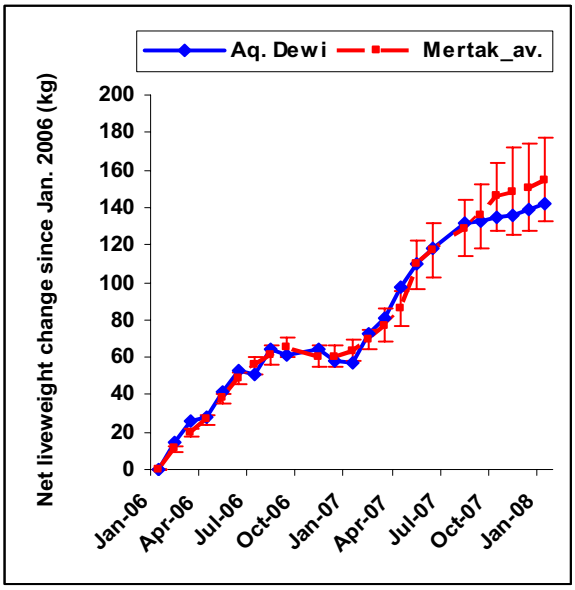


Figure 2: a. Comparison of liveweight trends of mature cows for Amaq Dewi vs. the average for Mertak best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Aq. Dewi's cows performed a little better than best bet farmer average in 2006, losing weight in late dry in 2006 and 2007 (drought year). There was considerable variation between his cows as shown by the error bars. b Comparison of net liveweight change for Aq.Dewi's's young male cattle compared with average for Mertak best bet farmers. Dewi's male cattle performed similar to the average for Mertak males during 2006-07.

Best bet farmer: Amaq Kusmayadi, Dusun Kelekuh, Desa Mertak, Lombok

Main points from original interview notes

- Currently has 1 cows + 2 calves
- Uses all of rice straw at present as feed.
- Already has Gliricidia fences (well managed)
- Has suitable area of upper terraces close to road for demonstration forage bank
- Potential for new grasses and more Sesbania on upland terraces
- Also has wet lowland terrace (too wet for rice) which has potential for forages

Major constraints to cattle production

- lack of good quality local forage, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

<table>
<tr><td colspan="2">Activity / Land type</td><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>S</td><td>O</td><td>N</td><td>D</td></tr>
<tr><td>Food crops</td><td>Lowland (0.7ha)</td><td colspan="2">Rice, Cassava</td><td colspan="3">Mungbean, Soybean, Cassava</td><td colspan="3">Cassava</td><td></td><td></td><td colspan="2">Rice, Cassava</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Upland 1ha and 0.34ha</td><td colspan="2">Rice, Mungbean, Cassava, Cotton</td><td colspan="3">Cassava, Cotton</td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Rice, Mungbean, Cassava, Cotton</td></tr>
<tr><td colspan="2">Rice, Cassava, Cotton</td><td colspan="3">Cassava, Cotton</td><td colspan="2"></td><td></td><td></td><td></td><td colspan="2">Rice, Cassava, Cotton</td></tr>
<tr><td colspan="2">Cattle feeding strategy</td><td colspan="5">Tethered continuously close to house</td><td colspan="7">– build backyard kandang and feed C/C there in dry season</td></tr>
</table>

Calving / Weaning						Early calving					Earlier mating							Early weaning/ pref feeding				
Critical feed shortage period																						
On–farm cut and carry	Grass		Grass, Sesbania, Mung residue			Grass, Sesbania Gliricidia					Cassava, Sesbania					Sesbania, Gliricidia				Grass + Sesbania		
	Introduced grasses an legumes in upland terrace and bunds and wet lower terrace areas. More use of Gliricidia fences																					
Off-farm residue / cut and carry							Gliricidia, Dry grass							Grass , Dry grass			Trucked feed (mainly rice) from Praya (4 trucks/yr)					
Conserved feed (period of use)						Ammoniate rice straw			Soy and Mungbean residue fed immediately					Feed out ammoniated rice								
Peak labour periods – Cattle																	Feed collection					
Peak labour periods – Cropping	Harvesting																			Preparation and sowing		

Summary of best bet progress to February 2008

Farmer: Mq. Erma, Mertak	Actual best bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	Grasses and legumes for forage bank and nursery in upland cropping area	06-07 wet	Mixed success – dry season	good
Best bet 2	Setaria and more Sesbania for upland and lowland lowland terrace bunds	06-07 wet	Mixed success – dry season	OK Setaria suffered from dry
Best bet 3	Grasses and legumes for wet lower terrace area	06-07 wet	Good result	Flooded 2008 farmer moved grasses
Best bet 4	Ammonated rice straw	Not started	none	none
Best bet 5	Early calving/weaning/preferential feeding / animal management	2007	Pref feeding of bull	Some pref feeding
Overall assessment	Farmer put much effort into upland forage bank area but early planting suffered from dry conditions. Good start for wet lower terrace plantings of introduced grasses. Farmer has propagated and planted all of terrace now. Farmer expanding and using tree legumes and preferentially feeding young males including project bull in 2007			
Farmer attitudes	Farmer very enthusiastic and keen to promote technologies amongst farmers. Needs to focus more on getting his own forage and cattle management right but making good progress			
Direct impacts	Farmer says his cattle better off this year (2007-08) in growth and condition though Cow liveweight data suggests his cows are doing about average for Mertak best bet farmers. Perhaps the below maintenance levels of cut and carry dry matter provided throughout the year are having an impact here Farmer reports that project bull gained 30kg in 40 days in mid dry season 2007. Unfortunately no reliable liveweight data to verify this. Farmer sold original bull (with permission) and bought new younger bull as consequence. Farmer reduced his reliance on off-farm forage this year (used no truckloads in 2007) Farmer changing farming system focus more on cattle production, with switch to more cassava/cassava system as dual purpose human/cattle feeds (more reliable than rice/mung bean) and expansion of forage banks.			
Indirect impacts	Better appreciation of value of higher quality forages and preferential feeding of young stock and early weaning as essential part of package Better appreciation of opportunities to move into cattle production as more profitable enterprise.			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

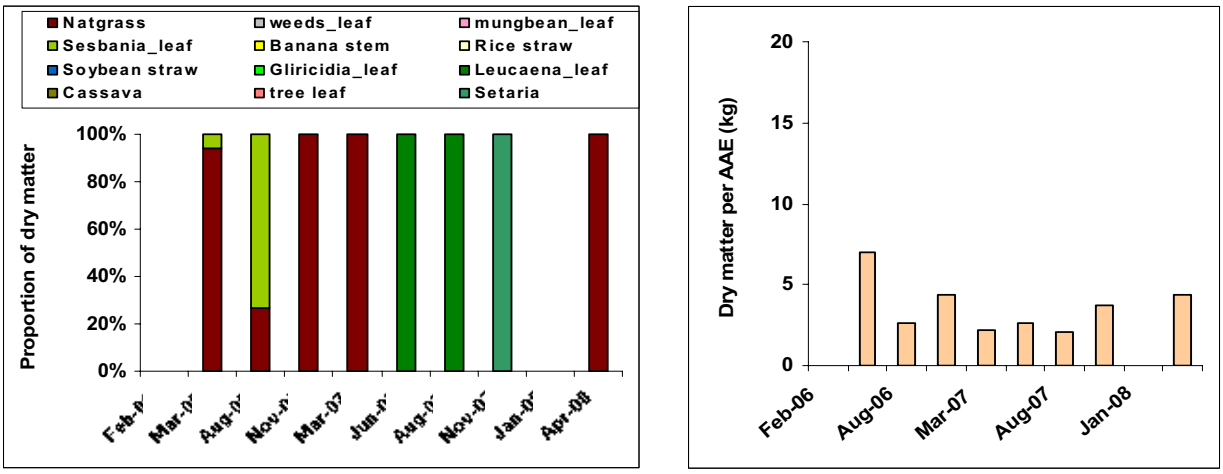


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Amaq Kusmayadi, Mertak from February 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Aq. Kusmayadi's cattle are receiving below maintenance levels of dry matter per AAE throughout the year from cut and carry forage, though he also grazes his cattle in upland area near cropland and around the village after crop harvest. 1a shows that he still relies heavily on native grass in wet season but by mid 2007 was supplying most of his dry season cut and carry from Leucaena in particular, supplemented by new grasses such as Setaria from his new forage bank – though amounts fed were fairly small overall.

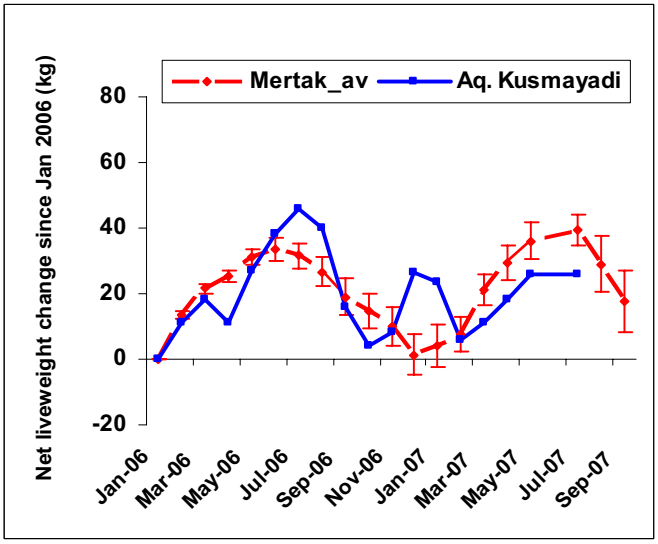


Figure 2: Comparison of liveweight trends of mature cows for Amaq Kusmayadi vs. the average for Mertak best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Aq. Kusmayadi's cow performed about average for Mertak best bet farmers, losing weight in late dry in 2006 and 2007 (drought year). His cow has looked especially poor in 2007/2008 due mainly to provision of insufficient dry matter compared to the project bull he also looks after. No male cattle liveweight data available for Aq. Kusmayadi – hence no figure.

Best bet farmer: Amaq Kamil, Dusun Kelekuh, Desa Mertak, Lombok

Main points from original interview notes

- Animal number 8 – 4 cows, 1 heifer, 3 calves – good opportunity for early weaning / preferential feeding
- Small area for exclusive grazing close to backyard – good for backyard forage bank
- Rice used for mulch on mung bean and then used as feed if needed - poor quality.
- Conserves mung and soy residue
- 10 farmers share one truck every 2 weeks for 3 month period during dry season for off farm forage from central Lombok (mainly rice straw)
- Has spare undeveloped upland plus seasonally unused mid and upper cropping terraces which may be suitable for annual forages as alternate 2nd crops or companion plantings

Major constraints to cattle production

- Lack of good quality local forage, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

Activity / Land type		J	F	M	A	M	J	J	A	S	O	N	D
Food crops	Lowland (1ha)												
		Rice				Mungbean						Rice	
	Upland (1ha)	Maize/ Mungbean/ Cassava/ Soybean	Cassava inter-row sown with verano stylo for forage and nitrogen									Maize/ Mungbean/ Cassava/ Soybean	
Grazing land (0.24ha)		Tethered grazing											
Calving / Weaning					Earlier calving			Earlier mating				Early weaning/ pref feeding	
Critical feed shortage period													
On–farm cut and carry		Grass, Elephant grass (lowland bunds), Sesbania, Gliricidia, Cassava						Sesbania, Gliricidia, Cassava, Rice		Sesbania, Gliricidia, Cassava		Grass, Sesbania, Gliricidia,	
		Introduced forages in backyard forage bank and on unused upland. Setaria/EG on bunds, more Gliricidia fences											
Off-farm residue / cut and carry								Dry grass	Rice, Soybean, grass,				
Conserved feed (period of use)							Soybean, Mungbean						
Peak labour periods – Cattle									Feed collection and hand feeding				
Peak labour periods – Cropping		Harvesting										Preparation and sowing	

Summary of best bet progress to February 2008

Farmer: Kamil, Mertak	Actual best bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	forages for backyard forage bank	Did not proceed	none	
Best bet 2	Grasses for upland bunds	06-07 wet?	Some?	
Best bet 3	Legumes for intercropping in upland terraces	Did not proceed	none	
Best bet 5	Pasture forages on upland terraces	Did not proceed	none	
Best bet 6	Early calving/weaning/preferential feeding	Did not proceed	none	
Overall assessment	Sowed grasses and legumes in lower terraces and Setaria on bunds. Did not sow forage bank in backyard as too dry and could not protect from grazing. Did early weaning / preferential feeding in January 07 and reports improved cow and calf condition already. Also feeding Gliricidia and Leucaena obtained from around village and has since planted more on own land + elephant grass and Centrosema pascourum to increase forage supply. Farmer not that interested in proceeding with backyard forage banks as he says he can't control grazing during establishment. Is using some Gliricidia Of the designated best bets early weaning / preferential feeding and grass establishment on bunds working best. As well, advice to use gamal and lamtoro really working well for him.			
Farmer attitudes	Farmer attitude a problem here – may be more enthusiastic once he sees other farmers reap rewards for effort			
Direct impacts	Before project (2006) bought 5 trucks of rice straw (shared with other farmers?) @ Rp 250,000 per load – total Rp 1.35 million. This is in addition to grazing and C/C around village Now uses gamal and lamtoro gathered from his own and other local sources (used none prior to project).In 2007 bought in 3 smaller trucks (shared with other farmers) at a total cost of Rp 450,000. Still had to supplement with banana stem and other feeds when communal gamal supplies ran out after Aug-Sept 2007. He says cattle condition has improved, especially cow and calf condition due to EW and PF of tree legumes though cattle liveweight data don't support this. He has sold 1 cow to build dam and 1 other one year old sapi (no sex given) to pay for share farming costs Has built backyard kandang for more efficient cattle feeding, using proceeds of cattle sale.			
Indirect impacts	Difficult to see yet			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

*** Note: No forage data available for Amaq. Kamil so no forage figures*

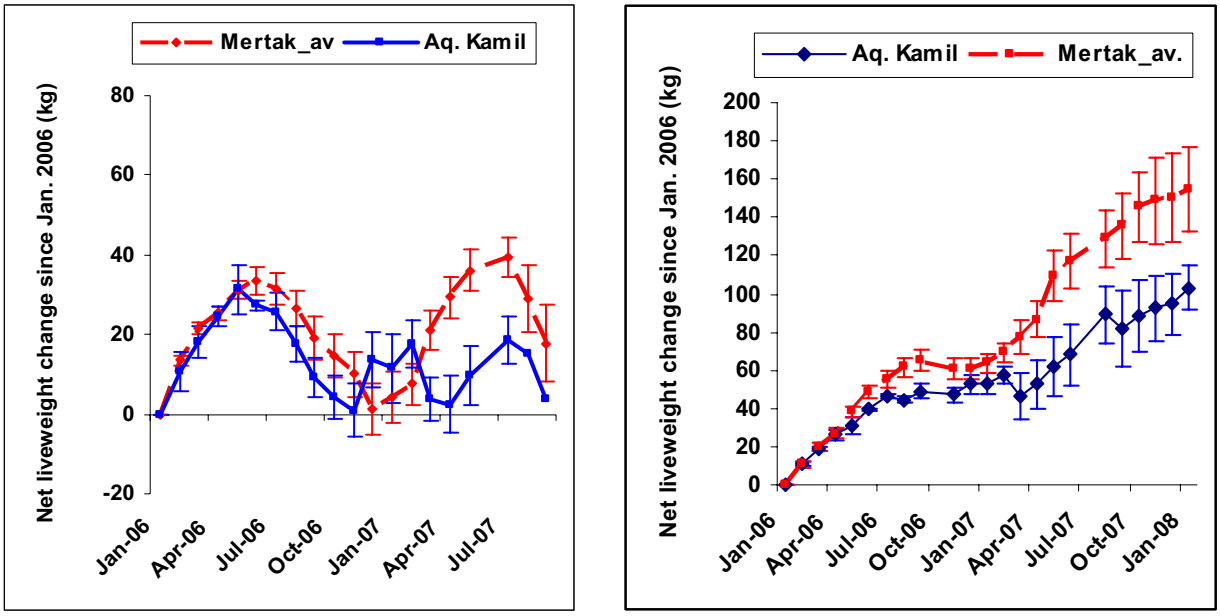


Figure 2 a. Comparison of liveweight trends of mature cows for Amaq Kamil vs. the average for Mertak best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Aq. Kamil's cows performed worse than average for Mertak best bet farmers, losing weight in late dry in 2006 and failing to compensate during wet season 2007. His cow has looked again poor in wet season 2007-08 - mainly through insufficient quality dry matter provision and highly restricted tethered grazing. b. Comparison of net liveweight change for Aq .Kamil's young male cattle compared with average for Mertak best bet farmers. Aq. Kamil's male cattle performed below the average for Mertak males during 2007 in particular.

Best bet farmer: Amaq Mawadi, Dusun Baremontong, Desa Mertak, Lombok

Main points from original interview notes

- Currently has 9 cattle (main activity). 1 bull, 4 cows, 1 heifer, 3 calves
- Mostly grazes in upland – little cut and carry
- Large area for grazing – renting
- Cattle as source of income rather than bank – potential for early weaning / preferential feeding
- Rice straw conserved in piles
- Gets in some off-farm rice straw but mainly uses his own – potential for ammoniation
- Has farm dam for own use Leucaena around perimeter
- Grazing area for his exclusive use
- Very weedy at present but with much potential
- Old 'bunds' capture runoff temporarily.

Major constraints to cattle production

- Lack of good quality local forage, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

Activity / Land type		J	F	M	A	M	J	J	A	S	O	N	D
Food crops	Upland/Lowland (0.5ha & 1ha)	Soybean										Soybean	
		Rice,			Soybean and Mungbean							Rice	
Grazing land (2.0ha)		Upland improved pasture system using verano stylo, sown and native grasses and Gliricidia hedges on old bunds for grazing, also grazing forages for shaded area											
Calving / Weaning					Earlier calving			Earlier mating				Early weaning / pref feeding	
Critical feed shortage period													
On–farm cut and carry		Grass						Rice & soy (own), grass	Rice & soy, Sesbania	Sesbania (from rainfed lowland)			
Off-farm residue / cut and carry									Rice and soybean (3 trucks/year)				
Conserved feed (period of use)					Ammoniate rice straw			Feed out ammoniated rice					
Peak labour periods – Cattle									Feed collection				
Peak labour periods – Cropping		Harvesting									Preparation and sowing		

Summary of best bet progress to February 2008

Farmer: Aq. Mawadi, Mertak	**Actual best bet**	**Commenced**	**2006-07 progress**	**2007-08 progress**
Best bet 1	Pasture grasses and legumes for large upland grazing area	06-07 wet	Very good	Very good
Best bet 2	Gliricidia on upland bunds for tree legume / pasture grazing system	06-07 wet	Very good	Very good
Best bet 3	Ammonated rice straw	Not started	none	none
Best bet 5	Early calving/weaning/preferential feeding	Not started	none	none
Overall assessment	Excellent establishment and growth of verano but farmer reluctant to graze it. Verano was producing around 12 tonnes/ha fresh weight in Feb 2008. Good Gliricidia hedges on old bunds and good improved forage grasses near dam and on adjacent bunds. Grass (Setaria and Brachiaria) establishment in adjacent area around dam also good but currently flooded Farmer did not use Verano in year 1 because he wished to let it seed but is now harvesting for cut and carry rather than grazing as originally planned. Farmer keen to expand forage No attempt at preferential feeding or early weaning though farmer feeding more Gliricidia and Leucaena now. He had 13 cows through 2006, 10 cows in 2007 but no calves due to failure of his bull. He refused to use project bull, due to small charge involve for service			
Farmer attitudes	Farmer very enthusiastic and keen to expand. Need to convince him to adopt animal feeding and breeding management technologies as he has many cattle and well set up with backyard kandang			
Direct impacts	No immediate impact attributable to new forages as yet as farmer has not yet exploited them Farmer believes feeding tree legumes with rice straw has made some difference to cattle performance in 2007 but too early to really see results in cattle production. Though he says his cattle condition improved a little but still no real impact on price for age so far. However farmer's cattle condition shows benefit of more tree legume in diet though liveweight data does not appear to support this			

Indirect impacts	Better appreciation of value of higher quality forages and preferential feeding of young stock and early weaning as essential part of package Better appreciation of opportunities to improve upland pastures and forage banks to improve year round forage supply

Relevant graphical summaries of best bet impacts on forage use and cattle performance

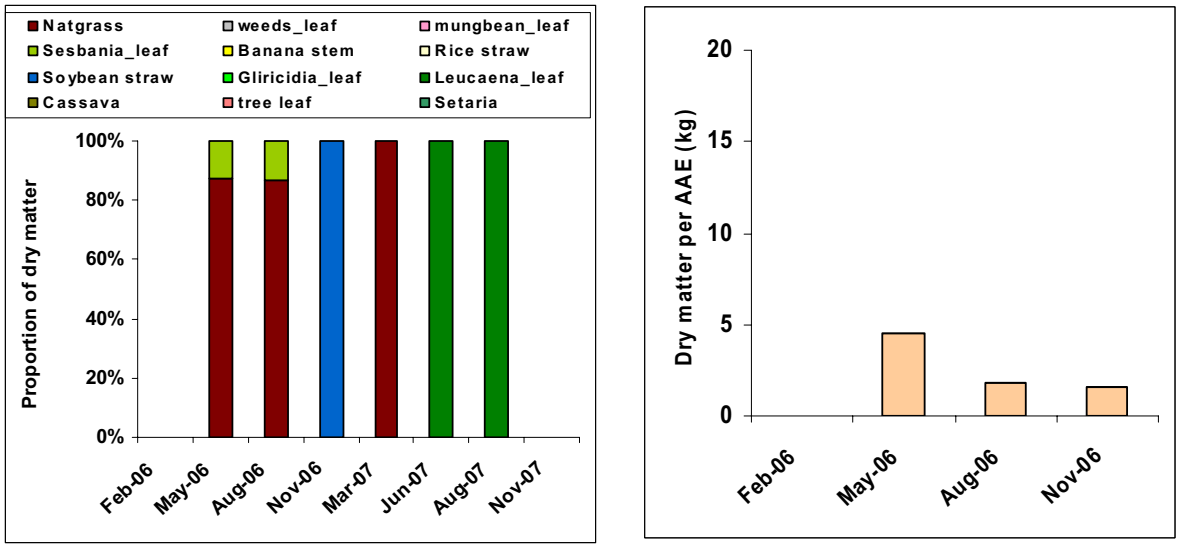


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Amaq Mawadi, Mertak between February 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Aq. Mawadi's cattle are receiving below maintenance levels of dry matter per AAE throughout the year from cut and carry forage, but he primarily grazes his cattle in his upland pastures or cropland after crop harvest, so cut and carry is still only a minor component of his total feed supply. 1a shows that he used Leucaena from around his dam area in dry season 2007, though amounts were only small. Though he has a significant area of Verano stylo he did not use this during 2007 as he wanted to save it for seed for expansion.

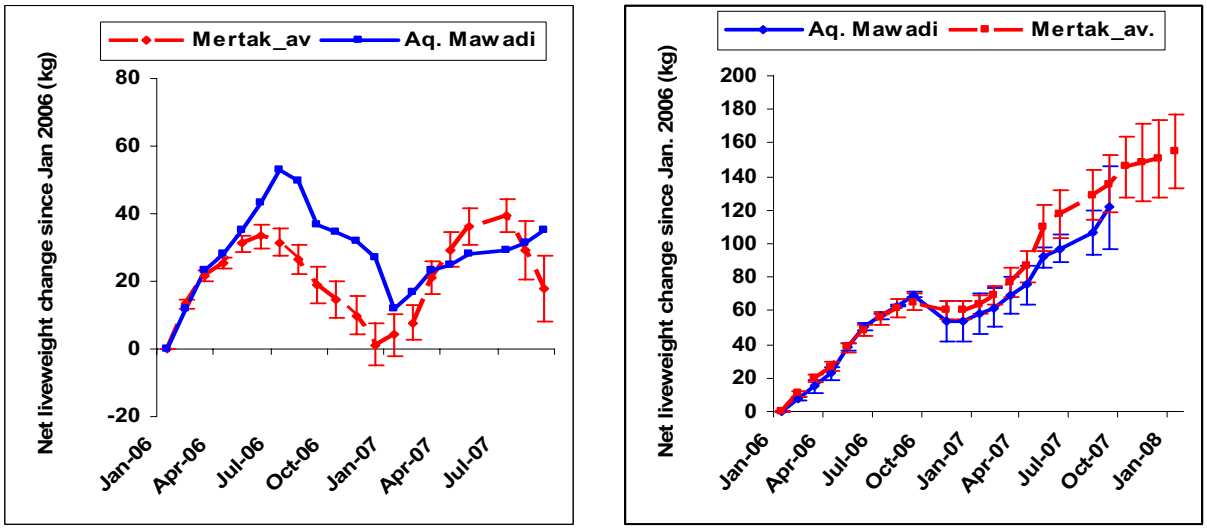


Figure 2: a. Comparison of liveweight trends of mature cows for Amaq Mawadi vs. the average for Mertak best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Aq. Kamil's cows performed around average for Mertak best bet farmers. Unfortunately despite having up to 10 cows at times Aq. Mawadi rarely brought the same animals for weighing. As a result only one cow could e consistently

tracked over time. b. Comparison of net liveweight change for Aq.Mawadi's young male cattle compared with average for Mertak best bet farmers. Mawadi's male cattle performed about average for Mertak males in 2006-07.

Best bet farmer: Bapak Sandi, Dusun Semunduk, Desa Mertak, Lombok

Main points from original interview notes

- Currently has 3 cattle – 1 heifer, 1 calf and 1 cow
- 0.05ha area is low in landscape, has heavy black soil and has plenty of soil moisture (even in July). Very shady.
- No rice conservation recently because of failed rice crop.

Major constraints to cattle production

- Lack of good quality local forage, especially in dry season
- Little spare land for new forages apart from cropping terraces and small shaded low lying area

Calendar of existing farming system and suggested best bet options to meet constraints

Activity / Land type		J	F	M	A	M	J	J	A	S	O	N	D
Food crops	Lowland (0.8ha, 2 persils)												
		Rice/Maize/Bean		Mungbean								Rice/Maize/Bean	
	Upland (0.05ha)												
		Bamboo, Sesbania, Leuceana, Kelapa, Srikaya											
Cattle feeding strategy		Tethered continuously close to house, hand feeding.											
Calving / Weaning													
Critical feed shortage period													
On–farm cut and carry		Grass, Sesbania	Grass maize	Grass rice	Grass Sesb		Grass Sesb Mung	Grass	Sesb, Gliric, Leuc		Sesb, Gliric	Grass Sesb	Grass Sesb, Glir, Leuc
				Setaria on bunds/ introduced grasses and legs + EG in small lowland forage bank									
Off-farm residue / cut and carry									Dried grass, rice	Rice (2 trucks per year)			
Conserved feed (period of use)				Ammoniate rice straw				Rice, Mung	Feed out ammoniated rice straw				
Peak labour periods – Cattle								Feed collection and hand feeding					
Peak labour periods – Cropping		Harvesting									Preparation and sowing		

Summary of best bet progress to February 2008

Farmer: Bk. Sandi, Mertak	Actual best bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	Establish Setaria on bunds	06-07 wet	fair	Fair
Best bet 2	Grasses and legumes for shaded lower slope area	06-07	Poor – too dry	OK
Best bet 3	Ammonated rice straw	Not started	none	none

Overall assessment	Reasonable Setaria establishment Poor establishment of sown forages In shaded lowland plot – too dry? Farmer accessing Gliricidia around village in dry season
Farmer attitudes	Farmer still keen to continue despite initial failures.
Direct impacts	No immediate impact as not enough new forage contribution However farmer's cow condition shows benefit of more tree legume in diet in 2007 (see cut and carry forage figure) compared to Mertak best bet farmers average.
Indirect impacts	Difficult to see yet though farmer very keen to expand forage resource and aware of value of tree legumes like gamal

Relevant graphical summaries of best bet impacts on forage use and cattle performance

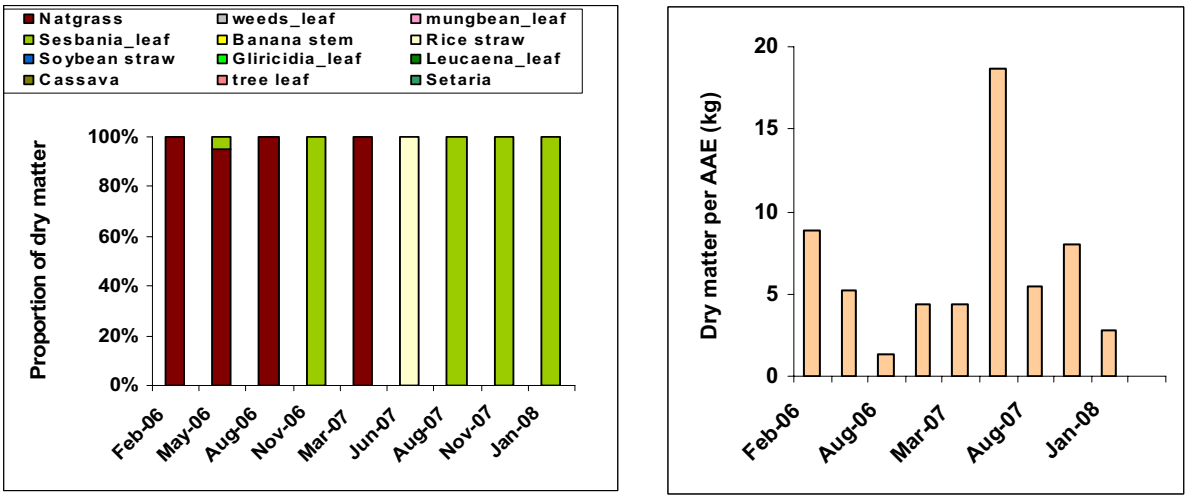


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Bapak Sandi, Mertak between February 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Bk. Sandi's cattle are receiving below maintenance levels of dry matter per AAE throughout the year from cut and carry forage, except in August 2007 when he fed rice straw. Figure 1a shows that he used Sesbania in late dry season 2006 and 2007, though amounts were only small.

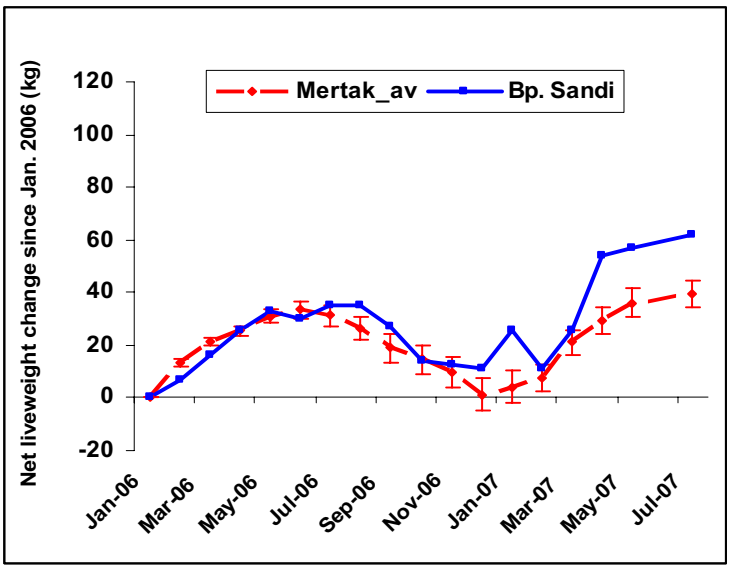


Figure 2: Comparison of liveweight trends of mature cows for Papak Sandi vs. the average for Mertak best bet farmers for the study period February 2006 to November 2007. Data

(means and standard errors) show Papak Sandi's cow (the one most consistently brought for weighing) performed around average for Mertak best bet farmers in 2006 but above the average for early dry 2007 (the last weighing for this animal).

Best bet farmer: Amaq Herman, Dusun Semunduk, Desa Mertak, Lombok

Main points from original interview notes

- Currently has 6 cattle. 4 cows, 1 heifer, 1 calf
- Largish area for grazing near coast
- Rice not conserved

Major constraints to cattle production

- Lack of good quality local forage, especially in dry season

Calendar of existing farming system and suggested best bet options to meet constraints

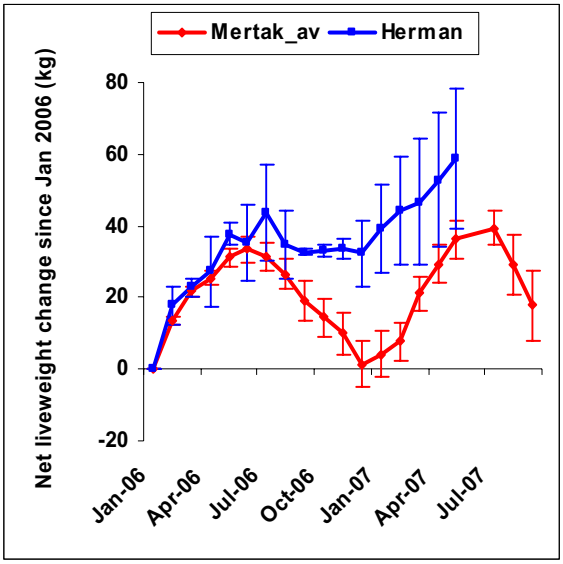
<table>
<tr><td colspan="2">Activity / Land type</td><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>S</td><td>O</td><td>N</td><td>D</td></tr>
<tr><td rowspan="4">Food crops</td><td>Lowland - Rented (0.1ha)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="4">Rice/Peanut</td><td>Soy bean</td><td></td><td></td><td></td><td></td><td colspan="3">Rice/Peanut</td></tr>
<tr><td rowspan="2">Upland (0.30ha, 2 persils of 0.15ha)</td><td colspan="2">Rice, Maize, Cotton, Cassava</td><td colspan="2">Cassava, Cotton</td><td colspan="4">Cassava</td><td colspan="3">Rice, Maize, Cotton, Cassava</td></tr>
<tr><td colspan="2">Maize, Soybean</td><td colspan="5">Cassava</td><td colspan="4">Maize, Soybean, Cassava</td></tr>
<tr><td colspan="2">Grazing area (1.3ha)</td><td colspan="2"></td><td colspan="6">Verano + grasses in upland grazing area</td><td colspan="4"></td></tr>
<tr><td colspan="2">Calving / Weaning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Critical feed shortage period</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="2">On–farm cut and carry</td><td>Grass Sesb</td><td>Grass maize</td><td>Grass rice</td><td>Grass Sesban</td><td>Grass Sesbania Mung</td><td></td><td>Grass</td><td>Sesbania Gliricidia Leuceana</td><td></td><td>Sesb, Gliric</td><td>Gras Sesb</td><td>Grass Sesb Glir Leuc</td></tr>
<tr><td colspan="12">Setaria / Gliricidia on upland bunds / verano intercropped with Cassava on lowland terraces</td></tr>
<tr><td colspan="2">Off-farm residue / cut and carry</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Dried grass</td><td colspan="3">Rice (trucked in)</td></tr>
<tr><td colspan="2">Conserved feed (period of use)</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Soy bean</td><td></td><td colspan="2">Feed ammoniated straw</td><td></td></tr>
<tr><td colspan="2">Peak labour periods – Cattle</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Feed collection and hand feeding</td></tr>
<tr><td colspan="2">Peak labour periods – Cropping</td><td></td><td></td><td></td><td colspan="3">Ammoniate rice straw</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Summary of best bet progress to February 2008

Farmer: Herman, Mertak	Actual best bet	Commenced	2006-07 progress	2007-08 progress
Best bet 1	Pasture legumes and grasses for partly fenced upland grazing area	No start	Some planting	Only fair
Best bet 2	Setaria / Gliricidia s for upland bunds	No start	Some planting	fair
Best bet 3	Forage legumes under Cassava in lowland coastal cropping area	Not sure if attempted	Some planting?	Have not seen
	Ammonated rice straw	No start	none	none
Overall assessment	Have not visited site recently but colleagues report little success or progress to date			
Farmer attitudes	Farmer attitude appears to be a problem here			
Direct impacts	No immediate impact as best bet activity yet to be undertaken. No forage monitoring data available Liveweight data suggests his cattle doing about average for Mertak best bet farmers.			
Indirect impacts	Difficult to assess			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

*** Note: No forage data collected for Amaq Herman so no forage figures*



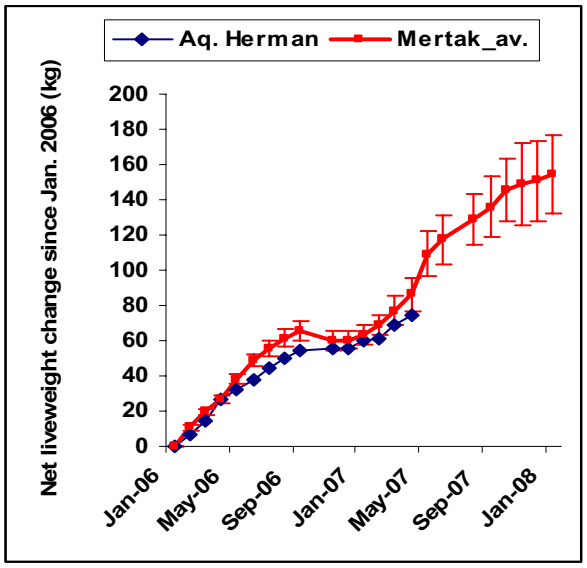


Figure 2:a. Comparison of liveweight trends of mature cows for Amaq Herman vs. the average for Mertak best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Aq. Herman's cows performed better than average for Mertak best bet farmers from mid dry 2006 on, though there was considerable variation as evidenced by the standard error bars. b Comparison of net liveweight change for Aq. Herman's young male cattle compared with average for Mertak best bet farmers. Herman's male cattle performed about average for Mertak males during 2006-07.

Best bet et farmer: Amaq Junaidi, Dusun Semunduk, Desa Mertak, Lombok

Main points from original interview notes

- Currently has 9 cattle – opportunity for early weaning / pref feeding / controlled mating
- Largish area for grazing near coast
- Sizeable land holdings on coast – options for both grazed pastures and cut and carry forages

- No apparent usage of crop residues

Major constraints to cattle production

- Lack of good quality local forage, especially in dry season for both c/c and grazing

Calendar of existing farming system and suggested best bet options to meet constraints

Activity / Land type		J	F	M	A	M	J	J	A	S	O	N	D
Food crops	Lowland (0.54 and 0.58ha)	Maize, Soybean, Cotton, Soybean				Cassava						Maize Soybean	
		Maize, Soybean, Cotton, Soybean, Cassava										Maize	
	Upland (2.25ha, 3 persils of 1.5, 0.3, 0.45ha)			Cassava + verano andcentro intercropping for forage + N source									
		Rice, Cotton										Rice Cotton	
		Sesbania, dry grass, padang pengembalaan											
Grazing area (2 of upland persils)		Tethered grazing											
Calving / Weaning			Weaning		Calving			Mating					
Critical feed shortage period													
On–farm cut and carry		Verano and grasses for upland grazing area near coast, Setaria andGliricidia for upland terrace bunds											
Off-farm residue / cut and carry													
Conserved feed (period of use)					Ammoniate rice straw				Feed out ammoniated rice straw				
Peak labour periods – Cattle										Feed collection and hand feeding			
Peak labour periods – Cropping													

Summary of best bet progress to February 2008

Farmer: Junaidi, Mertak	**Actual best bet**	**Commenced**	**2006-07 progress**	**2007-08 progress**
Best bet 1	Pasture legumes and grasses for partly fenced upland grazing area	06-07 wet	Good verano growth	
Best bet 2	Setaria / Gliricidia s for upland bunds	06-07 wet	Good start?	
Best bet 3	Forage legumes under Cassava in lowland coastal cropping area	06-07 wet	Good?	
	Ammonated rice straw	No start	none	
Overall assessment	Established stylos in unused lowland area instead of original upland site because of dry conditions in 2006/07. Stylos growing well in new area. His cattle liked both verano and seca stylos. Established forage legumes under cassava and turi in coastal lowland Did not do rice straw ammoniation as little rice straw available 2007. Has planted some Gliricidia and grasses in upland area Has also adopted early weaning / preferential feeding and controlled mating on advice from project team and other farmers. EW working well so far Has now planted a further 400 Sesbania (turi) trees in addition to gamal hedges in upland. Will continue all successful best bet practices. Would like to focus on developing forages and early weaning and cattle housing for efficient feeding. Plans to put tiles roof on his kandang this year.			
Farmer attitudes	Farmer enthusiastic to expand both pasture, grasses/ Gliricidia on bunds and verano intercropping			

Direct impacts	He says his cattle condition and growth rates have improved since adopting early weaning / preferential feeding and generally feeding cut and carry tree legumes, stylos and cassava. He has observed better cow/calf condition already from feeding gamal, lamtoro and turi to cows and calves However this not supported by cattle liveweight data which shows his cows doing about average for Mertak best bet farmers. His cattle have attracted on average an extra Rp 700,000 each for sapi of the same age and sex as his neighbour's cattle Not sure if any measurable impact on animal production or condition but farmer reports cattle better this year despite dry conditions Farmer says he did not have to truck in forage this year as he has been using tree legumes more
Indirect impacts	Difficult to assess as yet. However farmer has better appreciation of value of tree legumes and pasture legumes

Relevant graphical summaries of best bet impacts on forage use and cattle performance

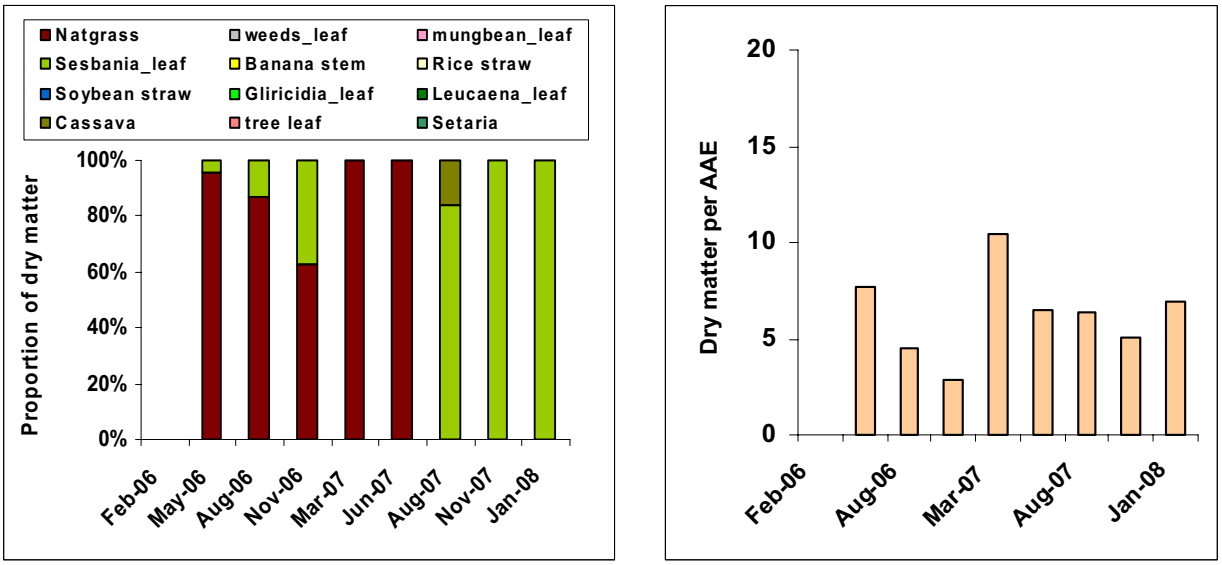


Figure 1: a. Trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Amaq Junaidi, Mertak between February 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Aq. Junaidi's cattle are receiving around maintenance levels of dry matter per AAE from cut and carry at times though less in late dry season. Figure 1a shows that he relied much more on native grass (probably sourced off farm) in 2006 but used much more Sesbania and Cassava and no native grass in late dry season 2007, though amounts were only small.

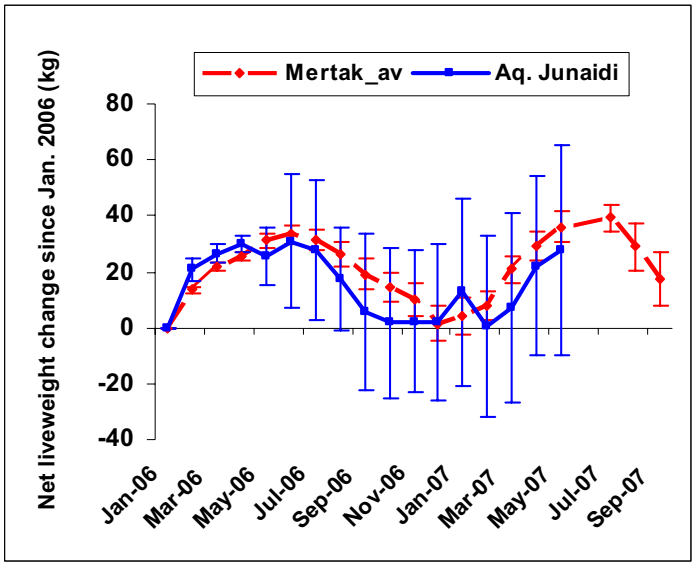


Figure 2: a. Comparison of liveweight ight trends of mature cows for Amaq Junaidi vs. the average for Mertak best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Aq. Junaidi's cows performed around average for Mertak best bet farmers from mid dry 2006 on, though there was considerable variation between animals as evidenced by the standard error bars.

Note: No male cattle data available for Aq. Junaidi – hence no figure.

Best bet farmer: Amaq Adul, Dusun Semunduk, Desa Mertak, Lombok

Main points from original interview notes

- Currently has 8 cattle. 3 cows, 2 calves, 3 bull – potential for early weaning / preferential feeding
- Wants to shift out of rice and concentrate on cattle
- Has over 1ha of unused upland beyond his crop area currently with Heteropogon and Chinese apple (Ziziphus sp) – great potential for mixed grass/ legume pasture development
- Also has a lot of unused (weed infested) upland close to household – potential forage area
- Also a permanently wet lowland area (poorly drained) – potential for forage legume cropping

Major constraints to cattle production

- Lack of good quality local forage, especially in dry season for both c/c and grazing

Calendar of existing farming system and suggested best bet options to meet constraints

<table>
<tr><td colspan="2">Activity / Land type</td><td>J</td><td>F</td><td>M</td><td>A</td><td>M</td><td>J</td><td>J</td><td>A</td><td>S</td><td>O</td><td>N</td><td>D</td></tr>
<tr><td rowspan="4">Food crops</td><td rowspan="2">Lowland (0.75ha)</td><td colspan="3">Rice, Soybean</td><td colspan="3">Soybean</td><td colspan="3">Short term forage legume to exploit wet area</td><td></td><td></td><td colspan="2">Rice, Maize, Soybean</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Upland (0.5ha)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Maize/Cotton</td><td colspan="2">Cotton</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Maize/ cotton</td></tr>
<tr><td colspan="2">Grazing area (1.25ha)</td><td colspan="12">Verano and Seca stylo for native pasture upland area across creekarea</td></tr>
</table>

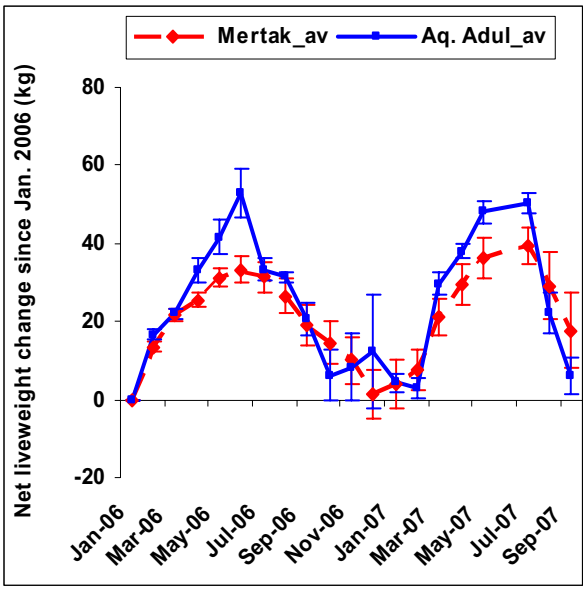
Calving / Weaning	Weaning				Weaning		Mating					
Critical feed shortage period												
On–farm cut and carry	Grass		Sesbania								Grass	
	Seteria and EG for lowland bunds – small forage bank for backyard, more Gliricidia around upland											
Off-farm residue / cut and carry										Grass, Rice (2 trucks per year)		
Conserved feed (period of use)								Rice, Soybean (not last year due to failed crop)				
Peak labour periods – Cattle										Feed collection and hand feeding		
Peak labour periods – Cropping	Harvesting										Prep and sowing	

Summary of best bet progress to February 2008

Farmer: Aq. Adul, Mertak	**Actual best bet**	**Commenced**	**2006-07 progress**	**2007-08 progress**
Best bet 1	Pasture legumes + Gliricidia hedges for Heteropogon covered upland area across creek	06-07 wet	Poor / patchy due to drought	Excellent
Best bet 2	Setaria / EG s for lowland bunds	Did it start?	Fair – drought affected	Fair – drought affected
Best bet 3	Short term forage for wet lowland cropping terraces after 2nd crop	Did not start	None	None
Best bet 4	Forage grasses and legumes for backyard forage bank	06-07 wet	fair	fair
Overall assessment	Excellent establishment of Stylos and Gliricidia hedges in 2007-08 despite poor germination and slow start due to drought in 2006-07 Farmer very keen to expand and has now planted new grasses and legumes in an adjacent area Farmer has been cutting and feeding Stylos and Gliricidia to stock since late 2007 Backyard forage bank of introduces grasses and legumes less successful due to 2007 drought Probably worth re-sowing some plots in upland grazing area as this is a potentially valuable forage resource area			
Farmer attitudes	Farmer enthusiastic to expand both mixed pastures and Gliricidia on uplands plus new grasses on bunds despite early setbacks. Also keen to intercrop Cassava with verano stylo			
Direct impacts	No measurable impact on animal production or condition (his cattle doing about average for mertak best bet farmers in terms of liveweight trends during 2006-07) but farmer reports cattle better this year despite dry conditions possibly due to increased tree legume use.			
Indirect impacts	Difficult to assess as yet. However farmer has better appreciation of value of tree legumes and pasture legumes.			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

*** Note: No forage related figures for Amaq Adul because no forage monitoring data available.*



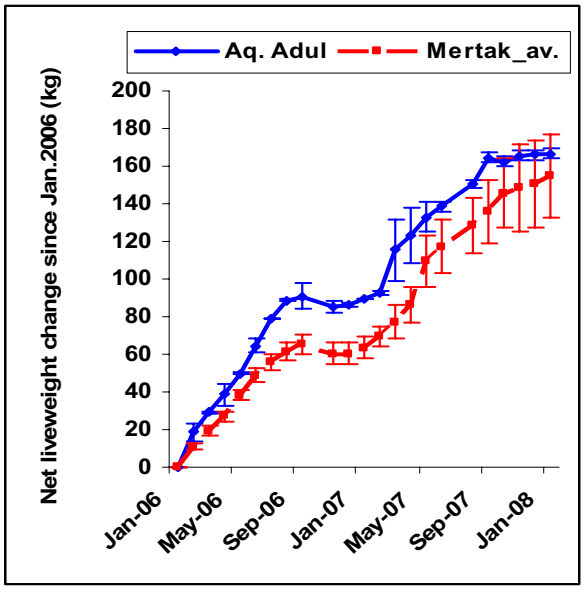


Figure 2:a. Comparison of liveweight trends of mature cows for Amaq Adul vs. the average for Mertak best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Aq. Adul's cows performed around average for Mertak best bet farmers throughout 2006 and 2007. b. Comparison of net liveweight change for Aq. Adul's young male cattle compared with average for Mertak best bet farmers. Adul's male cattle performed about average for Mertak males during 2006-07.

11.6.8 Dusun SPA, Sumbawa

Table 6 details the best bet activities originally identified for each farmer and implemented at SPA village, Sumbawa.

Table 6 best bet activities identified and implemented by SPA farmers 2005-2007

Village / farmer	New forage introduction		Better use of existing forages (tree legs and EG)		Crop residue conservation (inc. rice straw ammoniation)		Preferential feeding / early weaning	
	Identified	started	Identified	started	Identified	started	Identified	Started
SPA								
Mq. Warni	1	1	1	1	2	2		1
Saekoni	1	1	1	1	2	1	1	1
Aq. Sabri	0	1	1	1	1	0	1	1
Mq. Anti	2	1	1	1	2	0	1	0
Ahyar	1	1	1	1	2	1	1	1
Ramli	1	1	1	1	0	0	0	1
Tot.al	6	6	6	6	9	4	4	5

SPA village was originally involved in the previous ACIAR AS2/2000/135 project and though remote from other sites, was included because of its history of involvement and existing farming system and biophysical benchmark data base. However it was considered a "low level" site in terms of the degree and frequency of project contact and activity. Initially five best bet farmers were selected and interviewed in November 2005 and identified forage best bets were established during the 2005-06 wet season. Subsequently one more farmer (Ramli) was added to the best bet farmer group, in

consequence of his interest and involvement in previous forage and cattle monitoring activities. .

Due to vastly increased use of tree legumes for year round forage supply at SPA in the years following the previous ACIAR 125 project forage constraints were no longer seen as a major issue by SPA farmers (ref Dompu workshop May 2005). However farmers were interested in obtaining new grass varieties to compliment tree legume forage especially for wet season use, They were also interested in learning more about better cattle management and feeding options and increased forage production closer to households to reduce cut and carry labour demand. This is reflected in the array of best bet options identified and attempted (table 6). While some initial attempts at new forage establishment failed due to flooding on some sites in 2005-06, then dry conditions during the 2006-07 wet season, prompting re-location to backyards in, farmers attempted all the forage best bet options identified and significant forage banks of introduced grass and legumes were established by Aq. Warni, Aq, Anti and Ramli in particular. Likewise all farmers successfully attempted best bet activities related to better management and feeding of tree legumes such as Gliricidia. Three of the farmers conserved cow pea as part of best bet activities. While rice straw ammoniation was successfully demonstrated by project staff in mid 2006, with all best bet farmers participating, no farmer has since shown interest in pursuing this option. Again the reasons given mainly relate to the labour and logistics of carting and storage of rice straw, the relative abundance of high quality tree legumes as standing forage banks and the opportunity cost of using the labour involved for other forage and animal related activities.

As forage supply and quality needs are now underpinned by expanded tree legume use at SPA, with consequent impacts on cattle performance, increased trader interest and higher prices, farmers were more receptive to the idea of preferential feeding and early weaning as means of increasing growth of young males and improving the reproductive performance of cows.

Though early weaning, preferential feeding and controlled mating options were canvassed with only 4 of the best bet farmers, five farmers were practicing at least some of these options (and 3 doing all) by February 2008. Several farmers also showed interest in shifting their farming system towards greater cattle production and so were more disposed to early adoption of weaning and feeding strategies than farmers in other study villages.

The shift to minimum till cropping systems and away from use of cattle for land cultivation has also opened up options for wet season calving, which some farmers showed interest in.

The need to increase stock water supply was first identified at SPA during project 125 and one farmer (Mq. Anti) subsequently installed a small grey water recycling and storage dam in his backyard in 2002. Grey water re-cycling was promoted as an additional best bet option within project 005, especially in the drier villages of SPA and Mertak. By February 2008 most of our SPA best bet farmers had installed grey water storage areas for use as stock water. Many have been using this system for 2-3 years with no apparent negative effects.

Best bet farmer: Mamiq Warni, Dusun SPA, Dompu district Sumbawa. NTB

Main points from original interview notes

- Currently agists 6 cattle owned by someone else. Looking to buy 3 of own cattle shortly. Feels that 9 is optimal number for his operation and feed availability.
- Looking after new project bull.
- L2 rice currently unused. L1 rice used as mulch and then mulch used as cattle feed (mixed with tree legume) in late dry season.

- Cowpea residue not stored -just collected and fed direct. Cowpea 1 straw not able to be conserved as time of year is too wet. Option for cowpea 2 crop.
- Calving times not too bad. Could push back a little to get weaning before land preparation activities in November. Consider preferential feeding of weaners.
- Has very good Leucaena fences around L2.
- Progressive farmer. Recognises need for legumes in diet. Trying other species in backyard.
- Tethers cattle alongside field when working there (cropping season)
- Has L2 area opportunistically cropped with soy beans with pigeon pea intercrop – this area has potential for both legume (Gliricidia, stylo) and perennial grass (Setaria/Panicum) on bunds – also possible 2nd crop for stylo / centro in bays here
- Can control communal here and is interested to develop new forge & grazing resources.
- Backyard area is 0.5-0.75 ha, not 0.25 ha so potential for expansion of forage banks there. (stylo, Panicum , Arachis etc.)
- Farmer is one of case study group from 125 so good records of previous history

Major constraints to animal production

- Availability of high quality feed from mid to late dry. Especially cut and carry.
- Communal grazing of L2 and crop residues reduces scope for improved pasture/ shrub legume forage banks – but farmer willing to control this
- Calving and weaning a little late. Pressure on suckling cow in November/December when also being used for draught. If push back too far however the cow is heavily pregnant when ploughing field. Trade-off.
- Amount of quality, conserved forage available for feeding in dry season
- Weaners fed same material as cows
- Disease is currently a problem – SPA lost 7 cattle recently to SE. Animals being treated with injection apparently by PPL during our visit.

Best bet options suggested at interview/ farm inspection

Suggested best bet option	How option addresses constraints
Perennial grasses and legumes in 2nd land and backyard	will increase high quality forage supply in mid—late dry
More and better use of tree legumes in L2 and backyard	will increase high quality forage supply in mid—late dry and protect from grazing
Conservation of 2nd crop cow pea	increase quality forage supply and roughage for use in late dry
Harvest and conserve volunteer Glycene	increase available forage supply and roughage for use in late dry
Ammonated rice straw	utilise unused resource, provide quality roughage during late dry
Early calving/weaning/preferential feeding	takes pressure off cow during early/mid pregnancy – increases growth rate of weaners

Aq. Warni – calendar of existing farming system and best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Land 1	0.75 ha	Food crop	Sticky rice				Tobacco						Sticky rice	
			Cowpea 1	Cowpea 2									Cowpea 1	
		Grazing						Occasional tethered grazing						
		Cut and Carry		Cowpea 1 residue			Cowpea 2 residue		Grass from bunds					
Land 2	1.0 ha	Food crop	Rice (bunded, 0.5 ha)										Rice	
			Cashews (0.5 ha)											
		Grazing						Occasional tethered grazing						
		Cut and Carry							Banana stem / Cashew apple / grass from bunds					
								Leucaena / Gliricidia from living fences and bunds						
							Perennial grasses and tree legumes on bunds (Gliricidia and Leucaena fence exists to exclude other cattle)							
B.Yard	0.25 ha	Grazing	Tethered in evening at least. No preferential feeding of calves.											
		Cut and Carry				Stylo, Panicum		Gliricidia / Leucaena						
Cattle breeding						Calving			Mating			Weaning & preferential feeding		
Conserved feed (period of use)								Ammoniated rice straw from L2 (prioritise for cows)						
								Cowpea 2 residue (prioritise for calves)						
						Dry and store Glycine during early dry								
											Soybean (poor quality?)			
Peak labour periods			Rice										Rice	
Off-farm residue / cut and carry														

Summary of best bet progress to February 2008

Farmer: Mq. Warni, SPA	Actual Best Bet	Commenced	2006 progress	2007 progress
Best bet 1	Perennial grasses and legumes in 2nd land and in backyard	05-06 wet season	successful	Excellent - expanding
Best bet 2	More and better use of tree legumes in L2 and backyard	05-06 wet season	successful	Excellent - expanding
Best bet 3	Harvesting and conservation of 2nd crop cow pea	06 season	successful	successful
Best bet 4	Harvest and conserve volunteer Glycene	06 season	successful	successful
Best bet 5	Ammonated rice straw	06 season	successful demo	not repeated
	Early /weaning/preferential feeding	06-07 season	Not started	good start

Overall assessment	Farmer implemented everything we suggested on his bet bet list, including forage bank establishment, increased planting and use of Gliricidia and Leucaena, early weaning and preferential feeding, crop residue conservation (including rice straw ammoniation and cow pea residue conservation) and use of recycled water for cattle. Farmer conserved some cow pea from land 1 - worked well - will continue. Has strengthened and expanded Gliricidia fences around land 1 and 2 areas and 600m of new fences in upland block in 06-07 wet Rice straw ammoniation demonstration worked well and cattle consumed it OK but said he is unlikely to pursue it as he has plenty of other forage now.
Farmer attitudes	Farmer very enthusiastic about forage/animal technologies and has become a mentor and champion for promotion of these within SPA and beyond.
Direct impacts	He says that his cattle condition is better now than before he started best bets. Cow liveweight data appear to support this with Mq. Warni's cows doing a little better than SPA average especially in 2007. However this is not reflected in data for young males in 2006. 2007 data less reliable due to infrequent weighing and high turnover of cattle between weighings at SPA. His cattle now attract a premium price compared to surrounding villages and buyers now seek out his cattle for purchase. As a result his income from cattle has increased significantly. He sold 3 cattle since project started for twice as much as he would have received before project. Less labour spent shifting cattle for tether grazing Farmer now has adequate good quality forage year round Farmer has bought a horse and cart with proceeds of increased cattle sales to cart forage and other goods
Indirect impacts	Better cattle and feed management and appreciation of value of legumes in feed mix Appreciation of value of preferential feeding of young stock and early weaning as essential part of package Mq. Warni's senior position in SPA influences other villagers to adopt 005 best bet technologies

Relevant graphical summaries of best bet impacts on forage use and cattle performance

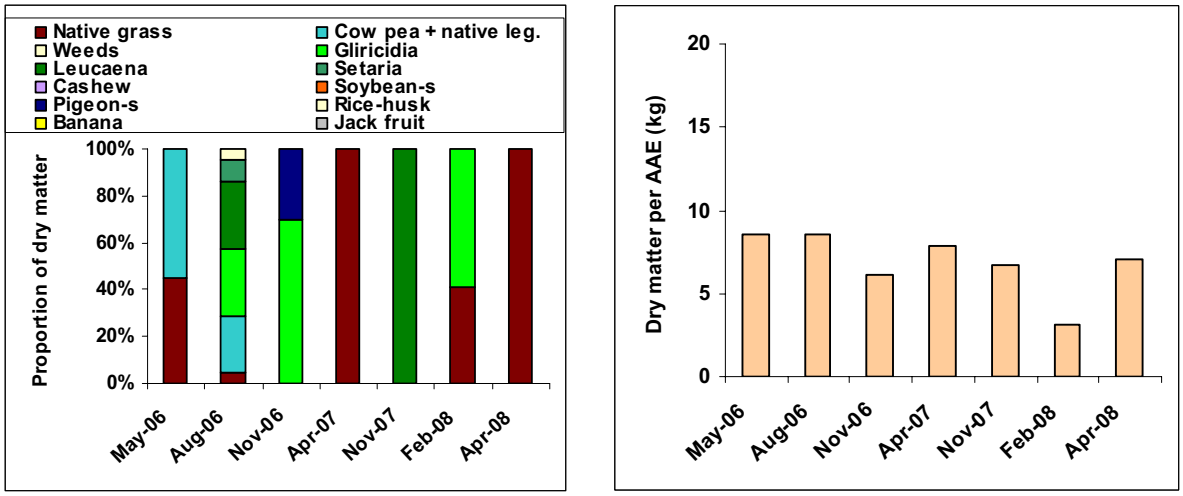


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Mamiq Warni, SPA between May 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Mq. Warni's cattle are receiving around adequate maintenance levels of dry matter for most of the year from cut and carry forage except in Feb. when busy with crop harvest. He also does some grazing in his L2 upland (especially cows) in wet season. Fig 1a. shows he uses a range of cut and carry forages including native legume, cow pea, pigeon pea, Leucaena, native and introduced grasses. Though he has a significant new forage bank of grasses he is saving most of this for planting material.

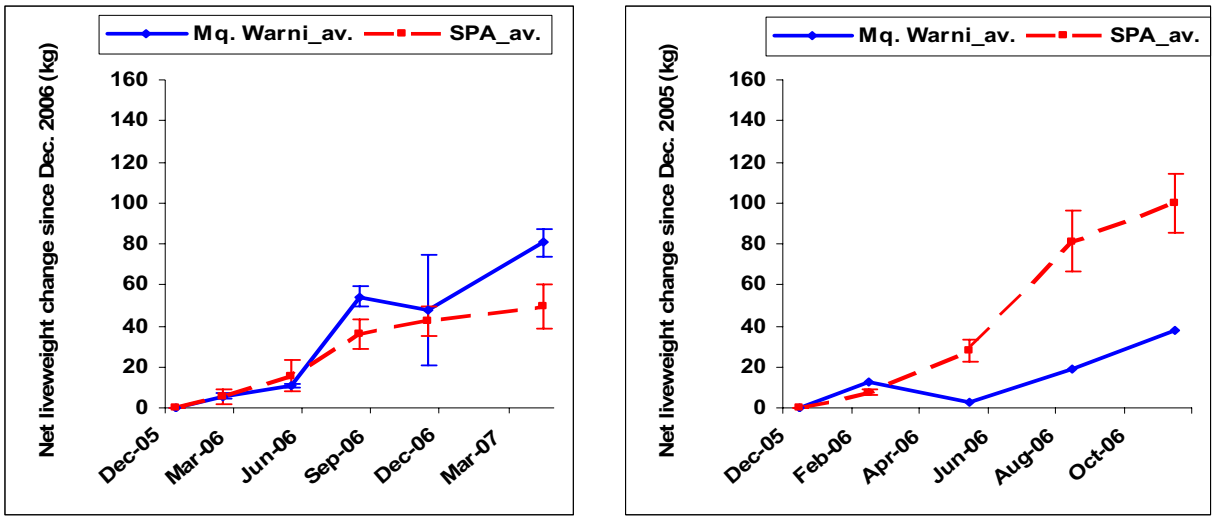


Figure 2: a. Comparison of liveweight trends of mature cows for Mamiq Warni vs. the average for SPA best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Mamiq Warni's cows performed around average for Mertak best bet farmers throughout 2006 but pulled away in 2007. b. Comparison of liveweight trends of young male cattle for Mamiq Warni vs. the average for SPA best bet farmers for the study period Dec. 2005 to December 2006. Data (means and standard errors) show Mamiq Warni's young male sapi performed far worse than SPA best bet farmer average throughout 2006, hardly gaining any liveweight. Unfortunately little reliable cattle data exists for young male cattle in 2007 due to frequency of sales and sporadic weighing. However farmer reports his young early weaned males did very well during 2007.

Best bet farmer: Saekoni, Dusun SPA, Dompu district, Sumbawa. NTB

Main points from original interview notes

- Cowpea crop tried recently but failed – prepared to try again.
- Shaun – I actually had Saikoni with 2 parcels of L2 land which were completely fenced with Gliricidia – probably the same areas you have in L1
- Free grazing now commonplace (change from 125). Basically any crop residue or cattle feed is free game for anyone. Ownership only seems to apply to harvestable product and cattle. Backyard also restricted to owners.
- Establishing forage banks in L1 and L2 is difficult as a result. Needs strong fence to exclude grazing stock but cut and carry is still potentially removed. We did hear from Anti that if you fenced off an area and visited it every other day, ownership would be respected!.
- Has 2 cows and 2 calves currently. Owns another 5 cows and 2 calves that others look after.
- Feels that current cattle number is the maximum he can handle – labour constrained.
- Appears to have plenty of feed.

Major constraints to animal production

- Communal grazing of L2 and crop residues constrains pasture development or conservation use of 2nd crop residue. Farmer doesn't think he can do anything to control this – a major constraint to pasture forage development
- Has L2 land fenced with Gliricidia but not cattle proof – farmer doesn't think he can exclude other cattle with Gliricidia fences
- Labour constraints to increasing cattle numbers

- Forage resources limited in late dry

Best bet options suggested at interview/ farm inspection

Originally suggested best bet option	How best bet option addresses constraints
Harvesting and conservation of 2nd crop cow pea	will increase available quality forage supply and roughage for use in late dry
Ammonated rice straw	utilises unused resource, provides better quality roughage during mid-late dry
Early calving/weaning/preferential feeding	takes pressure off cow during early/mid pregnancy – increases growth rate of weaners
Additional forage best bets added Nov 06	
More and better use of tree legumes in L2	will increase high quality forage supply in mid—late dry and protect from grazing
Perennial grasses and legumes in 2nd land	will increase high quality forage supply in mid—late dry

Saekoni - calendar of existing farming system and best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Lowland	5 parcels 3 rented 2 cultivated 3.5ha total	Food crop	Rice (1.5ha)			Cowpea (0.3ha)							Rice	
		Grazing							Free grazing (brought back to house each night and fed Gliricidia)					
		Cut and Carry	Grass						Gliricidia fences around both parcels. 1 month rest between cuts.				Grass	
Upland	None	Food crop												
		Grazing												
		Cut and Carry												
Backyard	0.25ha	Food Crop												
		Grazing	Tethered in evening at least.											
		Cut and Carry	Small amount of leucaena for convenient feeding at any time of year (minor source)											
Cattle breeding							Earlier Calving		Earlier Mating				Weaning & preferential feeding	
Off-farm cut and carry														
Off-farm grazing									Free grazing					
Conserved feed (period of use)									Ammoniated rice straw					
									Cowpea residue					
Peak labour periods			Rice										Rice	

Summary of best bet progress to February 2008

Farmer: Saekoni, SPA	Actual best bet	Commenced	2006 progress	2007 progress
Best bet 1	Harvesting and conservation of 2nd crop cow pea	05-06 wet	Successful	Not done
Best bet 2	Ammonated rice straw	not done	Not attempted	Not attempted
Best bet 3	Early calving/weaning/preferential feeding	06-07 wet	Not attempted	Good start
Best bet 4	More and better use of tree legumes in L2	05-06	Successful	Successful
Best bet 5	Perennial grasses and legumes in 2nd land	06-07	Not yet attempted	Partly successful
Overall assessment	Farmer started best bet program by strengthening and expanding Gliricidia fences to protect crop residues from communal grazing. Enclosed L2 cow pea area with new gamal fence (1075m) but did not conserve cowpeas as too far to bring home but didn't conserve cow pea as too far away – Instead kept and grazed later. He also started feeding much more Gliricidia and Leucaena preferentially to young cattle with other farmers Planted new L2 forage bank. Did early weaning / preferential feeding but not controlled mating/earlier calving. In 06-07 wet he planted introduced forages in upland plot – partly successful During 06-07 he bought additional young grower cattle to feed in his backyard kandang He also started early weaning his own calves in 2007			
Farmer attitudes	Farmer very enthusiastic about 005 forage/animal technologies and has become a mentor and champion for promotion of these within SPA and beyond.			
Direct impacts	Monitoring data show the extent of tree legume use in dry season 2006 and 2007. Cut and carry dry matter adequate for maintenance and growth. No measurable impact on cattle performance through feeding new and existing forages as yet – liveweight data shows his cows doing about average for SPA best bet farmers. No reliable liveweight data available to compare young male performance. Less labour spent shifting cattle for tether grazing Farmer now has adequate good quality forage year round Farmer bought a new motor bike in 2007 with proceeds of increased cattle sales Farmer now wants to buy more cows to increase own calf production			
Indirect impacts	Better cattle and feed management and appreciation of value of legumes in feed mix Appreciation of value of preferential feeding of young stock and early weaning as essential part of package Farmer recognises the opportunity to switch farming emphasis to more cattle production with a steadier income			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

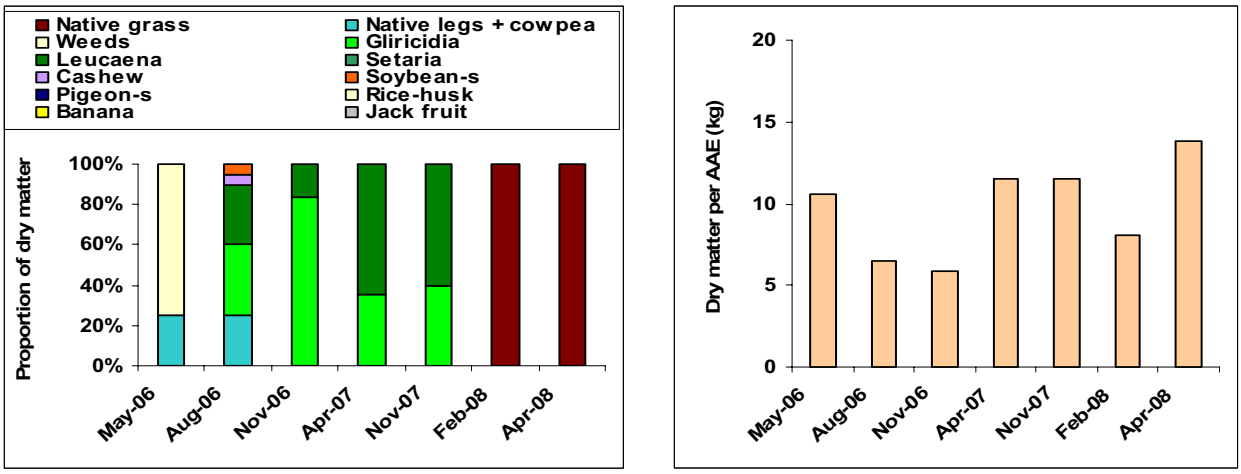


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Saekoni, SPA between May 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Saekoni's cattle are receiving adequate maintenance levels of dry matter for most of the year from cut and carry forage except in Feb. when busy with crop harvest. Fig a. shows he uses a range of cut and carry forages, predominantly native grass during the wet season then mainly tree legumes during the dry season supplemented by conserved cow pea and native legume in the early dry. Though he has small new forage bank of grasses he is saving most of this for planting material so they do not appear yet in cut and carry forage data.

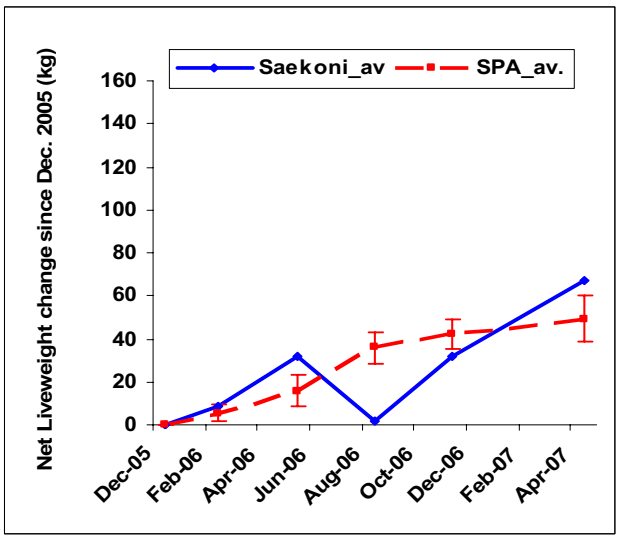


Figure 2: Comparison of liveweight trends of mature cows for Amaq Saekoni vs. the average for SPA best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Saekoni's cows performed around average for SPA best bet farmers throughout 2006 but pulled away in 2007. There was no data available for young males for Saekoni.

Best bet farmer: Lalu Sabruddin (Amaq Sabri), Dusun SPA, Dompu district, Sumbawa.

Main points from original interview notes

- 2nd Land 2 no use to him - given/sold to his brother.

- Currently has 3 cows, 2 calves and 1 heifer
- Wants to increase cow (breeding herd) number but is limited by water. Lactating cow needs about 20L per day as minimum. Is recycling household water already.
- Calves every year he reckons.
- Involved in last project.
- Currently uses rice straw as mulch for 2nd crops
- His cattle were weighed as part of 125 – can check live weight trends to view previous performance
- Not sure if calving/mating times are his or general village aspiration as answer was consensual between farmers present at interview
- Farmer says water is a major constraint to increasing livestock numbers

Major constraints to animal production

- Water supply for livestock
- Availability of high quality forage in late dry
- No 2nd land on which to expand shrub legume or sown pasture forage
- Communal grazing of L1 and crop residues after harvest

Best bet options suggested at interview/ farm inspection

Originally suggested best bet option	How best bet option addresses constraints
Establishing forage bank within L1 area currently fenced off with Gliricidia fences	will provide additional high quality C/C forage during dry season
Retaining and conserving 2nd crop cow pea residue	will provide high quality roughage for feeding during late mid-dry season
Ammonated rice straw	utilises unused resource, provides better quality roughage during mid-late dry
Early calving/weaning/preferential feeding	takes pressure off cow during early/mid pregnancy – increases growth rate of weaners
Provision of backyard water storage / recycling of household grey water	could help overcome existing water shortage constraint to livestock production

Aq. Sabri - calendar of existing farming system and best bet options to meet constraints

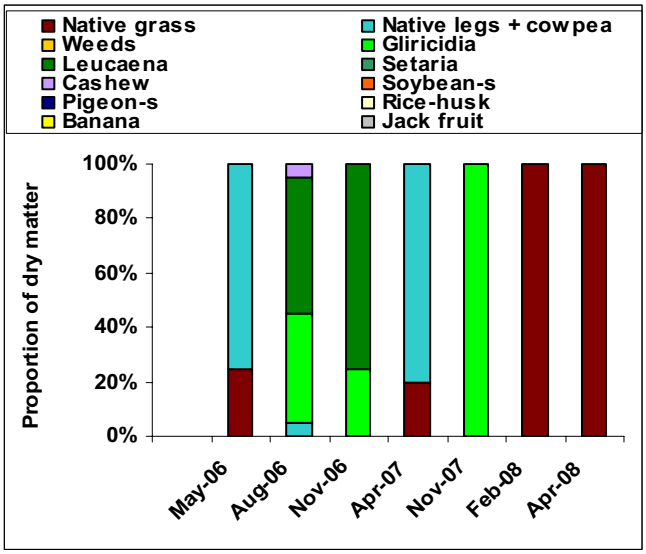
Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Land 1	0.75 ha	Food crop	Rice (0.4 ha)		Cowpea								Rice	
			Cashews (0.35 ha)											
		Grazing	Fenced-off and establish forage bank of cut and carry forage species for feed conservation. Reduced likelihood of other farmers removing as plenty of other feed available											
		Cut and Carry			Gliricidia Leucaena			Gliricidia Leucaena		Cashew apple	Gliricidia Leucaena		Grass	
B.Yard	0.25 ha	Grazing	Tethered in evening at least. No preferential feeding of calves.											
		Cut and Carry											Grass	
			Small amount of leucaena for convenient feeding at any time of year (minor source)											

Conserved feed (period of use).							Cowpea residue (weaners) Land 1 forage (weaners) Ammoniated rice straw (cows)						
Cattle breeding					Calving		Mating					Weaning & preferential feeding	
Off-farm grazing						Free grazing							
Off-farm cut and carry				Gliricidia Leucaena								Grass	
Peak labour periods	Rice											Rice	

Summary of best bet progress to February 2008

Farmer: Aq. Sabri, SPA	Actual best bet	Commenced	2006 progress	2007 progress
Best bet 1	Establishing forage bank within L1 area currently fenced off with Gliricidia fences	2005-06	Little	Some
Best bet 2	Retaining and conserving 2nd crop cow pea residue	Not sure	Not sure	Not sure
Best bet 3	Ammonated rice straw	Not started	none	none
Best bet 4	Early calving/weaning/preferential feeding	Not yet	none	none
Best bet 5	Provision of backyard water storage / recycling of household grey water	Not yet?	?	?
Overall assessment	Farmer has done a little additional planting and strengthening of Gliricidia fences but not much. Failed to successfully establish new forages in either year. Started early weaning/ pref feeding in 2006 – working. He leaned from Aq. Ahyar that a good kandang is better for feeding. He has also planted Setaria in backyard, with material obtained from other farmers. While he still thinks calves stressed for the first 2-3 weeks he says they soon get over it and cows respond well in terms of improved condition. No progress on recycling household water yet			
Farmer attitudes	Farmer not really motivated to adopt new forage and animal feeding and breeding options though still participating in cattle monitoring program and using a lot of tree legume through dry season fed in backyard kandang			
Direct impacts	early weaning / preferential feeding working really well - has early weaned 10 calves since 2006. He says there has been a noticeable increase in cattle condition and especially coat colour. Also big increase in growth rates leading to higher prices and more cattle sold since project began (no figures recorded). This has resulted in higher household income. He says SPA cattle now No. 1 with cattle buyers. He says cattle responding to increase in Gliricidia feeding in backyard kandang, but this is not reflected in cattle liveweight performance, with farmer's cows about average for SPA best bet farmers. No data available to compare performance of male cattle for Aq. Sabri.			
Indirect impacts	While farmer hasn't taken up specific identified best bet options he has benefited from increased understanding of the value of tree legumes in dry season diet and using these to preferentially feed younger cattle in backyard kandang			

Relevant graphical summaries of best bet impacts on forage use and cattle performance



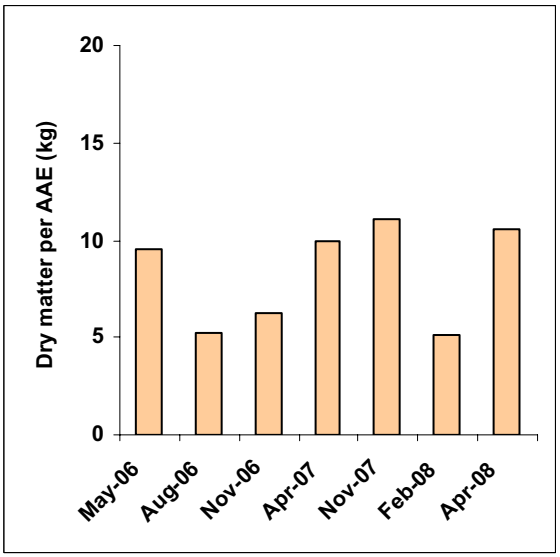


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. the amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Lalu Sabri, SPA between May 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Lalu Sabri's, cattle are receiving adequate maintenance levels of dry matter for most of the year from cut and carry forage except in Feb. when busy with crop harvest. Fig 1a. shows he uses a range of cut and carry forages, predominantly native grass during the wet season then mainly cow pea standing residue and native legume forage in early dry and tree legumes during the late dry season. Though he has small new forage bank of grasses he is saving most of this for planting material so they do not appear yet in cut and carry forage data.

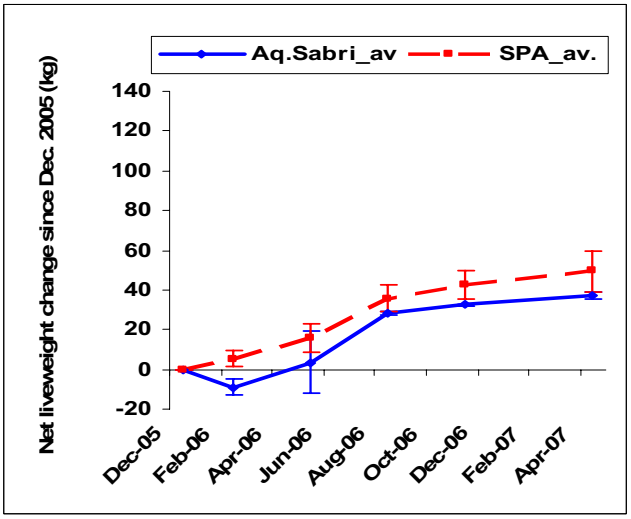


Figure 2: Comparison of liveweight trends of mature cows for Lalu Sabri vs. the average for SPA best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Lalu Sabri's cows performed slightly below the average for SPA best bet farmers throughout 2006-07. There was no data available for young males for Lalu Sabri.

Best bet farmer: Mamiq Anti, Dusun SPA, Dompu district, Sumbawa.

Main points from original interview notes

- No grazing for this farmer – backyard most of time and fed cut and carry.
- Currently has 1 cow and 1 calf. Recently sold 10 head for Haj.
- Major constraint to increasing stock number is water. Does recycle household water.
- Maximum cow number thought to be 4 due to water limitation. Has enough labour and feed!!.
- After Haj will buy cattle to build up herd again.
- Trialled Arachis, Stylo etc in cashew field during 125 trial (has some left)

Major constraints to animal production

- Water supply for livestock. Farmer reckons he has enough forage, but probably still not meeting livestock growth needs in dry
- Communal grazing of L2 and crop residues limits effective use of L1 crop residues or L2 cut and carry or grazed mixed pasture resource as no control over use by other farmers – However he has good Gliricidia fences around L2 land and is prepared to control this use.
- Though M. Anti is currently storing and using household grey water for stock, he feels water is a still a major constraint to increasing livestock production.

Best bet options suggested at interview/ farm inspection

Originally suggested best bet option	How best bet option addresses constraints
Establishment of improved perennial grasses / shrub legumes on bunds and pasture legumes under cashews in 2nd land	will increase high quality forage supply in mid—late dry, allowing delayed harvesting of shrub legume fence resource
Harvesting and conservation of 2nd crop cow pea	will increase available quality forage supply and roughage for use in late dry
Ammonated rice straw	utilises unused resource, provides better quality roughage during mid-late dry
Early calving/weaning/preferential feeding	takes pressure off cow during early/mid pregnancy – increases growth rate of weaners
Additional forage best bets added Nov 2006	**How best bet option addresses constraints**
Perennial grasses and legumes for backyard forage bank	will increase high quality forage supply in mid—late dry

Mq. Anti - calendar of existing farming system and best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Land 1	0.75 ha	Food crop	Rice (0.75ha). Straw retained in field			Cowpea							Rice	
		Grazing												
		Cut and Carry	Leucaena and Gliricidia fences											
Land 2	2 ha	Food crop	Rice (0.5ha). Straw used as tobacco mulch			Tobacco (0.04ha only)							Rice	
			Cashews (1.5ha)											
		Grazing							Fenced off improved pasture (Arachis etc.)					

									in cashew field (will 'guard' area to prevent others using					
		Cut and Carry	Leucaena and Gliricidia fences											
B Yard	0.25 ha	Grazing	Tethered in evening at least. No preferential feeding of calves.											
		Cut and Carry	Small amount of Gliricidia for convenient feeding at any time of year (minor source)											
Cattle breeding							Calving		Mating				Weaning & preferential feeding	
Conserved feed (period of use)									Cowpea residue					
									Ammoniated rice straw					
Off-farm cut and carry			Leucaena and Gliricidia fences (no regular times available)											
Off-farm grazing														
Peak labour periods			Rice										Rice	

Summary of best bet progress to February 2008

Farmer: Mq. Anti, SPA	Actual best bet	Commenced	2006 progress	2007 progress
Best bet 1	Establishment of improved perennial grasses / shrub legumes on bunds and pasture legumes under cashews in 2nd land	05-06 wet	Unsuccessful	Abandoned
Best bet 2	Harvesting and conservation of 2nd crop cow pea	06 season	good	Not done
Best bet 3	Ammonated rice straw	Not started	none	None
Best bet 4	Early calving/weaning/preferential feeding	06-07?	Feeding only	Feeding only
Best bet 5	Perennial grasses and legumes for backyard forage bank	06-07 wet5	Not started	good
Overall assessment	Original area for new forages flooded and adjacent upland site unsuccessful. Established good backyard forage bank in 06-07 wet. Farmer has also conserved cow pea in both years as planned and planted more Gliricidia around backyard and elsewhere. Some preferential feeding but little progress on early weaning yet. Did not conserve cow pea residue (due to labour involved) but grazed it directly as standing crop. Will continue growing new forages but shift his forage and cattle operations to L2 now he has secure gamal fences in place. Main reason for shifting from backyard is additional space and to avoid other cattle graze his backyard forages while he works his crops. Plans to establish up to 0.25ha forage bank with kandang facility in L2. He plans to grow mainly Setaria, Clitoria, Seca Stylo and Arachis. He currently has sufficient forage to support 3 sapi but intends expanding to 8 sapi (3 cows) when L2 area established.			
Farmer attitudes	Farmer still enthusiastic though sometimes slow to adopt new ideas or commit resources. Gradually rebuilding cattle numbers after selling 11 for Haj in 2005. Mq. Anti was first SPA farmer to use recycled household water for stock			
Direct impacts	Mq. Anti's one male sapi performed about average for SPA best bet farmers cattle during 2006-07.			
Indirect impacts	Participation in best bet program has raised farmer's awareness of need for better cattle feeding practices, value of tree legumes and opportunities for increasing cattle production in farming system.			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

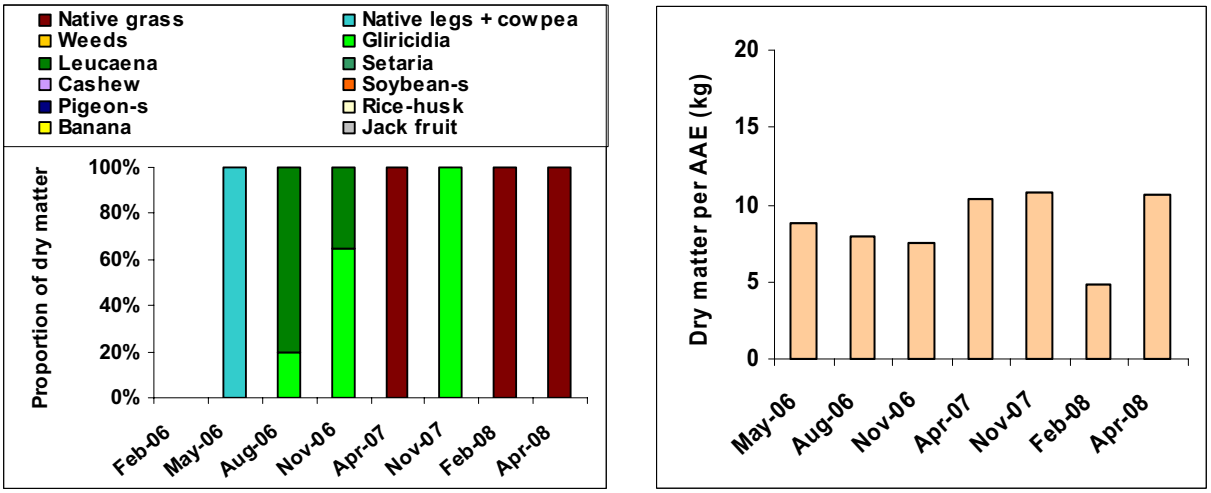


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Mamiq Anti, SPA between May 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Mamiq Anti's cattle are receiving adequate maintenance levels of dry matter for most of the year from cut and carry forage except in Feb. when busy with crop harvest. Fig a. shows he uses a range of cut and carry forages, predominantly native grass during the wet season, cow pea standing residue plus native legumes in early dry, then mainly tree legumes during the dry season. Though he has small backyard forage bank of grasses and legumes he is saving most of this for planting material to expand in upland so they do not appear yet in cut and carry forage data. Farmer has significantly expanded his Gliricidia hedges in 2007-08 wet season.

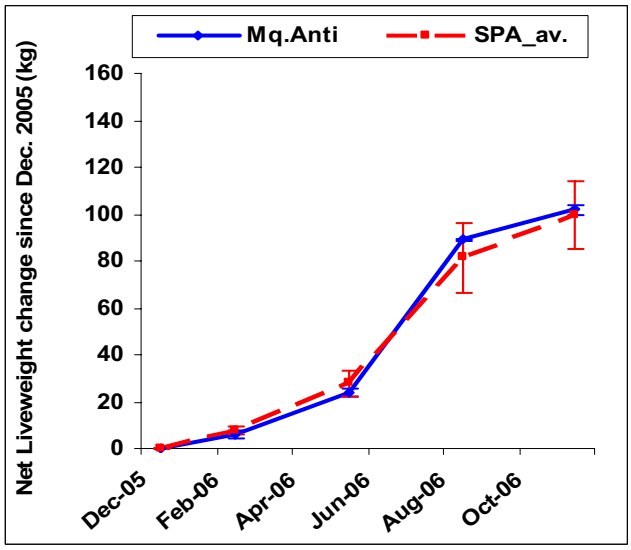


Figure 2: Comparison of liveweight trends of young male cattle for Mamiq Anti vs. the average for SPA best bet farmers for the study period Dec. 2005 to December 2006. Data (means and standard errors) show Mamiq Anti's young male cattle performed far better than SPA best bet farmer average throughout 2006, gaining almost 150kg in 12 months or just over 0.4kg per day compared to SPA best bet average of around 0.27 kg/head/day.

Best bet farmer: Amaq Ahyar, Dusun SPA, Dompu district, Sumbawa.

Main points from original interview notes

- Soybean residue too wet to conserve
- Currently has 2 cows, 1 heifer and 2 calves
- Already calving in April and mating in July, weaning between Oct and break on rainy season (possibility of weaning prior to ploughing time)

Major constraints to animal production

- Unable to utilise soy bean residue as still to wet to conserve at harvest
- Limited current supply of Gliricidia fences
- Has no L2 land to expand forage banks (pasture or shrub hedgerow legumes)

Best bet options suggested at interview/ farm inspection

Originally suggested best bet option	How best bet option addresses constraints
Increase in Gliricidia and Leucaena fenced area	provide additional quality dry season cut and carry forage
Harvesting and conservation of 2nd crop cow pea	will increase available quality forage supply and roughage for use in late dry
Ammonated rice straw	utilises unused resource, provides better quality roughage during mid-late dry
Early calving/weaning/preferential feeding	takes pressure off cow during early/mid pregnancy – increases growth rate of weaners
Perennial grasses and legumes for L2 forage bank	will increase high quality forage supply in mid—late dry

Mq. Anti - calendar of existing farming system and best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Land 1	3 parcels totalling 2.25 ha	Food crop	Rice (0.75ha). Straw retained in field		Cowpea								Rice	
			Soybean and sesame										Soybean and sesame	
		Feeding system	Tethered + cut & carry		Tethered								Tethered + cut & carry	
		Cut and Carry	Grass					Increase Gliricidia as a fence around other parcels of land					Grass	
B. Yard	0.25 ha	Feeding system	Tethered in evening at least. No preferential feeding of calves.											
		Cut and Carry	Small amount of Gliricidia and Leucaena for convenient feeding at any time of year (minor source)											
Cattle breeding						Calving		Mating				Weaning. Introduce preferential feeding		
Conserved feed (period of use)								Cowpea residue						
								Ammoniated rice straw						
Off-farm cut and carry			Grass						Gliricidia and Leucaena				Grass	
Peak labour periods			Rice										Rice	

Summary of best bet progress to February 2008

Farmer: Aq. Ahyar, SPA	Actual best bet	Commenced	2006 progress	2007 progress
Best bet 1	Increase in Gliricidia and Leucaena fenced area	05-06 wet	Good	good
Best bet 2	Harvesting and conservation of 2nd crop cow pea	05-06 wet	good	good
Best bet 3	Ammonated rice straw	Not started	none	none
Best bet 4	Early Calving weaning, preferential feeding	06-07	Some pref feeding	Good feeding & weaning?
Best bet 5	Perennial grasses and legumes for L2 forage bank	06-07 wet	Not yet started	fair
Overall assessment	Farmer has built backyard kandang to preferentially feed young cattle and planted new forages in upland forage bank (mixed success). Rice straw ammoniation not tried individually by farmers but they participated in a one-off demonstration. Did not conserve cowpeas as too far to bring home, but fed directly to sapi in the field as grazed crop residue. Start early weaning/ pref feeding in 2006/07. He enclosed 1.5 ha of L1 with 600m of additional gamal fence. Added L2 forage bank establishment in 06/07 but planted too late so poor establishment. He says he feeds gamal year round but only feed the older leaves in the wet season (reason unclear).			
Farmer attitudes	Farmer still very enthusiastic about whole forage / cattle feeding and management package Also keen to switch more to cattle based farming system			
Direct impacts	Aq. Ahyar's one male sapi performed significantly better than the SPA best bet average through 2006-07, due to the preferential feeding of high quality cut and carry diet of tree legumes, cowpea, soybean residue and new grasses, especially through the dry season. Spent 2 days / week travelling to Dompu, Pupak and also Taloko (8 km away) to gather forage (mainly native grass and soy bean residue) in addition to daily tethered grazing and local C/C collection. Now spends 2-3 hours/ day in dry season and 2 hours / day in wet season on cut and carry. He now produces enough gamal to support 6 cattle (including 2 cows + project bull) year round. He also share farms 6 other cattle with 3 farmers. Has reduced his cropping area from 3ha of rice to 1.5 ha rice and 1ha maize and shifted some labour from cropping to cattle which he considers more profitable.			
Indirect impacts	Participation in best bet program has raised farmer's awareness of need for better cattle feeding practices, value of tree legumes and opportunities for increasing cattle production in farming system.			

Relevant graphical summaries of best bet impacts on forage use and cattle performance

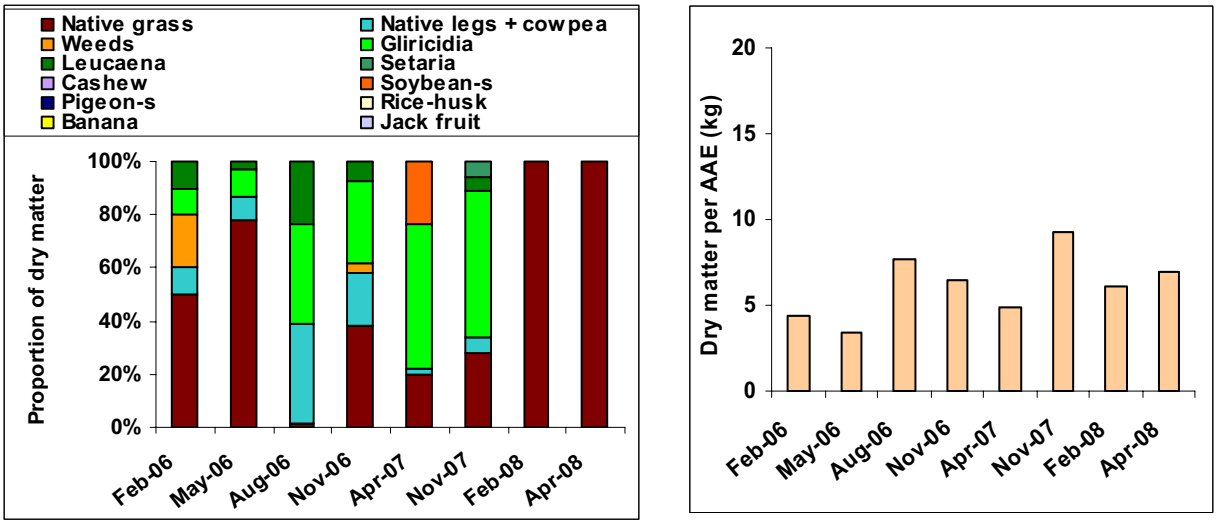


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Amaq Ahyar, SPA between May 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Amaq Ahyar's cattle are receiving close to maintenance levels of from cut and carry forage dry matter for most of the year. Fig a. shows he uses a range of cut and carry forages, predominantly mixed native pasture forage during the wet season, cow pea standing residue plus native legumes plus tree legumes in early dry, then mainly tree legumes and some soy bean residue during the dry season. Though he has small new forage bank of grasses he is saving most of this for planting material so only small amounts of mainly Setaria appear in forage monitoring data in dry season 2007.

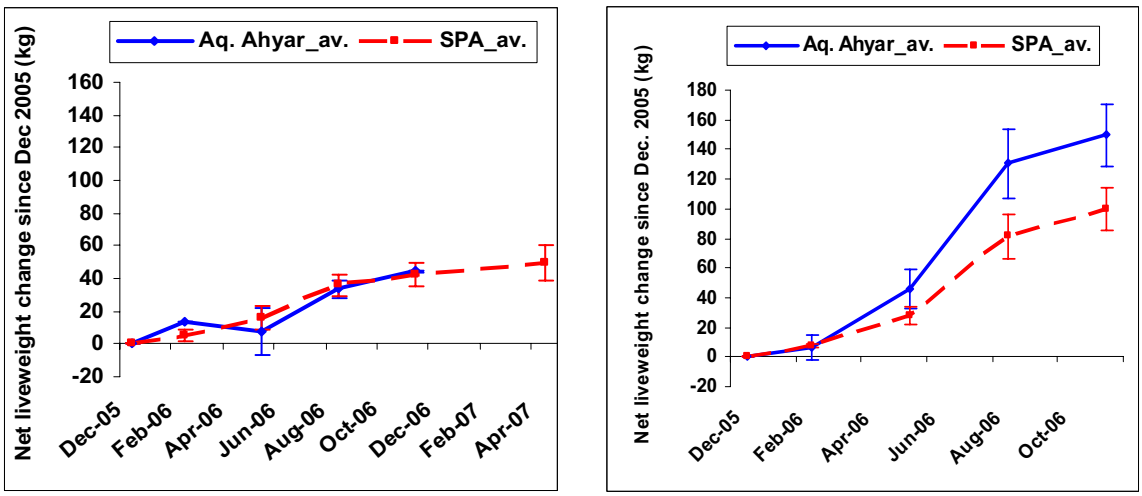


Figure 2: a. Comparison of liveweight trends of mature cows for Amaq Ahyar vs. the average for SPA best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Amaq Ahyar's cows performed around average for Mertak best bet farmers throughout 2006. No reliable data is available for 2007. b. Comparison of liveweight trends of young male cattle for Amaq Ahyar vs. the average for SPA best bet farmers for the study period Dec. 2005 to December 2006. Data (means and standard errors) show Amaq Ahyar's young male sapi performed around average SPA best bet farmer average throughout 2006. No reliable data is available for 2007 due to frequent turnover of young males and infrequent weighing.

Best bet farmer Ramli, Dusun SPA, Dompu district, Sumbawa.

Major constraints to animal production

- Limited access to high quality dry season forage
- Limited current supply of Gliricidia fences
- L2 land a long way away – difficult to develop forage bank there

Best bet options suggested at interview/ farm inspection

Originally suggested best bet option	How best bet option addresses constraints
Establish backyard forage bank of grasses & legumes	will increase high quality forage supply in mid-late dry
Increase in Gliricidia and Leucaena fences around backyard and L2	will provide additional high quality dry season cut and carry forage
Harvesting and conservation of 2nd crop cow pea and native Glycene	will increase available quality forage supply and roughage for use in late dry
Ammonated rice straw	utilises unused resource, provides better quality roughage during mid-late dry
Early calving/weaning/preferential feeding	takes pressure off cow during early/mid pregnancy – increases growth rate of weaners

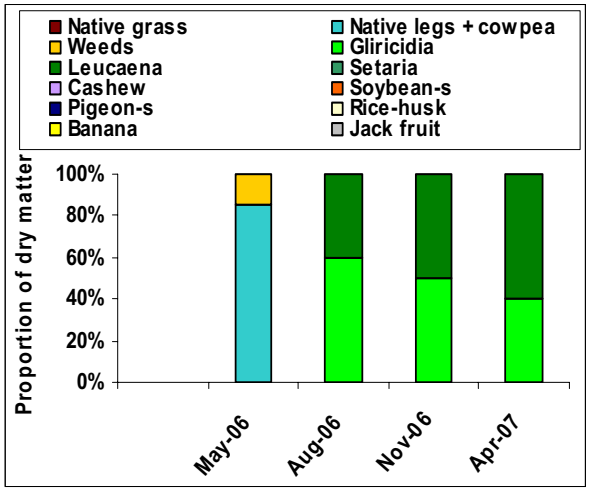
Ramli - calendar of existing farming system and best bet options to meet constraints

Land type	Area (ha)		J	F	M	A	M	J	J	A	S	O	N	D
Land 1	0.75ha	Food crop	Rice (0.75ha). Straw retained in field			Mung bean residue – conserve for dry season use							Rice	
		Grazing												
		Cut and Carry	Leucaena and Gliricidia fences											
Land 2	2ha	Food crop	Rice (0.5ha). Straw used as tobacco mulch		Tobacco (0.04ha only)								Rice	
			Cashews (1.5ha)											
		Grazing												
		Cut and Carry	Leucaena and Gliricidia fences											
B. Yard	0.25ha	Grazing	Tethered in evening at least. No preferential feeding of calves.											
		Cut and Carry	Establish backyard forage bank of new grasses and legumes + tree legumes											
Cattle breeding							Calving		Mating				Weaning & preferential feeding	
Conserved feed (period of use)									Cowpea residue					
									Ammoniated rice straw					
Off-farm cut and carry			Leucaena and Gliricidia fences (no regular times available)											
Off-farm grazing														
Peak labour periods			Rice										Rice	

Summary of best bet progress to February 2008

Farmer: Ramli, SPA	Actual Best Bet	Commenced	2006 progress	2007 progress
Best bet 1	Establish backyard forage bank of grasses and legumes	06-07 wet	Not started	Very good
Best bet 2	Increase in Gliricidia and Leucaena fences around backyard and L2	07-07 wet	Not started	Very good
Best bet 3	Harvesting and conservation of 2nd crop cow pea and native Glycene	07-07 wet	Not started	Very good
Best bet 4	Ammonated rice straw	Not attempted	none	none
Best bet 5	Early calving/weaning/preferential feeding	07-07 wet	Not started	Pref feeding only
Overall assessment	Ramli joined best bet program in 2006-07. He successfully established a backyard forage bank of grasses and legumes fenced with Gliricidia. He also harvested and conserved cow pea crop residue and exploited his tree legume fences in L1 and L2 land. He moved to full cut & carry in 06-07 and built a backyard kandang where he fed up to 90% Gliricidia and Leucaena at times through both wet and dry seasons. Farmer was keen to switch calving time to early wet (as no need for cows as draught animals now) but has since sold all his cattle to buy a car (partly with cattle sales proceeds) and is working in Lombok .			
Farmer attitudes	Young farmer, very enthusiastic to adopt new technology and concentrate on cattle production. Has benefited significantly from involvement with best bet program. Has left SPA but plans to return to cattle raising in the future. Plans to work part time as trader and part time as farmer. Will keep 2 cows and raise calves as revenue source			
Direct impacts	Body condition also much better – shiny coats, high condition scores. Buyers showed great interest in his cattle. He says resulting higher cattle prices. Cattle liveweight data show that while his cow performed about average for SPA his young male cattle performed considerably better than SPA average, growing at over 0.3kg/head/day for 9 months before being sold. His 0.05ha backyard forage bank plus high use of tree legumes, especially gamal contributed substantially to him being able to grow and sell 8 young male sapi over 2 years. Farmer sold all his cattle to buy car and moved to Lombok but plans to return to farming at SPA			
Indirect impacts	Participation in best bet program has raised farmer's awareness of need for better cattle feeding practices, value of tree legumes and opportunities for increasing cattle production in farming system. Through his trading activities he has spread forage material and best bet knowledge around Sumbawa and Lombok			

Relevant graphical summaries of best bet impacts on forage use and cattle performance



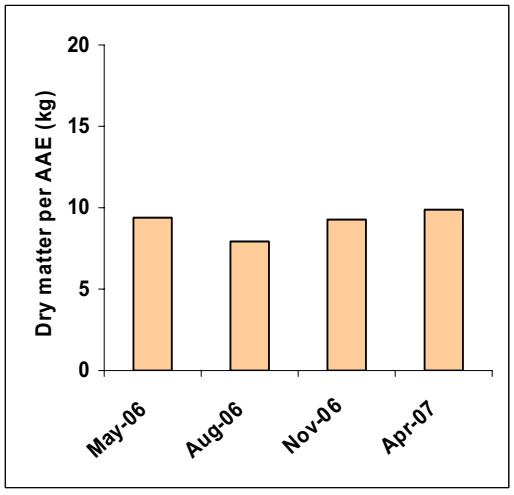
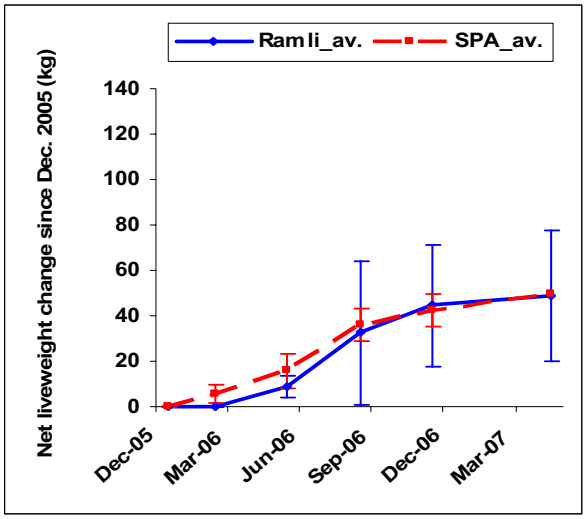


Figure 1: a. Seasonal trends in cut and carry dry matter composition and b. Seasonal trends in amount of cut and carry dry matter offered per adult animal equivalent (AAE) by Ramli (Amaq Renal), SPA between May 2006 and March 2008. An AAE of 250kg liveweight would require around3% of liveweight or around 7.5kg dry matter per day for maintenance and growth. The graph shows Ramli's cattle were receiving above maintenance levels of from cut and carry forage dry matter for most of the period monitored (Ramli only joined the best bet program in mid 2006 and sold his cattle to buy a truck for trading by mid 2007). Fig a. shows he used 100% tree legumes to kandang feeding for most of 2006-07 (after he joined project). He established a very successful backyard forage bank over 2006-07 wet but sold his cattle before he really used it.



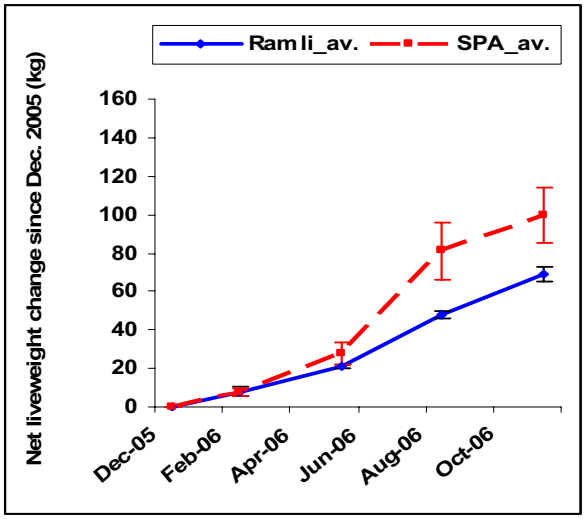


Figure 2: a. Comparison of liveweight trends of mature cows for Ramli vs. the average for SPA best bet farmers for the study period February 2006 to November 2007. Data (means and standard errors) show Ramli's cows performed around average for Mertak best bet farmers throughout 2006-07 though there was wide variation between animals as indicated by error bars. b. Comparison of liveweight trends of young male cattle for Ramli vs. the average for SPA best bet farmers for the study period Dec. 2005 to December 2006. Data (means and standard errors) show Ramli's young male sapi performed significantly better than SPA best bet farmer average from when he joined the best bet program in mid 2006 until he sold his cattle.