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Final report

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2 Executive summary

Why the work was done?

The growing demand for beef in Vietnam is providing an opportunity for smallholder crop-livestock farmers in Central Vietnam to increase household incomes through more productive beef breeding and fattening enterprises as part of their farming systems. However, significant challenges that need to be overcome to ensure these enterprises can be both profitable and sustainable include the low fertility of sandy soils in the region, long dry seasons, scarcity of good quality feed, and poor cattle management practices.

ACIAR Project LPS/2012/062 had the overall objective to assist in developing productive and profitable smallholder beef enterprises in Central Vietnam. The project sought to do this by developing more efficient smallholder cow-calf and cattle growing systems through improved feeding and management, developing stronger integration with markets and developing knowledge exchange and adoption pathways for expanding project impacts.

What was achieved?

The project methodologies included on-station and off-station cow-calf feeding and finishing trials and demonstrations as well as mixed methods for value chain and social research to understand the drivers of demand, the nature and constraints of supply and the capability of the provincial supply base.

The research identified that the main constraints in the system were currently, increasing numbers of animals are being fed in housing stalls using a ‘cut and carry’ system, small uneconomic farms lacking scale and driven by a ‘cash-in-hand’ model and marketing into long, complex, transactional and inefficient supply chains. Market information transfer is almost non-existent, so farm marketing of cattle is opportunistic, transactional and the prices received are often subject to manipulation and collusion between traders. This results in high levels of distrust, conflict and exploitation.

There is little meat and logistics infrastructure in the project provinces that meet international food safety or animal welfare standards and the only ‘cold chains’ that exist are for high end abattoirs in Đà Nẵng that supply tourist outlets. Hence, food hygiene and safety are major consumer concerns.

Retailing is overwhelmingly through traditional ‘wet markets’ largely for convenience and social reasons. The proportion sold through supermarkets is overall less than 5%. The foreign tourist market relies almost entirely on frozen imported Australian and US beef and the 3 – 5-star hotels are not interested in making local supply arrangements because of food safety concerns and the convenience of current supplies.

To counter that power asymmetry and lack of economic scale the project investigated influence pathways and sources of key resources, developed a systematic model for cattle club development and established cattle clubs in each project site where farmers collaborated to organise information transfer and skill development with the project partners. The initial focus was on training to improve animal husbandry skills and our research both identified the critical factors that facilitate adoption and scale-out then, after applying those in the project, demonstrated that uptake and scale-out was generally high (over 50%).

The ultimate goal was to progress to coordinated group marketing and shortening the respective supply chains by marketing through large Level 2 (Provincial) Collectors or direct to abattoirs. Hence, in Đắk Lắk Province, the project brought farmers together with the other chain participants to identify and solve some of the perceived problems and this resulted in collaboration between 60 farmers, a Level 2 Trader and one of two large abattoirs to coordinate beef marketing. This had not occurred by the end of the project in Phú Yên and Bình Định Provinces because the cattle clubs there were newly formed and too immature to progress to this stage during the project.

Target markets and product value specifications were identified via mixed method consumer research conducted by this project which focussed the design of this project's research activities in production and best practice value chain model design.

Recommendations were made to project participants regarding the progressive development of production and marketing capability and the supply chain system to meet the modernising of consumer demand and food retailing.

What impacts has the project had or is it likely to have in the future?

As a result of the project research, the main production recommendations improved cow-calf management regarding supplementary feeding of concentrates, shortened the calving interval, improved the establishment and management of forage species appropriate for the soil constraints and using concentrates to improve growth rates of growing and finishing cattle. An experiment on the tolerance of improved forage varieties to single and multiple waterlogging events will add to the scientific literature and will continue with on-going Masters' research at UTAS. Combined, these studies are likely to have lasting scientific impacts.

The VCA itself identified the competitive weaknesses, constraints and infrastructural challenges of traditional supply chains juxtaposing these with the emergence of modern, integrated, coordinated, specification-driven chains endogenously from the exploitation of opportunities by entrepreneurial individuals. It provided a detailed understanding of the market dynamics in the major cities of Đà Nẵng, Ho Chi Minh City and Buon Ma Thuot and the baseline economic study identified that cattle production has a negative IRR. The consumer research employed a new, rigorous mixed method and challenged traditional views of Vietnamese beef value attributes whilst identifying three future marketing segments.

The first adaptation and application of an existing Western qualitative methodology called Value Network Analysis to a developing country context provided a new means of investigating the role of social networks in value chain development. The project also successfully developed and tested cattle club formation and operation protocols in three provinces that have utility for other research projects. This project researched and detailed the significance of farmer champions in the scale out process. It also investigated the use of reciprocal cross visits between farmer champions and smallholders wishing to increase their knowledge. It also adapted the 'Theory of Planned Behaviour', a mainstream marketing theory that explains how and why individuals who have technical knowledge don't apply it in their own circumstances, to contextualise adoption and non-adoption and streamline the selection of extension methods.

One of the main project impacts is in capacity building with young Vietnamese researchers from the project undertaking three PhD and two Masters' programs at UTAS. Vietnamese team members including senior academics were able to improve their technical English, learn new methods, attend international conferences and publish in Western journals through this project. DARD partners also became more aware of value chain management principles through training and field activities.

More than 250 Vietnamese farmers, 37% of which were women farmers, in three communes participated directly in training and extension activities. Adoption varied but mostly exceeded 50%. There will be on-going engagement by all in the learning alliances established by the project using the methods and materials developed. Three handbooks and seven factsheets were produced for extension as well as two training videos in Vietnamese. A train the trainer activity was conducted for using the handbook and the factsheets.

What future actions might be required?

A clear set of recommendations ahs been provided to Vietnamese partners regarding improving production, the development of a more coordinated and competitive marketing system and improvement of the cool chain to major markets.

3 Background

This background outlines the intent, plans for the project, and is adapted from the original project proposal submitted and signed off by ACIAR.

The issue

The growing demand for beef in Vietnam is providing an opportunity for smallholder crop-livestock farmers in Central Vietnam to increase household income through more productive beef breeding and fattening enterprises. Farmers in the South-Central Coast provinces of Bình Định and Phú Yên have responded positively to this opportunity by rapidly increasing cattle numbers since 2001. However, significant challenges that need to be overcome to ensure these enterprises can be both profitable and sustainable include the low fertility of sandy soils in the region, long dry seasons, scarcity of good quality feed, and poor cattle management practices.

The ACIAR project 'Better integration of beef cattle production with crop production systems in South-Central Coastal Vietnam' (SMCN/2007/109/3) benchmarked these crop-livestock systems and implemented strategies for improved productivity. In particular, the combination of improved forage production using new species and better cattle management practices resulted in reduced labour being spent supplying feed for cattle. An external review of the project identified the importance of building on this work to develop whole production system strategies and improve overall system profitability.

In contrast, the Central Highlands province of Đắk Lắk has benefited from a strong recent history of research and development focused on cattle feeding and management. As a result, the breeding and fattening systems in Đắk Lắk are more developed than on the South-Central Coast and the greatest opportunity for enhancing producers' livelihoods is through improved understanding of and engagement with growing market opportunities.

Trends in Vietnamese beef production

The growing demand for beef in Vietnam is providing an opportunity for smallholder crop-livestock farmers to increase beef production as part of their farming system and improve household profitability. Farmers in the South-Central Coast provinces of Bình Định and Phú Yên, and the Central Highlands province of Đắk Lắk have responded positively to this opportunity with cattle numbers rapidly increasing from 2001 to 2006 (Figure 1). Since 2006 there has been a decline in cattle numbers in these provinces, primarily due to competition for grazing resources (Nguyen Huu Van, pers. comm.). This trend is reflected at a National level (Figure 2); however, production has continued to increase, primarily due to improvements in animal genetics and feeding technologies.

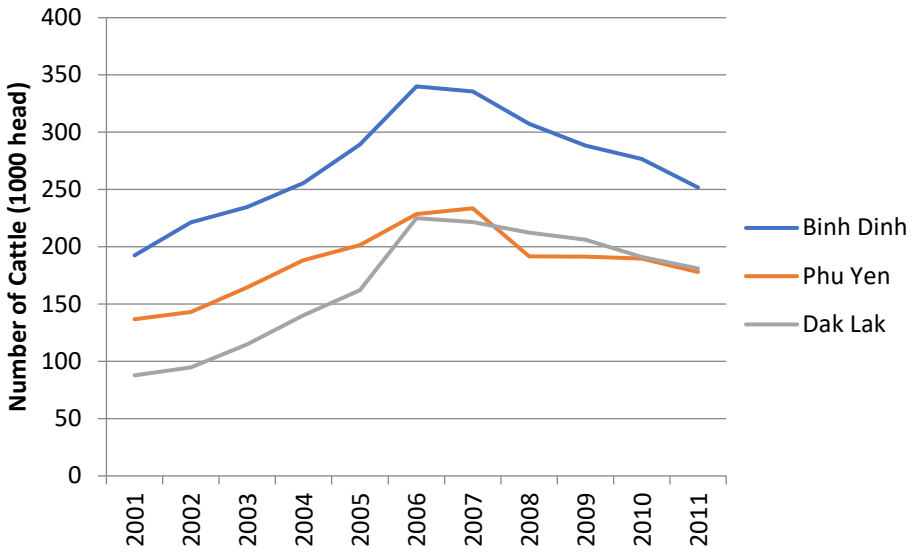

Figure 1: Cattle numbers for selected Coastal Provinces from 2001 to 2011. (Source: General Statistical Office, 2012).

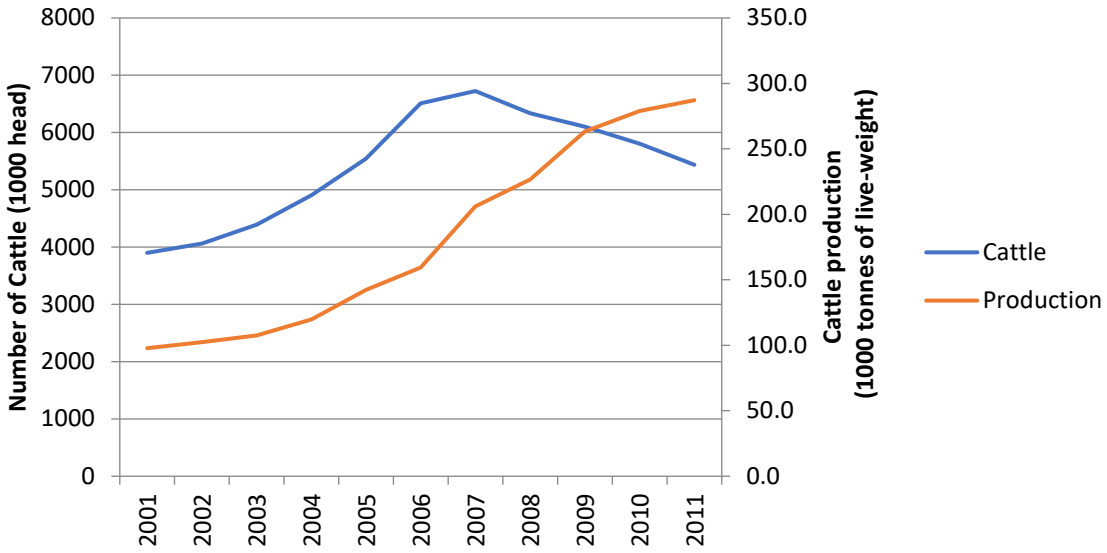

Figure 2: Number of beef cattle and annual live-weight production for Vietnam (Source: General Statistical Office, 2012).

Growth has been led primarily through domestic demand (an estimated 95% of beef is consumed domestically), especially in Ho Chi Minh City, which is the market for an estimated 70-80% of cattle from the South-Central Coast Region. Currently Vietnam imports 200-300 thousand tonnes of beef per year (MARD 2011).

Beef production in the South-Central Coast and Central Highlands

For smallholder farmers in the South-Central Coast region, beef production has long been an important part of the farming system. Beef production offers an opportunity for diversification of income, provides manure for sale or for use on crops and forages, and provides an alternative end use for the large volume of crop by-products. Herds are commonly small (typically 3-4 cattle per household) with a mix of yellow cattle, typically used

for extensive production, and crossbred cattle, typically used for semi-intensive production (Parsons et al. 2012). The most common systems of production are grazing with supplementation, and stall-feeding.

The province of Đắk Lắk in the Central Highlands of Vietnam has a more highly developed beef production system than the South-Central Coast, based on growing and feeding high quality forages. The improvement began in the early 2000s as coffee farmers began to diversify and convert some of their least profitable land into forage production for cattle (Khanh et al. 2006). Farmers initially utilized forages to feed thin cattle, however when the number of thin cattle on the market declined they turned to producing their own calves. Within 5 years of the first 25 farmers evaluating the use of forages for cattle in 2000, the number of households with dedicated production of forages had increased to over 2,000 by 2005 (Figure 3). Adopters of more intensive forage production reportedly had 73% more cattle, spent 55% less labour on feeding cattle, and achieved 71% greater returns than non-adopters. Today, although there are production issues that could still be addressed, such as forage production on acid and degraded soils, farmers remain largely disengaged from markets and market information. It is most likely that the greatest opportunity for producers in this region is through improved understanding of and engagement with the market.

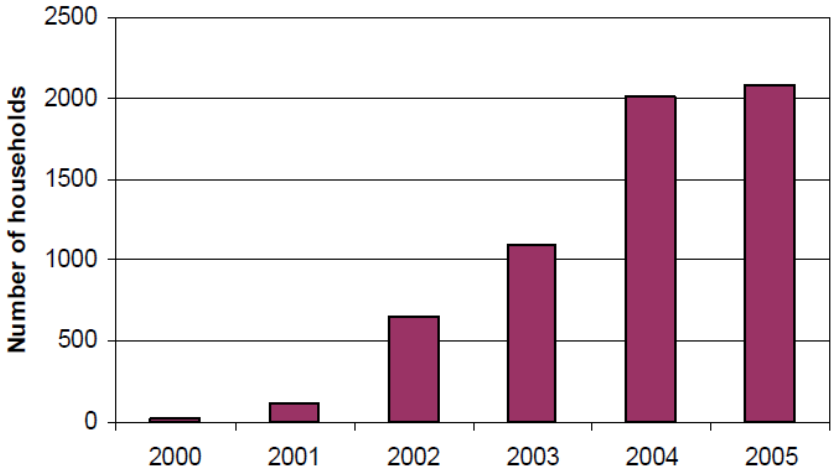

Figure 3: The number of farmers planting forages in Ea Kar, Đắk Lắk (Khanh et al. 2006).

Opportunities for development through research

Challenges for beef production in the South-Central Coast include the low fertility sandy soils, a long hot dry season, waterlogging in the wet season, scarcity of good quality cattle feed, and poor cattle production practices. ACIAR project SMCN/2007/109/3 primarily used on-farm research to address these issues, and developed improved systems of feeding, cattle management, and manure use. The 45 participating farmers experienced substantially improved cattle productivity, incomes, and labour savings with positive associated socioeconomic outcomes. An external review of the project identified the importance of building on this work to 'fine tune' the systems. The opportunity exists to build on the existing work to develop a substantial and comprehensive toolbox of options for cow-calf production, animal nutrition, and forage production that can be used by smallholder farmers to improve their livelihoods through beef production. Improved knowledge of and linkages with the market will help ensure that farmers and other chain participants are in a position to benefit from improved production practices. Linked to beef production systems is the need to develop appropriate strategies for knowledge exchange. A feature of the project SMCN/2007/109/3 was the use of the 'best-bet' system whereby farmers and researchers in collaboration decided on a combination of technologies and practices that could lead to

improved production and profitability. A range of technologies and practices were then tested and adapted by farmers and monitored by the researchers. Significant transfer of practices from farmer to farmer was also observed. If improved understanding of the processes by which farmers decided to adopt or not adopt could be developed, this would enable Vietnamese organisations like DARD to effectively promote and encourage growth of these practices more broadly. Further description of the outputs and achievements of SMCN/2007/109/3 are in Appendix D.

Higher level research questions

- What technologies and management practices can improve the efficiency and profitability of smallholder cattle production in the South-Central Coastal region of Vietnam?
- What value chain and marketing changes can allow participants in each stage of the chain to maximise productivity and become more engaged in the market, thus enhancing in particular the profitability of smallholder cattle producers?
- What mechanisms for knowledge transfer and innovation can most successfully lead to expanded impacts for smallholder cattle producers?

4 Objectives

The aim of the project was to develop more productive and profitable smallholder beef enterprises in Central Vietnam. The specific objectives of the project were:

Objective 1

Develop more efficient smallholder cow-calf and cattle growing systems through improved feeding and management. This was addressed by the following activities:

1.1 Improve the cow-calf system through appropriate animal management and developing strategies for supplying adequate nutrition.

1.2 Improve supplementary feeding of growing calves and finishing cattle through experimentation.

1.3 Improve management of forages for production and quality.

Objective 2

Develop stronger integration with markets for beef cattle producers in Central Vietnam who already have a production orientation. This was addressed by the following activities:

2.1 Select a range of types of new and existing markets with the most potential to improve smallholder incomes.

2.2 Identify the consumer value attributes in the selected or focal markets and conduct a Rapid Value Chain Analysis of the focal chains.

2.3 Analyse the facilitators and constraints of the efficiency and effectiveness in the focal value chains with particular emphasis on the distribution of economic value

2.4 Identify and prioritise the bio-physical, social and structural constraints that will improve chain performance in delivering consumer value.

2.5 Intervene in the focal chains, based on the models of adoption and adaption developed in Objective 3, to improve production and marketing practices that will improve smallholder livelihoods and chain participant value sharing.

Objective 3

Identify and develop knowledge exchange and adoption pathways for expanding impacts within smallholder beef cattle enterprises in the South-Central Coast and Central Highlands. This was addressed by the following activities:

3.1 Identify socio-economic characteristics that affect knowledge transfer, adoption and adaption.

3.2 Map knowledge pathways in value chains to identify key people, businesses and organisations for each stage of the chain that influence farming and business practices.

3.3 Facilitate knowledge exchange and adoption pathways in selected communes that support Objective 2 and the scaling-out of the adoption of project outcomes.

3.4 Continuously improve knowledge exchange and adoption pathways on the basis of experience.

5 Methodology

5.1 Site selection

5.1.1 Provinces

The scoping study conducted as part of the development of the project proposal identified the provinces of Bình Định, Phú Yên and Đắk Lắk for research work. Both Bình Định and Phú Yên provinces were used as study provinces in the preceding project SMCN/2007/109 'Sustainable and profitable crop and livestock systems for south-central coastal Vietnam' and the DARD of both provinces were most keen to continue the development of beef production in their provinces. Both Bình Định and Phú Yên are two of the main provinces for beef production in Vietnam. Ninh Thuan province, also used in SMCN/2007/109, was omitted from this project due to relatively lower number of beef cattle and it being logistically more difficult to access. Đắk Lắk province was added to the project as it has a strong history in the development of smallholder beef enterprises and also has a history of cattle clubs which would prove important for the social research aspects of the project.

5.1.2 Districts and Communes

Bình Định

Tây Giang commune in Tay Son district was identified as being a major beef cattle reproduction region in Bình Định. In early visits to the region, researchers identified that most weaned calves were sold to communes in Phú Yên for growing and finishing. They also identified that cow body condition was low and that significant gains could be made in cow reproductive performance. There was also little in the way of improved forages and establishment of these could be used as a step-wise technical learning process for smallholders before moving to the more technical improving cow nutrition. This had the support of local and provincial DARD. Significant gains had already been made in the neighbouring district of Phu Cat (Cat Trinh commune) in SMCN/2007/109 and this would provide smallholder opportunities for cross visits.

Phú Yên

The commune of An Chan in Tuy An district was chosen in the SMCN/2007/109 as a study location for farming systems surveys and the introduction of improved forages. This site provided the current project smallholders who had already been successful in the adoption of a technology (improved forages) and would provide a good study location for the finishing of beef cattle where more technical animal nutrition interventions were required. This had the support of local and provincial DARD. In addition, many of the farmers were accessing young cattle for growing and finishing from Bình Định province. This provided an important source point for beginning the value chain research.

Đắk Lắk

The commune of Ea Kar was chosen due to its long history in R4D projects. Ea Kar district has 103,747 ha of total area in which there are 51,289 hectares of agricultural land, 37,859 hectares of forest land, special use land 7,170 hectares, 1407 hectares of land and unused land is 6,022 ha. Generally, Ea Kar land is used as agricultural land is mainly unused land is very limited small proportion of the whole district. The population of Ea Kar is currently is at 149,203 people with 35,205 households were distributed over 16 communes and towns. The number of cattle of Ea Kar district is 15,276 of which 940 cattle are in Ea Kmut; 1,230 cattle at Cu Hue and 750 cattle at Xuan Phu commune. The number of cattle at the three selected communes for the project is not the highest number, but they were amongst the high ranking

in total cattle, have good breed sources, as well as substantial experience in the development of beef production and marketing. In addition, the district is amongst the poorest and includes a minority people, the E'de, some of whom will participate in the project.

5.2 Objective 1 activities and methods

5.2.1 Improve the cow-calf production systems

Baseline study

The objective of study was to evaluate the status of smallholder cow-calf reproduction in Central Coastal Vietnam. Surveys were conducted between January 2014 and March 2015 in two communes, Tây Giang commune, Tay Son district, Bình Định province; and An Chan commune, Tuy An district, Phú Yên province. Farmer interviews were used to collect information relating to the household and farming system. A total of 127 households were selected for interview (household must have had at least one cow-calf unit), in which 500 cows were assessed for body condition score and reproductive history, and 316 calves (0 – 6 months old) were weighed. The results could then be used to determine if improvements had been made after completing on-farm demonstrations.

On-station experiment

A study was undertaken to investigate the effects of post-partum concentrate supplementation on cow and calf performance traits. This was conducted under UTAS Animal Ethics Application Number A0013695. The experiment was conducted in Luong's farm (13°49'28"N, 109°00'27"E), located in Nhon Tan Commune, An Nhon District, Bình Định Province. The experiment was established in January 2015. Data was collected from January 2016 to February 2017.

The experiment was conducted on sixteen cows of crossbred Brahman genetic origin 4 or 5 years of age and between 350kg and 400 kg. Cows were divided into two treatments groups; control (ML-mother low) and treatment (MH-mother high). Seven cows in ML group were fed a low level of concentrate at 0.35%/100kg BW, while 9 cows in MH group were fed a high level of concentrate at 0.7%/100kg BW. The concentrate consisted of: cassava powder (40%), maize powder (40%), condensed protein feed (17%), urea (1%), salt (1%) and mineral (1%) by dry matter (DM). The crude protein (CP) was 16% and the concentrate contained 13% moisture. The cows were fed the concentrate and cultivated forage individually in stalls at 0800h and 1500h. The green forage intake represented approximately 1.5% of body weight. Rice straw was freely available at night, with intake representing approximately 0.5% of body weight. The cows had ad libitum access to drinking water at all times.

Feed intake of cow was recorded daily. Feed samples were collected for DM analysis. The live-weight and body condition score (BCS) of cows were recorded at calving and monthly intervals until 4 months after calving. Cows were weighed in the morning at 0630h before being fed. BCS was assessed on a scale from 1 to 5 (1-emaciated, to 5-fat) with increments of 0.25 (Gaden et al. 2005). This indicator was measured by one experienced person. The oestrus cycles, conception and pregnancy rates of cows were recorded. These indicators were measured of days from calving to oestrus expression, successful insemination time. Data was analysed by using the GLM procedure of Minitab Software Version 16.2. The results are presented in the tables by mean ± standard error (SE).

Calves had free access to suckle milk until weaning at 4 months. Concentrate was introduced to calves at 7 days of age. The feed intake of calves was recorded when the calf actively began feeding on the concentrate. Concentrate consisted of rice bran 40% + maize

powder 39% + condensed protein feed 20% + mineral 1% on dry matter basis. The nutrition value of mixed concentrate for calf were 18% crude protein, 87% dry matter. Live weight, girth and length of calves were measured at birth, and monthly until 4 months of age.

On-farm demonstrations

Effects of on farm post-partum supplementation of Brahman crossbred cows on cow-calf performance traits in Tây Giang commune, Bình Định Province, Vietnam

Eleven farmers were chosen by project staff and nominated by local extension people, as well as by DARD people and 15 cow-calf units form these farms were used for demonstration. Cows used in the demonstration had raised at least one calf prior to the demonstration. This allowed the comparison before and after the demonstration. Mixed concentrate was prepared from locally available feed resources. The diet contained 40% cassava powder, 40% maize meal, 17% high condensed protein powder from Greenfeed Company, 1% salt, 1% urea and 1% mineral premix. Concentrate contained 16% CP and approximately 10-12 MJ ME/kgDM. The amount of supplementation concentrate was 0.7% LW of cow, offered for 3 months post-calving. Concentrate intake of cow and calf (separately) were recorded daily during the supplement period by weighing offered feed and refused feed. Offered and refused roughage (rice straw; cut and carry) of cow and calf were weighed three continuous days in each 10 days in order to measure the feed intake.

The oestrus cycles, conception and pregnancy rates in supplemented cows were investigated. This required monitoring of days from calving to successful insemination. Cattle were weighed and condition scored between 06h30 – 07h30 (before being fed) as soon as possible after birth and monthly within the on-farm demonstration period. Body condition score (BCS) was estimated (method previously described) at the time of weighing cattle and monthly until 3 months. Calves were weighed and girth and length measured at birth and monthly intervals until 6 months of age.

Effects of on-farm early concentrate supplementation and early weaning of Brahman crossbred calves on cow-calf performance traits in An Chan commune, Phú Yên Province, Vietnam

Fifteen farmers were chosen (as described above) and 15 cow-calf units were used for the demonstration.

At 7 days post calving, calves were fed a “introductory supplement” until 1 month old. Firstly, the practicing feed were mix with banana which was hand applied to the calves’ mouth. This continued until calves began to become familiar with the concentrate. After the first month, calves freely accessed the concentrate until 4 months of age. Introductory supplement for calves consisted of a mix by 50% of rice bran and 50% of soybean. Mixed concentrate consisted of 40% rice bran; 39% maize powder; 20% high condensed protein powder from Greenfeed company and1% mixed mineral powder. Concentrate contained 18% crude protein (CP) and about 10-12 MJ ME/kg DM. Calves also had free access to green forages, in this case to Mulato II. Forages were wilted for 12h before feeding. Concentrate and rice straw intake of cow and calf (separately) were recorded daily (as above).

Cow and calf performance parameters were measured as described above. Calves were weighed and girth and length measured at birth and monthly interval until 6 months of age. Weaning time for calves involved in the feeding demonstration was nominally 4th months, but actual weaning time was decided by individual farmers, based on their observations of how well calves were eating.

Extension

One handbook and two factsheets were produced based on information from the published literature and project results. Local examples and photos were used to give them a regional and local context. Factsheets were primarily aimed at smallholder farmers while the

handbook was produced more for extension staff for use as a training tool. A train the trainer workshop was conducted for use of the handbook and factsheets. Copies of the factsheets and handbooks were presented to each of the provincial DARDs for distribution within their departments and networks.

5.2.2 Improve supplementary feeding of growing calves and finishing cattle

Difficulties including cost and availability in obtaining suitable cows for the on-station experiment resulted in the feeding experiment of calves needing to be abandoned before implementation. This experiment was listed as Activity 1.2.1 in the original proposal. This was a decision made by the project leadership team in conjunction with ACIAR.

Beef finishing demonstration in An Chan

Fifteen smallholder households were selected in An Chan, Phú Yên for participation in the beef feeding demonstrations using the following criteria:

- Willing to be involved in the demonstration; and having the commitment to support monitoring, learning and sharing of knowledge gained from the demonstration;
- Having at least one beef cattle that is ready for finishing
- Having enough time and appropriate cattle shelter for monitoring the feed intake and weighing the cattle. Having enough green forage and rice straw for beef cattle during the demonstration period.

The selection of cattle was based on the following criteria:

- Male, Brahman crossbreds, about 24 months old (22-26 months)
- Good body condition score: BCS = 3.00 (2.75 – 3.25)
- Minimum starting liveweight of 350kg
- In good health
- De-wormed against internal parasites

Based on these criteria a total of 20 Brahman cross cattle were selected from 15 households. Selected cattle were approximately 24 months old, body weight was 412.3 ± 36.6 kg (mean ±SD). The 20 cattle were allocated into two groups; control group (10); and the treatment group (10).

Feeding:

Control group (CG): Cattle were fed green forages (mainly elephant grass, but sometime replacement by native grass and corn foliage when elephant grass was not available) during the day and rice straw ad libitum during the night. Concentrate was supplied based on usual practice by farmers (rice mixed with water spinach and well cooked, then mixed with water and rice bran or commercial duck concentrate).

Treatment group (TG): Similar regime of green forages and rice straw were fed to the animal. For concentrate, cattle were fed a commercial product (product code GF85 of Greenfeed Company, Vietnam), specialized for beef cattle during finishing period with the following characteristics: pellet form, ME 2500 Kcal/kg, CP 14%.

The amount of concentrate fed increased from 1.0% LW/day (first month) to 1.25% LW/day (second month). Concentrate was fed three times a day. Chemical composition of feed using in demonstration was present in Table 1.

Measurements

Feed intake:

Concentrate intake was recorded every day during the finishing period by weighing offered feed and refused feed. Offered and refused roughage (Elephant grass + rice straw) were weighed every day in order to measure the feed intake.

Table 1 Chemical composition of feed used in demonstrations

Type of feed	DM (%)	CP (%DM)	ME (kcal/kg DM)
Native grass	19.2	10.0	2091
Elephant grass	18.0	9.0	2091
Water spinach	11.5	22.6	2426
Maize foliage	27.4	9.5	2190
Rice straw	90.3	5.6	2032
GF85 industrial feed	86.0	14.0	2500
Rice bran	90.0	11.8	2301
Rice	87.7	8.34	2939

Beef finishing demonstrations in Ea Kar, Đắk Lắk

Study location

This on-farm demonstration was conducted with smallholder farmers in Ea Kar district in Đắk Lắk province. The site was chosen by collaboration between Đắk Lắk DARDs and LPS/2012/062 project staff. The demonstration designed followed similar methods used in the An Chan demonstration described above. A total of 16 cattle were selected. Mean body weight was 324kg, 88kg lighter than An Chan.

Cattle performance and economic assessment:

Cattle were weighed and condition scored between 0630h – 0730h (before morning feeding). Cattle were weighed using an Iconix FX15 Indicator and Loadbar livestock weighing system (Iconix. 2014).

An economic assessment of the concentrate feeding treatments were estimated post experiment. We assumed that both control and treatment cattle ate the similar amount of forages. We just consider the cost of money investment for concentrate + water spinach, and then balanced with the money that earned from LWG after finishing.

Statistical analysis

Statistical analyses were performed using the general linear model procedure of SPSS 16.0. The differences between means were compared using a least significant difference method. Statistical difference was declared at $P<0.05$.

5.2.3 Improve management of forages for production and quality

Forage waterlogging tolerance studies

A pot study was conducted in a greenhouse at the Hue University of Agriculture and Forestry (HUAF) campus in Hue (16°28'N, 107°34'E), Hue province to test the effects of waterlogging on a number of improve forage cultivars. The experiment ran between September and December 2015. The 7 forage treatments were *Panicum maximum* cv. TD58, *Pennisetum purpureum x glaucum* cv. VA06, *Brachiaria* hybrid cv. Mulato II, *Brachiaria humidicola*, *Brachiaria ruziziensis, Paspalum atratum* cv. Ubon, and *Digitaria eriantha*. Tillers were obtained from a range of sources, grown in the ground before being transferred to pots 300 mm tall and 270 mm in diameter filled with sandy loam. Tiller number per pot differed between species but not within species.

The experiment followed a split-plot design with five waterlogging treatments, seven forage species and 4 replications (blocks). The five waterlogging treatments were: 1. Control (CT) - water level maintained at 30 mm from the bottom of the pot; 2. 10 day single saturation

(WL10S) - water level raised to soil surface for 10 days, then returned to 30 mm from the bottom of the pot for remainder of the experiment; 3. 10 day repeated saturation (WL10C) - water level raised to soil surface for 10 days, then returned to 30 mm from the bottom of the pot for 10 days, this cycle was then repeated; 4. 20 day single saturation (WL20S) - water level raised to soil surface for 20 days, then returned to 30 mm from the bottom of the pot for the remainder of the experiment; 5. 20 days continuous saturation (WL20C) - water level raised to soil surface for 20 days and remained there for the entirety of the experiment. Pots were arranged in blocks in polystyrene box, each with a different waterlogging treatment.

Plant measurements were taken at the completion of each 21 day cycle and included the number of live tillers, dead tillers, length of longest leaf. Plant health was also measured using chlorophyll fluorometer and chlorophyll meter. Measurements were taken at the same time of day. Plants were harvested to 150mm about ground surface. Dry matter was determined by drying samples for 48 hours at 105°C.

Detailed methods will be provided in the journal article.

Extension materials

Extension materials were produced based on research from the current project, the preceding SMCN/2007/109 project and additional literature. The handbook titled ‘Handbook of forage development in smallholders’ was developed to assist extension workers in delivering forage workshops to smallholders. A further 5 factsheets were developed for smallholders on how to establish and grow forage varieties *Brachiaria* hybrid cv. Mulato II, *Panicum maximum* cv. TD58, *Pennisetum purpureum* cv. VA06, *Paspalum atratum*, and *Leucaena leucocephala* cv. Taramba. In addition, a factsheet was developed on how to choose species that are tolerant of waterlogging and how to manage forages during waterlogging.

5.3 Objective 2 activities and methods

Objective 2: Develop stronger integration with markets for beef cattle producers in Central Vietnam who already have a production orientation.

The following sections describe the methodology for each sub-objective in the sequence of the component activities.

5.3.1 Activity 2.1: Select a range of types of new and existing markets and provincial value chains with the most potential to improve smallholder incomes.

This activity focused on the key step of selecting the most appropriate farmer participants, understanding their operating environment and identifying the existing and optimal channels to market. Note that to improve the logical flow in this report, the sequence of the following sections has been changed from the original Project Proposal.

Conduct training of research team and key staff

The objective’s initial implementation involved a four-day value chain training program for the core Project Team. Training comprised of theory and practical field sessions with critical reflection used both as an educative and a research tool (Mortari 2015) with great effect and became a standard team practice. The approach to conducting this training was an application of David Kolb's Experiential Learning Model (ELM) (1984) and the ‘reflection-in-action’ theory of Donald Schön (1983), two of the most widely employed learning theories in adult learning. This was followed by a one-day value chain orientation program for the participating DARD staff in each of the three focal provinces.

Develop appropriate selection criteria and select the communes

To develop appropriate selection criteria and select the communes to be involved in the project, the method recommended by Collins, Dent and Bonney (2015) was employed. The team discussed and developed a list of criteria on which to base the selection of participating communes ensuring an objective and defensible evidence for the selection process that incorporates the purpose of the project as well as local socio-economic and physical conditions. Then an investigation of secondary demographic and socio-economic data was undertaken and discussions were held with DARD partners and commune leadership regarding the level of interest amongst the communes to participate. Three communes were selected.

Conduct a baseline study of the selected communes

A baseline economic study of the selected communes was conducted to understand the cost structure and contribution of cattle production to family livelihoods. The method was guided by AUSAid's Baseline Study Guidelines (2003) and FAO 2009, *Overview of methods for baseline assessments*, FAO Integrated Food Security Support Service.

Hence, the research set out to answer the following research questions

1. What are the current socio-economic characteristics of cattle production?
2. What are the current socio-economic characteristics of cattle marketing?
3. What is the economic efficiency and contribution to household economy of cattle production?
4. What knowledge do farmers have about the beef supply chain and market?

The research sites were two communes on the South-Central Coastal region: Tây Giang (Bình Định Province) and An Chan (Phú Yên Province). These were selected using a process explained in Activity 2.1.3 (summarised in the previous section).

A structured survey questionnaire method was employed using 60 to 90-minute face-to-face interviews with:

- Key informants comprised of:
    - 10 experienced farmers;
    - 4 local extension officers.
- A sample of 60 farmers chosen by random sampling in two communes associated with An Chan (30 households/commune).

Secondary data was gathered from provincial veterinary department and communal authority about the number of cattle heads and the number of cattle flown in different supply chains. The quantitative economic data were analysed using simple descriptive and *ex ante* summative methods to provide insights into the research questions.

Select the participating farmers

In August 2015 in Đắk Lắk Province a number of meetings through 2016 and early 2017 to facilitate group formation. This was several months earlier than in the South-Central Coast because the Ea Kar District has had a long engagement with ĐH Tây Nguyên University (TU) and had several well-developed cattle clubs. This experience was used as the basis for developing the subsequent method for the South-Central Coast sites as outlined in *Activity 3.1.2 Case Study 3 cattle club study draft research protocol.* Invitations were also broadcast to all farmers in the selected commune/hamlets through the local Peoples Committee.

Identify lead firms or actors in the selected chains and engage

The downstream traders, slaughterhouses and retailers were identified by interview and in the farmer meetings. All these downstream chain participants were invited to the meetings

All meetings were facilitated through the cooperation and auspices of the District Office of the DARD. DARD Officers accompanied the Research Team for each visit and were integral to the success of the activities.

All meetings were conducted using participatory discussion facilitated by the Project Coordinator for ĐH Tây Nguyên in Đắk Lắk Province, Assoc Prof Trần Quang Hạnh and Assoc Prof Pham The Hue.

Literature review and secondary information collection

To ensure the project was based on relevant prior research, a literature review and secondary information collection was undertaken, and the report circulated to all project team members.

What are the most appropriate markets with the greatest opportunity for the smallholder farmers in the three focal provinces, Bình Định, Phú Yên, and Đắk Lắk?

To answer this Research Question, we focused on answering three subsidiary research questions:

- What are the current channels to market?
- What potential future markets exist for smallholder farmers?
- What are the critical characteristics that will enable market access to these markets?

Market research was conducted in Ho Chi Minh City (HCMC) and Đà Nẵng. The methodology for this market research followed the guidelines provided by Collins, Dent and Bonney (2015, pp. 81 - 7) using 'desktop research' to gather secondary data and a semi-structured convergent interviewing technique to gather primary data from the market and chain participants employing using a 'backwards market research' approach (Andreasen 1985, 2002) as a 'snowball sampling technique'[1], starting at the end of the process because the existing channels were not well understood and it was not clear which target market would finally be selected.

This meant that in both HCMC and Đà Nẵng, researchers started the data collection by interviewing supermarket managers and retail stallholders in 'wet markets' and worked backwards to wholesalers, abattoirs, Collector Level 2s (regional wholesalers) or feedlot operators, Collector Level 1s (local commune collectors) and smallholder farmers. One hundred and fifteen semi-structured, convergent interviews were undertaken to enable the researchers to understand as far as possible the complex variables involved in the respective markets without any a priori categorisation that might constrain the responses. The two main importers of Australian cattle into Vietnam were also interviewed.

This methodology resulted in the identification of key emergent issues for further exploration in subsequent interviews and facilitated the breadth and depth of data. However, the full breadth of potential topics for questioning was never superseded because the Interview Guide and Prompts were always the basic framework for the researcher and some issues returned to central focus as interviewing continued.

Finally, Porter's Five Forces Analysis (FFA) (2008) was used to analyse the alternative market opportunities for the project provinces as recommended by the USAID Microlinks Value Chain Development Wiki (2014). The FFA has been identified in the 'top ten' management tools around the world in both Developed and Developing contexts (Qehaja, Kutllovci & Shiroka Pula 2017).

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[1] Also called "Chain Referral Sampling" is a form of purposive or non-probability sampling technique used to identify potential subjects where subjects are unknown, small in number and hard to locate.

5.3.2 Activity 2.2: Identify the consumer value attributes in the focal markets and conduct a Rapid Value Chain Analysis (RVCA) of the focal chains.

What are the critical consumer value attributes that drive these focal markets?

Three methods were employed to identify consumer value preferences and the data was then triangulated. The first undertaken were the qualitative interviews with selected supply chain wholesalers and retailers including senior executives and meat managers from all the major supermarkets. This was then used to design the affective or 'hedonic' sensory testing undertaken in two different markets in Đà Nẵng and Buôn Ma Thuột, Đắk Lắk Province.

Qualitative interviews

Qualitative interviews were undertaken (and in some instances observations were recorded) of approximately 75 random meat shoppers, 17 executives and meat buyers, 3 wholesalers as well as hotels and restaurants in Buôn Ma Thuột, Đà Nẵng and HCMC. In total, more than 115 qualitative interviews were undertaken regarding what consumers' value in meat attributes. The Research Questions were:

- Can consumers differentiate between the consumer physical purchasing attributes of Australian beef
- What are the differences between the Ea Kar experimental Brahman hybrid beef treatment cattle and the control cattle for the consumer physical purchasing attributes (texture, smell, colour) and taste attributes?
- Can consumers differentiate between the consumer physical purchasing attributes AND the consumer taste attributes of traditional Yellow Cattle and Brahman hybrid beef grown in Ea Kar?

Some fundamental questions about consumer value and sensory acuity emerged from this and led to the development of rigorous quantitative surveying and physical analysis.

Affective sensory testing

The Meat and Livestock Australia (MLA) sensory testing protocol was used as a guide for the development of this project protocol (Watson et al. 2008). This protocol provides a hands-on guide to researchers and evaluation facilitators on conducting affective sensory evaluation of beef meat, facilitate comparison between previous and future sensory evaluations conducted in the similar context, and maintain rigour of the evaluation process.

This protocol was used after the informed consent from 126 participants in Đà Nẵng and 121 respondents in Buôn Ma Thuột.

Physical and chemical testing of meat samples

The objective was to evaluate the physical quality of beef samples sold in Đà Nẵng market. The recorded indexes included pH, colour, shear force, drip and cooking loss, and chemical composition. Eight *Longissimus dorsi* muscles between the 10th or 11st rib to the last rib of eight cattle (4 cattle imported from Australia and 4 cattle was bought from South-Central Coastal) was sampled for physical characteristics analysis. Two kilograms of each sample was collected, identified and placed in separate bags and immediately transported to the laboratory (Faculty of Animal Science, Hue University of Agriculture and Forestry – HUAF) in an ice box within 4 hours.

Analytical methods

The data were analysed using qualitative content analysis (sometimes referred to as 'thematic' analysis) (Guest, MacQueen & Namey 2012; Kohlbacher 2006; Wheeler 1988) and used to inform the design of the related consumer value investigations.

The data were interrogated initially using descriptive techniques, various other statistical techniques including cluster analysis to identify segments of consumers; that is, those consumers with similar purchasing characteristics based on similar demographics, psychographics, geographics, product benefits or behaviours. Thus, was selected as one of the most useful for understanding the segmentation of Vietnamese beef consumers (Gacula Jr 2013; Meilgaard, Carr & Civille 2007). SPSS statistical package was used to undertake this analysis.

Undertake a Rapid Value Chain Analysis (RVCA) of the focal chains as specified in Activity 2.2 encompassed the three following research questions:

> *What are the pre and post-project chain efficiencies and distribution of economic value?*
>
> *What are the priority bio-physical and social constraints on chain performance in delivering the identified consumer value?*
>
> *What interventions are recommended, based on the models of adoption and adaption developed in Objective 3, to improve production and marketing practices that will improve smallholder livelihoods and chain participant value sharing?*

The VCA focused on what has to be done to improve the chains' ability to 'do the right things' and 'do things right'. This required a multi-dimensional diagnosis, 'in the eyes of the consumer' (using data from consumer value research from the previous research question) of the current state of:

1. Material flow (whether it is wasteful, necessary or value adding) in the chains,
2. Communication and information flows (strategic and operational) in the chain, and,
3. The governance of the chain, which involved examining how the relationships within and between people and businesses in the chains are managed.

The VCA investigated these dimensions against a backdrop of knowledge about the significant factors in the chain's external environment, such as marketing, bio-physical, economic, socio-economic or cultural and institutional influences on chain structure, behaviour and processes. The VCA highlighted where these influences may need to be examined in more depth by discipline-based research.

Employing the VCA Model in Collins, Dent, & Bonney (2015, p. 29) data from the VCA was both integrated with and informed by the marketing, economic, social, institutional and bio-physical research components. This provided a better understanding of the magnitude of these influences, how and why they occur and therefore how they might be managed to reduce or enhance their effects on the chain as well as providing validation of the VCA through triangulation.

This produced a comprehensive, multi-disciplinary VCA incorporating a range of discipline-based research provided the basis for identifying chain improvement/establishment projects across all three project objectives, focusing on collective opportunities for increasing chain efficiencies and creating new value for consumers with more equitable sharing of the costs and benefits from creating the new form of value.

5.4 Objective 3 activities and methods

Objective 3 aimed *to identify and develop knowledge exchange and adoption pathways for expanding impacts within smallholder beef cattle enterprises in the South-Central Coast and Central Highlands* by *building on the experience and knowledge of adoption and adaptation processes gained in ACIAR Project SMCN/2007/109*. Key activities included:

5.4.1 Identify socio-economic characteristics affecting knowledge transfer, adoption and adaption *(Activity 3.1)*

Review the literature on the focal smallholder cultures to assist the development of change protocols

The key objectives were to a) review of published and unpublished literature and b) conduct interviews with farmers and influential cattle production stakeholders, to explore the socio-economic and cultural influences on focal smallholder knowledge transfer pathways, adoption outcomes and responses to change. This review provided valuable insights which helped guide the subsequent focus and strategies employed in Objective 3 research.

Monitor the impacts of the ACIAR Project SMCN/2007/109/3 and previous cattle development projects in Đắk Lắk, to assess the extent and mechanisms of adoption and adaption.

A preliminary exploratory survey of focal smallholder communities was conducted in July 2014 to a) familiarize Objective 3 team members with farming systems of former smallholder study communities in South-Central Coastal and Central Highland regions b) assess post-project progress and impacts on knowledge transfer, adoption and scale-out there and c) conduct survey methods testing for Activities 3.1.1, 3.1.2 and 3.1.3. Information and insights gained from this initial survey enabled the Objective 3 team to assess the suitability of proposed research strategies for the various activities and allocated resources and make recommendations for refinement of these strategies to meet research objectives.

The primary recommendation arising from this initial field survey was to restructure key elements of Activity 3.1.2 and 3.1.3 into 3 complimentary case studies, to provide more research focus, refine methodology and align research objectives with available resources. These recommendations were subsequently agreed to by the project management team.

As the 3 case studies spanned elements of the original Activity 3.1.2 and 3.1.3 criteria it was also recommended that these two activities be effectively merged for operational purposes Case study methods and results are thus reported under a combined activity 3.1.2 / 3.1.3 sub-heading

Case study 1: Assess the influence of ‘farmer champions’ on knowledge transfer and adoption and explore their potential utilisation to accelerate new forage technology adoption and scale-out in other communities.

Learnings from this case study fed into knowledge exchange and adoption recommendations developed under activity 3.3.2 and formed and were incorporated into the *Working with Farmers* training handbook developed for use by provincial and district DARD staff in the study regions.

Case study 2: Explore farmer derived reasons for adoption / non-adoption of new forage technologies and identify the boundaries that limit change by individuals, communities and within systems.

Learnings from this case study also contributed to better understanding of existing knowledge exchange pathways in focal communities and recommendations to support development of change protocols associated with Activity 3.3.2 and 2.1.1-8. Key learnings were also incorporated into the *Working with Farmers* training handbook developed for use by provincial and district DARD staff in the study regions.

Case study 3: a) Explore the history of cattle club development (in Đắk Lắk and elsewhere) to identify characteristics of successful and unsuccessful clubs, and potential for model transfer to other locations and b) field test and apply derived protocols for new cattle club development elsewhere.

Learnings from this case study fed into development of knowledge exchange and adoption recommendations under activities 3.3.2 and 2.1.1-8 and were incorporated into the *Cattle Club Development Guidelines* handbook developed for use by provincial and district DARD staff, commune extension staff and other key stakeholder in the study regions.

5.4.2 What are the knowledge pathways in focal chains to identify key people, businesses and organisations for each stage of the chain that influence farming and business practices? *(Activity 3.2)*

Conducted a value network analysis (VNA) as the basis for developing a culturally appropriate model for the change protocol knowledge exchange and adoption of VCM Models (linked to Activity 2.4.1).

5.4.3 How can knowledge exchange and adoption pathways in focal communes be facilitated that support Objective 2 and the scaling-out of the adoption of project outcomes? *(Activity 3.3)*

Development of a knowledge exchange and adoption framework to support the change protocol

Key leanings about knowledge exchange and adoption pathways were identified from the Three Activity 3.1.2 / 3.1.3 case studies and Activity 3.2.1 value network, linking into Activities 2.1.6-8. While they were not specifically developed into a formal framework, key recommendations were incorporated into the *Working with Farmers* (use of participatory extension methods) and *Cattle Club Development* training handbooks developed under activity 3.3.1 for use with and by district and provincial DARD staff and other stakeholders. They also formed a key component of the subsequent development of the *Working with Farmers* and *Guidelines for Cattle Club Development* extension handbooks developed and by the Objective 3 team and used for stakeholder training activities conducted under Activity 3.3.2

Conduct training to build the capacity

Training activities were conducted in association with several Objective 1, 2 and 3 activities throughout the course of the project. Specific training of District and Provincial DARD, staff and associated stakeholders occurred in association with Objective 2 value chain research in Activities 2.1.1, and 2.1.5-7, as described in subsection 5.3.1. The Objective 1 team provided technical training to farmers, commune and district extension staff and students associated with implementing and monitoring on-station and on farm studies. The objective 3 team provided on-going on-the-job training to commune and district extension staff in application of participatory action research and extension methods and in establishment of new cattle club formation. Objective 1 and 3 teams conducted specific train the trainer sessions in late 2016 on application of key research outcomes from on-station and on-farm cattle feeding and management studies for key stakeholders in Bình Định and Phú Yên, including commune and DARD extension staff, traders and feed company representatives. They also conducted formal classroom and on-the-job train the trainer workshops with district and provincial DARD extension staff and commune extension staff in Bình Định and Phú Yên during late 2017 focusing on application of extension materials (fact sheets and manuals) and new extension methods developed by the Objective 1 and 3 teams.

Establish learning alliances

Learning alliances between stakeholders were developed as part of individual activities in case study 1B (cross-visits) and case study 3B (new cattle club development) under activity 3.1.3 and as a consequence of activity 3.2.1 (VNA) activities within Objective 3, activity 2.1.6 (focal farmer identification) and activities 1.1.3 and 1.2.3 (on-farm cow-calf and male cattle feeding demonstrations). These learning alliances developed either informally in the course of conducting the on-farm activities (through bringing various stakeholders together via on-

farm workshops, exposure visits, meetings and field activities or through formal targeted field days and training sessions. Specific examples include the facilitated interaction of selected Tây Giang farmers and extension staff with both Cat Trinh farmer champions and extension staff in 2015 (via activity 3.1.3 case study 1 activities) and the field day and associated stakeholder training workshop on beef cattle finishing (2016) associated with activity 1.2.3, which brought cow calf and finisher farmers, traders, extension staff and feed company representatives together.

Gradual transition to Focal Farmer leadership of the knowledge exchange and scale-out process

Potential focal farmers (farmer champions) identified during the on-farm forage introduction (Case study1B) activity at Tây Giang and cow-calf supplementation and male cattle finishing demonstrations at Tây Giang and An Chan communes were carefully mentored to improve their communications skills and encouraged to take on leadership positions in newly formed cattle clubs. These focal farmers were also encouraged to take on key roles in demonstrating and communicating new practices to other farmers at field days and workshops, as part of the devolution of scale-out responsibilities.

5.4.4 Continuously improve knowledge exchange and adoption pathways on the basis of experience *(Activity 3.4)*

Review annually to project completion the implementation of the knowledge exchange and adoption framework *(Activity 3.4.1).*

6 Achievements against activities and outputs/milestones

Objective 1: Develop more efficient smallholder cow-calf and cattle growing systems through improved feeding and management.

No.	Activities	Outputs/ milestones	Completion date	Comments
1.1	**Improving the cow-calf system through appropriate animal management and developing strategies for supplying adequate nutrition**			
1.1.1	Understanding current cow-calf reproduction indices through monitoring	Activity report identifying points of intervention in the reproductive performance cycle	January 2018	• A baseline survey of cow-calf production systems in An Chan and Tây Giang was conducted in 2015, a follow up survey was undertaken in early 2017 with report completed in January 2018. • A conference paper was presented at SAADC in 2015. • A paper was also submitted and accepted by the Vietnam Journal of Agriculture and Rural Development (Published 2015)
1.1.2	Experiment: On station investigation of cost-effective energy and protein supplement products and levels to improve the reproductive performance of cow and post-natal growth of calves	1 peer reviewed journal paper (lead: Aduli Malau-Aduli) on cow-calf response to supplementation	January 2018	This experiment was a challenge from the outset due to the availability and cost of cows meeting the defined criteria. A reduced number of replicates per feeding treatment block was settled upon due to the unavailability of suitable cows. This prohibited the publication in peer-reviewed journal.
1.1.3	On-farm demonstration of improved cow-calf management	Report on LW, BCS changes, reproductive performance and maternal competence of cows, and household economic response. Peer reviewed journal paper on on-farm cow-calf improvements.	August 2017	• A conference paper was presented at SAADC in 2015. • Report completed (August 2017). • Journal article submitted and accepted to Vietnam Journal of Agricultural Sciences (Published July 2017) • Factsheet: Post-partum supplementary feeding of cows (Published October 2017)
1.2 Improved supplementary feeding of growing calves and finishing cattle through experimentation and nutritional modelling				
1.2.2	Experiment: Finishing cattle to market specifications	1 peer reviewed journal (lead: NX Ba) paper on finishing performance of cattle	August 2017	• Report completed (August 2017) • Factsheet: Finishing cattle to meet market requirements (Published October 2017) • Peer review article still being assessed by project team
1.2.3	Developing production guidelines for cost-effectively growing and finishing cattle	Production guidelines developed	October 2017	Handbook: Improving performance of cow and beef cattle in smallholders (Published October 2017)

1.3 Improved forage production, focusing on management practices under waterlogged conditions and maintaining soil fertility for optimal forage production and quality.				
1.3.1	Experiment: Reducing the impact of waterlogging on the survival, production, and quality of forages.	1 peer reviewed journal paper (lead: R Smith) on management of forages under waterlogging	May 2019	• Peer reviewed journal manuscript submitted to Grass and Forage Science for review May 2019 • A second experiment is being held over as part of Ms. Nguyen Thi Mui's John Allwright Fellowship Masters project to commence in 2018-19. This was in response to the mid-term review indicating that the focus should be on finishing existing project experiments and writing up rather than starting any new ones.
1.3.2	Developing guidelines for managing forage production on sandy soils	Production guidelines developed	October 2017	Significant stakeholder engagement was conducted in the development of these materials and are targeted both at smallholder farmers and also extension staff. Extension material developed: • Handbook: Forage development for smallholders • Factsheet: Technical guidelines for production and use of VA06 • Factsheet: Technical guidelines for production and use of TD58 • Factsheet: Technical guidelines for production and use of Mulato II • Factsheet: Technical guidelines for production and use of Paspalum • Factsheet: Technical guidelines for production and use of Leucaena
1.4 Improved cattle production in Đắk Lắk province				
1.4.1	Experiments to address production constraints in Đắk Lắk	Report	August 2017	Results incorporated into section 7.1.2 along with results from feeding demonstrations in An Chan, Phú Yên

Note: Activity 1.2.1 planned in the original proposal were removed in consultation with the Research Program Manager

Objective 2: Develop stronger integration with markets for beef cattle producers who already have a production orientation.

No.	Activities	Outputs/ Milestones	Completion date	Comments
Activity 2.1: Select a range of types of new and existing markets and provincial value chains with the most potential to improve smallholder incomes.				
2.1.1	Conduct training of research team and key staff from the DARD, & Extension Station collaborators, Provincial Department of Science & Technology and other private rural agents.	• Awareness and skills training conducted for the Research Team from three Provinces. • Detailed work plan agreed.	Project Team – May 2014 DARDs – July 2014	Activity Report completed. Both social and bio-physical research teams attended. This had the effect of building cross-disciplinary understanding and team cohesion and the effect has continued with shared approaches to social research activities. Very successful theoretical & practical VC training for project research team was conducted. In excess of 45 partner staff trained in the three project provinces.
2.1.2	Literature review and secondary information collection.	• Methodologies and findings on previous VCA related research reviewed. • Synthesised information on cattle production models from South-Central Coast project reviewed and incorporated.	September 2014	Activity Report completed. Incorporated into relevant reports and papers.
2.1.3	Develop appropriate selection criteria and select the communes to be involved in the project.	• Community diagnostic report	June 2014	Selection criteria were settled upon. Communes selected were; • Tây Giang, Bình Định, which is a major cow-calf production area which required improvement in animal nutrition and management • An Chan, Phú Yên, which is a commune focusing on both cow-calf and beef finishing production. Was a commune involved in the previous ACIAR project. • Ea Kar, Đắk Lắk, which is a commune that has a history of cattle clubs and a mixed beef production system.
2.1.4	Conduct a baseline study of the selected communes	• Economic Baseline Study Report	November 2015	The findings highlighted the marginal profitability of cattle raising if household labour and true cost of inputs is incorporated.

2.1.5	Conduct market analysis to identify TWO (2) focal project markets, one in Đà Nẵng and the other in HCMC and their supply chains.	• Report on the potential beef markets in Đà Nẵng and HCMC inc. market potential, market segmentation, price-quality differentials, price seasonality.	Activity Report completed January 2015. Market Report communicated to the relevant DARDs. Recommendations were incorporated into the research planning of Objectives 1.	The research highlighted: • The differences between the target markets • The five biggest beef industry constraints overall • The constraints for specifically accessing HCMC & Đà Nẵng • The shared constraint of the lack of competition in the distribution system • The market opportunities in Buôn Ma Thuột and Đà Nẵng
2.1.6	Select the participating farmers by conducting awareness training of VCM principles, the project objectives, activities and potential benefits.	• Short workshops with 50 participating farmers in each of the focal districts in three provinces (Total 150 farmers). • Workshop training materials.	Workshops were held in each of the focus communes. A methodology was piloted in Ea Kar District, Đắk Lắk Province, then translated into Tây Giang and An Chan Districts. Exposure visits between Tây Giang/An Chan and Đắk Lắk were conducted (See Activity 3.1.3).	Methodology developed was well-implemented, effective resulting in appropriate communes being selected. A new protocol has been developed and will be published in an appropriate journal or conference. Activity Report completed.
2.1.7	Identify lead firms or actors in the selected chains and engage through planning & training.	• Focal retailers identified. • Chain leaders identified. • Necessary 'just-in-time' training conducted.		This is quite advanced in Đắk Lắk Province with whole-of-chain meetings held, problems identified and collaboration projects to improve marketing practices identified. This will be completed in Phú Yên and Bình Định once cattle clubs have been established and an appropriate stage of development achieved.
Activity 2.2: Identify the consumer value attributes in the focal markets and conduct a Rapid Value Chain Analysis (RVCA) of the focal chains.				
2.2.1	Identify consumer and customer value attributes in the TWO focal market/s.	• Consumer research report for TWO (2) chains; 1 x Đà Nẵng and 1 x HCMC. • 1 peer reviewed conference paper on characterisation of potential markets.	Qualitative Consumer Research Report – February 2016 Sensory testing report – September 2016 Physico-chemical Testing Report -	Consumer research was conducted using: 1. Qualitative interviewing – 115 2. Hedonic Sensory Testing of approx. 250 consumers in two provinces 3. Physical and chemical testing of meat used in Activity 2.2.1 was conducted. Journal articles on the Hedonic Sensory Testing methodology and findings are being developed.

2.2.2	Undertake a Rapid Value Chain Analysis of TWO selected chains from three provinces.	• Preliminary report categorising and characterising the nature of value chains in Bình Định, Phú Yên & Đắk Lắk	Preliminary Value Chain Analysis Report - 7th July 2015 Final Value Chain Analysis Activity Report was completed 18th October 2016	The Rapid value chain analysis was conducted: 1. Bình Định & Phú Yên to Đà Nẵng City 2. Eakar District, Đắk Lắk Province to HCMC A PhD research study conducted interviews in Đắk Lắk as part of this project employed a quantitative survey of 134 smallholders, 4 collectors, 2 slaughterhouses, 20 wholesalers, and 30 retailers, then, conducted in-depth qualitative interviews with 40 chain actors. An investigation of three emerging modern integrated beef chains near HCMC were investigated and incorporated as exemplars. The weaknesses of the current supply chains were identified and reported.

Note: Activities 2.4.2, 2.4.3, 2.5.1, 2.5.2, 2.5.3, and 2.5.4 planned in the original proposal were removed after consultation with the Research Program Manager.

Objective 3: Identify and develop knowledge exchange and adoption pathways for expanding impacts within smallholder beef cattle enterprises.

No.	Activities	Outputs/ Milestones	Completion date	Comments
3.1 Identify socio-economic characteristics that affect knowledge transfer, adoption and adaption.				
3.1.1	Review the literature on the focal smallholder cultures to assist the development of change protocols (Activity 2.5.1).	• Report on recommended cultural change strategies.	July 2014	A proposal for production & marketing protocols, the Best Practice VCM Model presented at the 2017 AGM and discussed for extension implications re change protocols. Activity Report completed. Links to Activities 2.4.1 to 2.4.3
3.1.2	Monitor the impacts of the ACIAR Project SMCN/2007/109/3 and cattle development projects in Đắk Lắk, to assess the extent and mechanisms of adoption and adaption.	• Bi-annual consultation with local authorities. • Bi-annual consultation with other private rural agents.	Case Study 1 - Case Study 2 - Case Study 3 -	Three case studies were designed and carried out to explore the role of farmer champions, reasons for adoption and non-adoption, and the operation and transferability of cattle clubs. The Findings have formed the basis of trip reports, two conference papers and are currently being developed into two journal papers (for cases study 1 and 2). A practical guide for cattle club development has been developed from case study 3 learnings. Journal papers are in development for submission in 2018.
3.1.3	Conduct regular exposure visits and hold reflection meetings in project communities and communes to promote the project outcomes & benefits to non-participating farmers	• Report annually on visits and responses.	Annual Reports 2017, 2018	
3.2 Map knowledge pathways in focal chains to identify key people, businesses and organisations for each stage of the chain that influence farming and business practices.				
3.2.1	Conduct value network analysis as the basis for developing a culturally appropriate model for the change protocol (Activity 2.5.1), knowledge exchange and adoption of VCM Models.	• Report on key influencers in each participating commune. • 1 peer reviewed conference paper on characterisation of cultural change strategies.	March 2018	Activity Report completed has been prepared. Methodological development is continuing and two journal papers are in preparation: a methods paper focusing on the novel application of the R and MuxViz software packages and a case study paper.

3.3 Facilitate knowledge exchange and adoption pathways in focal communes that support Objective 2 and the scaling-out of the adoption of project outcomes.				
3.3.1	Develop a knowledge exchange and adoption framework to support the change protocol (Activity 2.5.1).	• A framework for improved engagement with smallholder beef producers and beef value chain actors. • 1 peer reviewed journal paper on the method for designing a knowledge exchange & adoption framework	March 2018	• Activity Report completed has been prepared. • Whilst elements associated with improving knowledge exchange pathways were emerging in the course of individual case studies under activities 3.1.3, 3.2.1 and 2.1.6 the timelines involved precluded full development of a formal knowledge exchange framework for specific testing within the scope of this project
3.3.2	Conduct training to build the capacity of DARD, Extension Station & Provincial Department of Science & Technology. and Extension Station officers and other private rural agents to support the project and facilitate subsequent scale-out of production and marketing best practice models.	Workshop materials developed with appropriate: • Methods; • Extension materials; • Training materials.	March 2018	• Activity Report completed has been prepared. • Stakeholder training methods field tested and refined with extension stakeholders within a single district in each of Bình Định and Phú Yên. • Training materials and training packages (including the 'Working with Farmers and Cattle Club Development extension guidebooks) developed from 3.3.1 outputs and field tested DARD and other next users in late 2017 and early 2018

3.3.3	Establish learning alliances associated with: a) Farmer 'interest groups' in each commune; b) Other chain participants including Middlemen c) Previously non-participating farmers who wish to engage with the project; d) Within & between Provincial DARD, and Extension Station, Provincial Department of Science & Technology officers and other private rural agents e) Stakeholders of other projects, e.g. CIAT/IFAD.	• Establishment of a learning alliance of farmers, representing all 3 provinces. • Establishment of a learning alliance of DARD, and Extension Station & Provincial Department of Science & Technology officers from all 3 study provinces. • Inclusion of other private rural agents.	March 2018	• Handbook: Using farmers in technical transfers • Eight (8) Farm notes have been printed and distributed to DARDs. • Learning alliances facilitated within Activity 3.1.3 Case study 3 cattle club development activities in Tây Giang and An Chan and developed under Activity 2.1.6 in Đắk Lắk. • Cattle Club establishment and operational guidebook developed as part of Case study 3 and used as a basic training tool both new CC members and key stakeholders involved in these emerging alliances • Activities such as field days and cross-visits within and between communes and provinces used as a vehicle to foster stakeholder interest in formation of learning alliances.
3.3.4	Graduated transition to Focal Farmer leadership of the knowledge exchange and scale-out process	• Local indigenous autonomy • Extension of best practices to non-participants in the project.		• Local indigenous autonomy achieved in Đắk Lắk and Tây Giang • Extension of best practices to non-participants in the project in both provinces is occurring. • However major constraints to such scale-out remain due to the impacts of periodic natural disasters (especially floods) and the challenge of fully engaging district and provincial DARDs in integrating derived best practice recommendations into policy development and application • Emerging farmer champions in Tây Giang and An Chan now taking the lead in development and management of new cattle clubs and dissemination of new knowledge • A new Cattle Club has been endogenously developed in Tây Giang District.

3.3.5	Monitor the implementation of the knowledge exchange and adoption framework to support Objectives 1 & 2.	• Tactical operational changes as required.	2017-18	• Initial uptake and application of new practices introduced under various Objective 1 and 2 activities was monitored during Objective 2 and 3 activities (especially activity 3.1.2 and 3.1.3 Case studies) as an indicator of the effectiveness of new knowledge delivery and sharing techniques introduced. • However, the timeline between development of new research findings and opportunities to translate these into effective deliverables for communication limited opportunities to fully develop and test an overall knowledge exchange framework within the project timeline an Objective 3 resource base.
3.4 Continuously improve knowledge exchange and adoption pathways on the basis of experience				
3.4.1	Review annually to project completion the implementation of the knowledge exchange and adoption framework with the chain actors and develop new, amended implementation plans on the basis of experience.	• Strategic changes as required to improve the knowledge exchange and adoption framework. • 1 peer reviewed journal paper on the results of the systematic approach to cultural change as a basis for VCM (lead: Ho Le Phi Khanh).	2017-18	Two papers published in the Journal of Innovation & Knowledge: • Ho, KLP, Nguyen, CN, Adhikari, R, Miles, MP & Bonney, L 2018, 'Exploring market orientation, innovation, and financial performance in agricultural value chains in emerging economies', *Journal of Innovation & Knowledge*, vol. 3, no. 3, pp. 154-63. • Ho, KLP, Nguyen, CN, Adhikari, R, Miles, MP & Bonney, L 2019, 'Leveraging innovation knowledge management to create positional advantage in agricultural value chains', *Journal of Innovation & Knowledge*, vol. 4, no. 2, pp. 115-23.

7 Key results and discussion

7.1 Objective 1: Develop more efficient smallholder cow-calf and cattle growing systems.

7.1.1 Improving cow-calf production systems

Baseline study

The objective of the baseline study was to evaluate the status of smallholder cow-calf reproduction in Central Coastal Vietnam. The cow-calf production system in the study communes has been moving from extensive to semi-intensive or intensive system. Household resources are important in helping farmers select animal genetics, method and strategy to develop livestock production (Nelson and Cramb 1998). Available labour and land area, particularly agricultural land are factors that greatly influence farmer's ability to produce livestock. Survey results indicated that the average number of people in a household was 4.79 in Tây Giang commune and 4.46 in An Chan (Table 2), in which, more than 60% of household population are labouring on and off farm (this group categorised by men 15-60 years of age and women 15-55 years of age). Total on-farm labour per household was close to 3 in both Tây Giang and An Chan (Table 2).

The land area of households in Tây Giang commune (5,400 m^2/household) was higher than that in An Chan commune (3,365 m^2/household) (Table 2). Most of the households (95% in An Chan and 88% in Tây Giang) use an area of land for cultivating grass. This means that farmers have had awareness in the development of cattle production of their family. The average land area of forages was 1.38 *sao (= 690 m^2)* (occupied 14% of agricultural land) while the land area of forages in An Chan was 2.8 sao (=1,400 m^2) per household (accounted for 83% of agricultural land). These results showed that there was a significant difference in the land area for planted forages in both communes. The percentage of cultivated grass land of total land in An Chan was higher when compared to other regions, such as EaKar district, Đak Lak province (Dung et al. 2015), and Dong Anh district, Ha Noi City (Ngoan et al. 2015). This may be in part due to improved forage introductions during SMCN/2007/109/3. The average land area of householder was quite small, especially in Phu Yen. The shortage of land was seen as a restriction for the households wanting to further develop cattle production. This finding has also been reported by Van *et al*. (2014), who reported that the area available to grow forages was the constraint of household farmers in Quang Tri province. That research recommended households who wanted to develop intensive livestock should convert some of the land area allocated to growing crops into cultivating forages.

Table 2 Mean (±SD) population, labour, and cultivated land of surveyed households of Tây Giang and An Chan commune.

Indicators	Tây Giang (N=66)	An Chan (N=61)
Total population (people/household)	4.79 ± 1.71	4.46 ± 1.16
Total labour (people/household)	2.88 ± 1.44	2.95 ± 1.20
Male labour (people/household)	1.48 ± 0.90	1.79 ± 0.97
Female labour (people/household)	1.39 ± 0.72	1.16 ± 0.52
Total area (m^2)	5400 ± 3862	3365 ± 2535
Area of agricultural land (m^2)	4900 ± 3975	1680 ± 1505
Improved forages area (m^2)	690 ± 330	1400 ± 1325

The number of cattle per household is an important indicator reflecting livestock production and their contribution to household income. The average number of cattle per household in Tây Giang commune was 4.5, while in An Chan commune it was 5.7 head (Table 3). These statistics indicate that cattle production in Bình Định and Phu Yen is typical of small householder beef producers. However, the number of cattle per household of surveyed communes of this study was slightly higher than that compared to the other provinces in the region and other regions in the country. For example, the average number of cattle/household was 2.8-3.0 in Quang Ngai province (Ngoan and Phuong 2008); 2.8 in Quang Tri province (Van et al. 2014); 3.7 in Dong Anh region, Ha Noi province (Ngoan et al. 2015); and 3.0 Tien Giang province (Truc 2013). This confirms that the South-Central Coast is still one of the major beef producing regions in Vietnam.

Cows accounted for 49.8% of cattle surveyed in Tây Giang and 36.6% in An Chan (Table 3). The higher proportion of cows in Tây Giang is reflective of this region selling many young cattle to other regions for growing and finishing, as they don't have the feed resources to finish significant numbers. In cattle production systems, the breed has a great impact on livestock performance, and the percentage of crossbred cattle can reflect the level of intensive cattle production (Le and Koops 2003). The results in this study showed that the percentage of crossbred cattle of surveyed households was high; the percentage of Zebu (crosses of yellow cattle with Sind or Brahman) crossbred cows in Tây Giang was 89.9% and An Chan 73.4%.

Table 3 Mean cattle number (±SD) per household and age structure of the cattle herd in Tây Giang and An Chan communes

Cattle (head/household)	Tây Giang (N=66)	An Chan (N=61)
Total cattle (head)	299	350
Mean cattle/household (head)	4.53 ± 1.82	5.74 ± 3.06
Age structure (%)		
Cow	49.8	36.6
Calf < 6 months	14.7	12.9
Calf 6-12 months	12.0	15.1
Young cattle 12-24 months	15.1	14.0
Cattle > 24 months (bulls and heifers)	8.36	21.4

Reproductive cows and calves are fed by grazing and stall-feeding or only stall-feeding. More than 90% of farmers provided water, salt for cattle, heat detection and estimated the calving date, although the percentage of farmers practicing early weaning of their calves was low (only 12.1% in Tây Giang and 3.3% in An Chan). Feed sources and types that were used for cows were diverse. There was no significant difference in terms of the amount or type of feed being offered to cows before and after calving.

The BCS of cows is an important indicator of cow-calf reproduction system. Evaluation of BCS can help farmers to adjust the nutritional intake of cows. Cow's BCS at calving, at peak of milk yield have a great influence on reproductive performance of cows (Mandour et al. 2015). The results of the BCS of 500 cows in two communes at different times of the year were shown in (Figure 1). The BCS of cows in the two communes trended to increase from pregnant to calving, then decrease to 3-6 months after calving. Body condition score (BCS) of the cows varied between periods of feed availability and shortage; BCS was satisfactory when seasonal feed supply and quality was good but relatively low in times when feed supply and quality was lacking, especially in Tây Giang (Figure 1). The results in Figure 1 show that in the late feed shortage period (March in Tây Giang and June in An Chan), the cows had lower BCS (average 0.18 in An Chan and 0.31 in Tây Giang) compared to the late feed available season (August in Tây Giang and March in An Chan). During the feed available season, the cow's BCS in the first trimester of the pregnant in Tây Giang and An Chan were 2.86 and 2.87, respectively. At the last trimester of pregnant, cow's BCS reached

3.26 in Tây Giang and 3.22 in An Chan commune. The standard deviation (SDs) were high, this indicated that the BCS of the cows had a large variation among individuals at the same time. This indicated that intervention in the cow-calf system should be focussed on increasing nutrition of cows post-partum, particularly during periods of feed shortages. This could be achieved by introducing supplementary feeding concentrates.

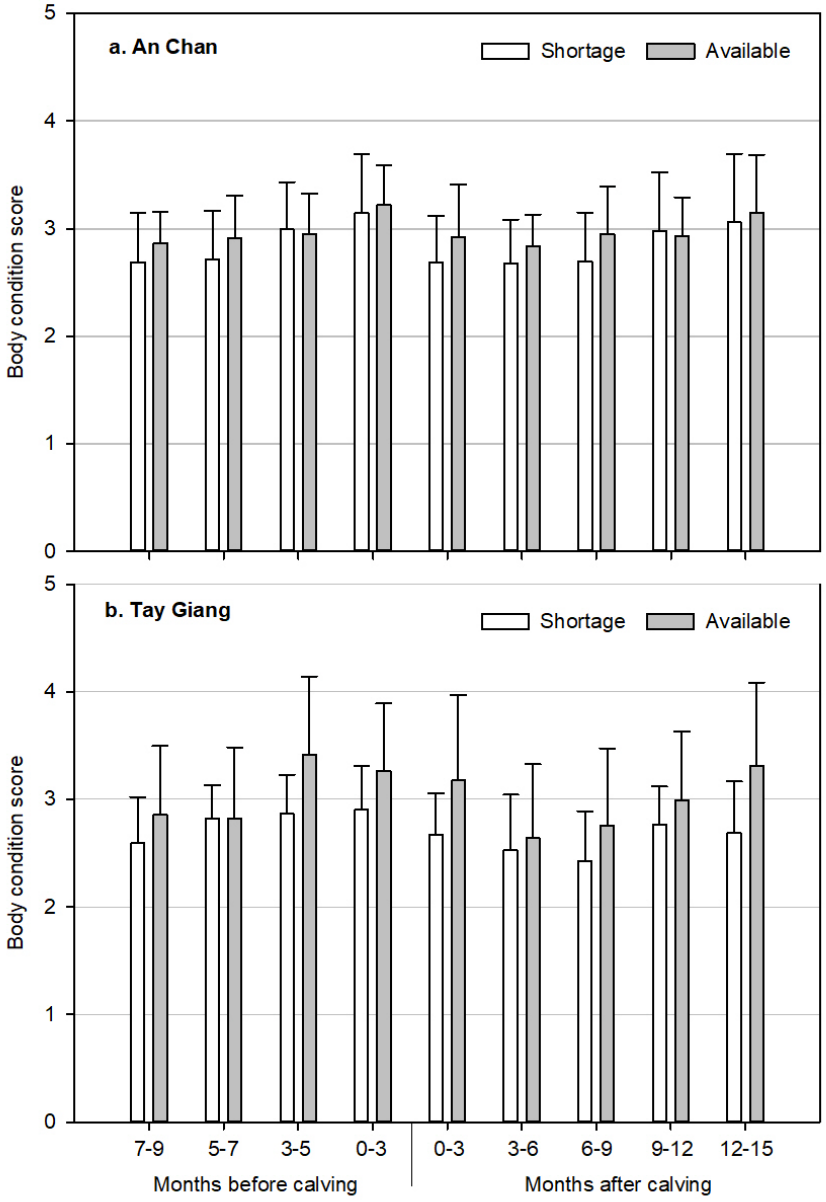

Figure 4 Body condition score of cows before and after calving in periods of feed shortage and feed availability in a) An Chan and b) Tây Giang. Error bars represent standard deviation of the mean.

Reproductive performance is an important factor to assess the efficiency of cow-calf production system. The assessment results of cow fertility are shown in Table 4. The results showed that the average of number calving parity of cows in Tây Giang were 3.56, while in An Chan were 3.7. The first oestrus of cows was 23.5 months in Tây Giang and 25.7 months in An Chan commune. There was a wide range of age at first oestrus in both Tây Giang and An Chan commune, from 12 to 36 months. The age at first calving was 33.3 months in Tây Giang and 35.3 months in An Chan commune. Similar trend followed with the first oestrus,

the first calving age of cows also had a wide range from 21 to 45.6 in both communes. First oestrus age, first mating age and first calving age were influenced by many factors, especially the nutrition level, cattle weight. The results also showed a great difference in the cow management of the householders. The age of cows at first calving in our study was higher than cows in Tien Giang province with an average of 25.8 months, fluctuating 23-28 months (Truc 2013). However, the first calving age of cows in this study was similar to the cows in Quang Ngai province (Phung 2009), and was lower than that of Brahman cows in Bình Định province with the first calving age was 36.29 months (Cai 2005).

The calving interval was 13.2 months in An Chan and 15.9 months in Tây Giang commune. There was a slight difference between the two areas about cow's calving interval, breeds may be a reason for this difference. In Tây Giang the majority of cow breeds were cross-breds between Brahman and Yellow cattle, while Phu Yen was mainly cross-breds between Sind and Yellow cattle. However, it is necessary to study carefully the cow management, nutrition management, breeding management in households level to propose a reasonable solutions for each commune. The calving to conception interval (CCI) is long. On average, the CCI was 4.62 months in An Chan and 6.21 months in Tây Giang. The survey found that most of the households do not apply early weaning techniques and do not feed the cows individually, according to each stage of reproduction. It can increase the time from and calving to conception.

This research indicated that the project should focus on improving calf growth rate, reducing the calving interval, particularly in Tây Giang and cow-calf value chain analysis in South-Central Coastal Vietnam.

Table 4 Mean (± SD) reproductive parameters of cows in householder in Tây Giang and An Chan commune

Indicator	Tây Giang		An Chan	
	n	X ± Sd	n	X ± Sd
Number of calving (calf)	220	3.56 ± 3.06	224	3.70 ± 2.46
Age of first oestrus (months)	205	23.4 ± 5.64	212	25.7 ± 5.40
Age of first mating (months)	205	23.7 ± 5.56	212	25.8 ± 5.54
Age of first calving (months)	205	33.3 ± 5.40	212	35.3 ± 5.32
Pregnant time (months)	255	284.3 ± 5.69	245	285.5 ± 6.27
Calving to first heat interval (days)	255	177.1 ± 116.4	245	137.8 ± 94.4
Calving to conception interval (days)	255	186.4 ± 116.1	245	138.5 ± 93.6
Calving interval (days)	255	476.9 ± 121.8	245	397.1 ± 75.1

On-station experiment

Long calving intervals are one of the major constraints to increasing beef production in the South-Central Coastal region of Vietnam. Calving intervals are thought to range between 13 and 15 months. Recent studies by Dung *et al.* (2015) reported calving intervals of cow between 397 days (approx. 13 months) and 476 days (approx. 15.5 months) in An Chan commune, Phu Yen and Tây Giang communes, and Bình Định respectively. Factors thought to be contributing to long calving intervals include (but are not limited to), irregular oestrus cycle, sub-optimal body condition, poor oestrous detection, and lack of access to good quality bulls. This has led to poor conception rates at first service, relatively older age at first mating (21 to 49 months (Truong et al. 2001), and seasonality of calving patterns. The previous ACIAR project (SMCN/2007/109/3) identified that poor body condition of cows during late pregnancy and lactation phases are a major contributor to long calving intervals. Therefore, Objective 1 of the current project sought to explore on-farm, cost effective and practical nutritional strategies for maintaining body condition score of cows from the 3rd trimester of pregnancy through to early post-partum and return to oestrous. Specifically, the

aim was to reduce the calving interval of cows of the farmers participating in the project to 12 months. Furthermore, investigated the effects of post-partum concentrate supplementation on cow and calf performance traits.

Changes in live weight of cows post-partum in response to supplementation with concentrates is presented in Table 5. The mean liveweight of cows in the mother low supplementation (ML) group was 32.3 kg higher than the mother high supplementation (MH) group at partum. In general, the mean liveweight of cows in the ML group steadily declined by 12.2%, while the MH group marginally increased by 4.2% during the 4 months post-partum. However, there was no significant difference between two treatments (P>0.05). There was no significant (P>0.05) difference in the BCS of cows between treatments at any of the measurement times (Table 6). Mean BCS of cows at birth in MH and ML groups were 3.28 and 3.32, respectively. The mean milk yield of cows in MH treatment was higher than cows in the ML treatment group at each of the measurement times (Table7). However, this difference was not statistically significant (P>0.05). The milk yield of MH group reached the highest point during the 1st month, at 2657 g/head/day. This figure declines sharply to 1638 by the 4th month. Meanwhile, the highest milk yield of ML group is observed during the 2nd month after calving. Milk yield decreases to 1396 (g/head/day) at 4th month. Total milk yield in 4 months of cows in MH group are 271.1 kg/cow that is higher than that on ML group, at 227.5 (kg/cow).

Table 5 Mean live weight (kg) of cows in response to low and high levels of concentrate supplementation over 4 months post-partum

Treatment/time	High level supplementation			Low level supplementation			
	n (cow)	Mean ± SE	Change %	n (cow)	Mean ± SE	Change %	P
At birth	9	356.2 ± 16.03		7	388.5 ± 18.17		0.20
1st month	9	361.4 ± 16.62	+1.5	7	393.4 ± 18.84	+1.3	0.22
2nd month	8	362.2 ± 17.73	+0.2	7	381.8 ± 18.96	-2.9	0.46
3rd month	7	370.0 ± 17.59	+2.1	6	360.8 ± 19.00	-5.5	0.73
4th month	6	371.0 ± 17.31	+0.3	6	346.2 ± 17.31	-4.1	0.33

Table 6 Mean body condition score (BCS) of cows in response to low and high levels of concentrate supplementation over 4 months post-partum

Month	High level supplementation		Low level supplementation		
	n (cow)	Mean ± SE	n (cow)	Mean ± SE	P
At birth	9	3.28 ± 0.73	7	3.32 ± 0.07	0.66
1st month	9	3.33 ± 0.05	7	3.39 ± 0.06	0.47
2nd month	8	3.38 ± 0.06	7	3.39 ± 0.06	0.84
3rd month	7	3.32 ± 0.08	6	3.30 ± 0.09	0.92
4th month	6	3.38 ± 0.09	6	3.25 ± 0.09	0.40

Table 7 Mean milk yield of cows (g/day/cow) in response to low and high levels of concentrate supplementation over 4 months post-partum

Month	High level supplementation		Low level supplementation		
	n (cow)	Mean ± SE	n (cow)	Mean ± SE	P
1st month	9	2656 ± 175	7	2144 ± 198	0.07
2nd month	9	2596 ± 161	7	2279 ± 183	0.22
3rd month	8	2149 ± 240	7	1850 ± 257	0.42
4th month	7	1638 ± 216	6	1396 ±233	0.33
Total 4 months (kg/cow)		271.1		227.5	

Return to oestrous was not detected in all of the cows before they were sold at the completion of the experiment by the farmer (some cows were sold shortly after calving). Of the cows that did return to oestrus-mean time from calving to heat detection of cows in MH group was 46 days and was much shorter than ML group, 129 days (P<0.05). The minimum and maximum figures in MH group were 34 and 90 days, respectively. Meanwhile, these data for ML group were 80 and 217 days.

Table 8 Fertility performance of cows in response to low and high levels of concentrate supplementation over 4 months post-partum

Indicators	High level supplementation	Low level supplementation	P
Number of cows in group	9	7	-
Number of cows heat detection after calving	5*	4*	-
Rate (%)	55.6	57.1	-
Calving to first heat detection (days)	46 ± 21.04	129.5 ± 23.52	0.03
Min (days)	34	80	-
Max (days)	90	217	-

***Note: The experiment ended before all of the cows had returned to oestrus.**

There was no significant (P>0.05) difference in the live weight of calves between the two supplementation treatments (Table 9). The live weight of calves at birth day in MH and ML groups are about 23 and 26 (kg/head), respectively. These figures increase rapidly in both treatments. Four months after calving, the live weight of calves in MH group is 109 (kg/head). This figure for ML group reaches 115 (kg/head) (Table 9).

Table 9 Live weight of calves at birth and monthly until 4 months of age (kg/head)

Age of calf	High level supplementation		Low level supplementation		
	n (calves)	Mean ± SE	n (calves)	Mean ± SE	P
At birth	9	23.50 ± 1.17	7	26.07 ± 1.32	0.17
1st month	8	45.69 ± 2.70	7	48.43 ± 2.88	0.50
2nd month	7	69.57 ± 3.33	6	74.55 ± 3.59	0.33
3rd month	6	91.92 ± 5.48	6	95.42 ± 5.48	0.66
4th month	5	109.20 ± 5.72	4	115.63 ± 6.40	0.48

In this research, there was no significant difference in the BW and BCS of cows in MH and ML groups (P>0.05). However, a significant (P<0.05) difference was observed in the interval from calving to the first heat detection between the two treatments. This result is similar

trend with findings from Hai et al. (2015) who reported that supplementary concentrate for cows in post-partum could reduce the interval from calving to conception of cows. In that study, the calving to conception interval was reduced from 212 days (no supplementation) to 144.5 days (with post-partum supplementation).

Body weight of calves at birth, milk production of cows are the elements affect to the calf performance. In this experiment, the body weight of calves at birth in MH group was lower than in the ML group throughout the experiment, although this was not significant. Lower calf weights in the MH treatment could be an artefact of lower cow live weights at partum. However, the high milk production is observed in MH group. Therefore, the growth performance of calves in MH group is improved. Hai *et al* (2015) showed that supplementing with improved diet (mixing concentrate) in last three months of pregnancy resulted in heavier calf weight at birth with roughly 28.8 kg/head.

A number of challenges were encountered in the conduct of this experiment. It was not possible to buy all the cows at the same time as planned. At that time, cow prices were high as smallholders were expanding their herds and wanted to retain cows of breeding age. The prices for cows increased to nearly 50 million VND for one cow compared to about 35-40 million in previous times. It was also difficult to find cows with similar timing of conception. Considerable labour was required to maintain cattle in good health. Some cows showed symptoms of mastitis and needed to be treated. Variable weather conditions during December 2016 caused deaths of two calves within days of birth. Post mortems of the calves concluded that high humidity and variable day and night time temperatures were the cause. The low numbers of replications (cows) in this experiment is likely to be a contributing factor to the lack of scientifically significant results.

On-farm demonstrations

Demonstration of post-partum supplementation of cows in Tây Giang commune showed that both body weight and body condition score could be maintained without significant decline. Calving to conception intervals were compared against that of the same cows in the previous lactation period. Calving to conception interval was improved from 170 days to 107 days and calving interval from 465 days to 392. This result is similar with Hai (2015) who found that post-partum supplementation can help to reduce calving interval by 60 days compared with traditional methods. These results are getting close to the goal of a calving interval of 12 months. If calving interval can be shortened to every 12 months then matching the feed supply to the lactation period will become achievable and a more sustainable system. After 3 months joining this demonstration, all of farmers reported a positive study experience with all expectations met and observed improvements to cow oestrus cycling and reductions in calving to conception interval. The other positive effect of this demonstration was the reported labour saving when changing the feeding method. Participant farmers (10 out of 11) reported significant time/labour savings (1-3 h/day) switching from concentrate and other additives cooked as a soup or porridge to feeding as a dry mix concentrate supplements. The expanding of the new technique was an important indicator to prove the success of this technique. From this demonstration, participant farmers reported that 81 farmers enquired/visited to learn about new practices with at least 11 now copying post-partum cow supplementation using dry mix feeds.

7.1.2 Improving feeding of growing calves and finishing cattle

Beef finishing demonstration – An Chan

Feed intake

The results of feed intake of cattle are presented in (Table 10). Concentrate, total DM, CP or metabolisable energy (ME) intake of cattle were significant difference between control group

and treatment group, whereas forage (rice straw and green forage) intake was similar among two groups of cattle.

Table 10 Feed intake and estimation nutritive intake of cattle

Nutritive intake	Control	Treatment	P
The first month			
Concentrate intake (kgDM/head/day)	2.08±0.70	4.14±0.37	<0.001
Rice straw intake	1.91±1.06	1.89±0.72	0.954
Green forage intake	5.45±1.18	4.63±0.70	0.077
Total DM intake			
Kg/head/day	9.44±1.95	10.66±0.71	0.082
%BW	2.29±0.44	2.46±1.43	0.249
CP intake (kg/head/day)	0.89±0.29	1.12±0.08	0.026
The second month			
Concentrate intake (kgDM/head/day)	2.95±0.89	5.50±0.29	<0.001
Rice straw intake	2.62±0.43	2.87±0.36	0.177
Green forage intake	4.08±1.03	3.48±0.75	0.158
Total DM intake			
Kg/head/day	9.65±1.21	11.84±0.89	<0.001
%BW	2.26±0.30	2.53±0.10	0.014
CP intake (kg/head/day)	0.92±0.27	1.27±0.09	0.001
Average of two months			
Mean concentrate intake (kgDM/head/day)	2.45±0.74	4.57±0.34	<0.001
Rice straw intake	2.19±0.65	2.18±0.47	0.988
Green forage intake	4.93±0.91	4.28±0.51	0.067
Mean total DM intake			
kg/head/day	9.54±1.47	11.06±0.66	0.008
%BW	2.32±0.33	2.59±0.08	0.022
Mean crude protein intake (kg/day)	0.96±0.18	1.17±0.08	0.003
Mean ME intake (Mcal/day)	21.2±3.47	24.9±1.56	0.007

Total DM intake in this study is similar or more than reported by Kearl (1982), who suggested that cattle with 400-450 kg body weight and live weight gain about 0.5-1.2 kg/d, have a DM intake of 2.3-2.4% of body weight.

From results of feed intake of cattle, concentrate level in diet of cattle in control groups was 25.5%, and proportion of protein in diet was 10%. These results are similar to those reported by Dung et al. (2013) who conducted a survey of smallholders in Central Vietnam to investigate feed intakes of finishing cattle. Their results showed that the level of concentrate and CP proportion in the diets of finishing cattle ranged from 24.0 to 37.0% and 8.37 to 9.82% respectively.

The results of this study also indicated again that, in fattening cattle system in Central Vietnam, although total feed intake is similar to requirement of cattle, the level of concentrate and CP proportion in diet is low.

Growth performance

Initial weight of cattle was similar between two groups (P>0.05). However, after two months of receiving the feeding treatments, live weight of cattle in treatment group was significantly (P<0.05) higher than the live weight of cattle in control group. Live weight gain of cattle in treatment group reached 1.16 kg/day, whereas live weight gain of cattle in control group was only 0.50 kg/day (Table 11).

Table 11 Live weight gain of cattle

Items	Control	Treatment	P
Initial weight (kg)	410.2±41.8	414.3±32.6	0.810
Weight after 1 month	418.3±44.35	453.1±35.05	0.067
Weight after 2 months	440.2±42.3	483.4±35.3	0.024
Total increasing LW in 2 months (kg)	30.2±13.5	69.3±9.68	<0.001
LWG at the first month (kg/day)	0.27±0.52	1.29±0.22	<0.001
LWG at the second month (kg/day)	0.74±0.38	1.02±0.21	0.055
Average of LWG	0.50±0.22	1.16±0.16	<0.001

Total feed intake, concentrate intake and protein intake was higher in cattle in the treatment group than those of cattle in control groups suggesting this would be the causative factors towards a greater live weight gain of cattle. Many studies reported that increasing concentrate improved live weight gain of cattle. French et al. (2001) reported that supplementation with concentrates increased final live weight and live weight gain of cattle. Cattle fed the high concentrate level showed the highest growth rate compared to medium or low level of concentrate (Rødbotten et al. 2002). Several authors concluded positive relationship between concentrate level and cattle production. Ba et al. (2008), Dung et al. (2013) documented that live weight gain of cattle increased linearly as the amount of concentrate intake. Based on these results, it could be concluded that increasing the concentrate level in diet is an important solution for improving growth performance in finishing cattle system in smallholder in Central Vietnam.

Estimation economic efficiency

Increasing concentrate level in diet led to increase cost of feed for cattle, but live weight gain of cattle improved, income from live weight gain of cattle also increased (Table 12). Treatment group farmers spend more cost of feed than farmers in the control group (47,626.4 VND/day compared to 28,324.8 VND/day) (Table 12). However, live weight gain of cattle in treatment group higher than its of cattle in control group (Table 11). The price of cattle in study time was 65,000 VND/kg live weight, total income from live weight gain in treatment group is more 2.3 times compared to control group. Gross margin of farmer in treatment group is more 6.2 times compared to control group (27,449 VND/day compared to 4,392 VND/day).

Table 12 Estimation economic efficiency

Items	Control	Treatment	P
The first month			
Outcome (cost of concentrate + water spinach)[1] (VND/day)	25,616.7	43,297.3	<0.001
Income from LWG (VND/day)[2]	17,550.0	84,066.7	<0.001
Gross margin (VND/day)	-8,066.7	40,769.4	<0.001
The second months			
Outcome (cost of concentrate + water spinach)[1] (VND/day)	32,154.4	57,608.0	<0.001
Income from LWG (VND/day)[2]	47,883.3	66,083.3	0.055
Gross margin (VND/day)	15,728.9	8,475.3	0.467
Average of two months			
Outcome (cost of concentrate + water spinach)[1] (VND/day)	28,324.8	47,626.4	<0.001
Income from LWG (VND/day)[2]	32,717.0	75,075.0	<0.001
Gross margin (VND/day)	4,392	27,449	<0.001

[1]Cost of feed: concentrate + water spinach, without including elephant grass and rice straw; [2] price of cattle: 65.000 VND/kg live weight.

Beef finishing demonstration – Ea Kar

Initial mean weights of cattle in treatment and control groups were not statically different (P>0.05) at 319 kg and 329 kg, respectively Table 13). At the completion of the feeding demonstration, weights of 2 groups of cattle reached 426 kg and 437 kg, respectively.

Table 13 Weight increase in cattle

	Treatment (n = 8)	Control (n = 8)
Weight (kg)	(M ± SD)	(M ± SD)
Initial	319.94 ±7.38	329 ± 12.71
First month (30 day)	347.9 ± 8.24	355.9 ± 12.41
Second month (60 day)	377.4 ± 8.47	381.3 ± 13.43
Third month (90 day)	410.4 ± 8.76	406.9 ± 15.30
Fourth month (120 day)	437.3 ± 8.52	425.7 ± 13.31
Absolute growth (g/head/day)		
Initial – 1st month	932 ± 111	897 ±72
1stmonth – 2nd month	983^{a} ± 47	847^{b} ± 77
2nd month – 3rd month	1100^{a} ± 43	851^{b} ± 218
3rd month – 4th month	898^{a} ± 74	627^{b} ± 131
Mean	978^{a} ± 44	806^{b} ± 170

Note: In the same row of exponents as different letters then the difference was statistically significant (P <0.05).

Weight gain was high at 806g/head/day in the control and 978 g/head/day. Monthly increase of weight was relatively even. Comparisons of weight gain during the trial showed there were significant differences between treatment and control (P<0.05). The comparison of live weight gain among the months of fattening period showed that in the first three month the difference of body weight gain was not significant, but it was much lower in the fourth month. At this stage cattle may have approached their mature weight. The increase in weight of cattle through months was 806 - 978 g/head/day higher than in previous studies (Chinh et al. 1992, Ly et al. 1995, Noi et al. 1999). In the experiments, fattening cattle only reached 510 - 580 g/head/day. The results of Cuong et al. (2008) revealed the weight of crossbred Brahman cattle gain 732-845 g/head/day. Our result is lower than that of Nguyen Huu Van et al. (2012) in fattening Brahman hybrids with a high-protein concentrate diet supplemented at 2% of body weight which weight gain was 667-1,259g /head/day). Our results are equivalent to the results of Hue (2017) in fattening of crossbred Brahman cattle by agricultural by-products (the weight gain of 766.7 - 904.2 g/head/day).

Table 14 Feed consumption (DM) per 1 kg weight increase

Month	Treatment (n = 8)	CV%	Control (n = 8)	CV%
1	8.35 ± 0.72	8.57	8.64 ± 1.19	13.73
2	8.39^{a} ± 0.23	2.73	9.39^{b} ± 0.26	2.72
3	9.49 ± 0.30	3.20	9.52 ± 2.25	2.60
4	10.20^{a} ± 0.20	1.98	9.67^{b} ± 0.23	2.35
Mean	9.11 ± 0.90	9.86	9.30 ± 0.46	4.95

Note: In the same row of exponents as different letters then the difference was statistically significant (P <0.05).

Feed consumption (kg dry matter/head/day) of two groups of cattle was from 9.11 to 9.30 kg DM/head/day. Feed consumption of control was higher than that of treatment but the difference was not statistically significant (P>0.05). Results of feed consumption of two groups of cattle were within the standard (ARC 1980, AFRC 1993, NRC. 2000) (7.1 - 8.8 kg DM/kg of weight gain). Another study implemented by Cuong et al. (2007) showed that fattened cattle consumed 8.19 to 11.38 kg dry matter/kg of weight gain. Cuong et al. (2008) found that the feed consumption of cattle fattened by different protein diets was from 8.17 to 9.23 kg dry matter/kg of weight gain.

Table 15 Feed consumption (protein) per kg weight increase

Month	Treatment (n = 8)	CV%	Control (n = 8)	CV%
1	1.24 [a] ± 0.10	7.87	1.08 [b] ± 0.16	15
2	1.25 [a] ± 0.03	2.51	1.18 [b] ± 0.03	2.95
3	1.40 [a] ± 0.04	2.97	1.20 [b] ± 0.03	2.82
4	1.50 [a] ± 0.03	1.85	1.22 [b] ± 0.03	2.54
Mean	1.35[a] ± 0.12	7.13	1.17[b] ± 0.06	5.37

Note: In the same row of exponents as different letters then the difference was statistically significant (P <0.05).

The protein intake of cattle in the experiment was rather high (1.17 - 1.35/head/day. Treatment group cattle got higher protein than cattle in the control group (P<0.05). High protein intake of cattle in treatment diet led to high growth. According to Hue (2017), protein intake in fattened crossbred Brahman cattle was 619.7 - 832.64 g/head/day lower than that in our results.

Table 16 Estimated economic efficiency

Indicator	Treatment	Control
Initial weight (kg)	319.94 ± 7.38	329.04 ± 12.71
Final weight (kg)	437.38 ± 8.52	425.71 ± 13.31
Increase of weight	117.44	96.87
Price for 1kg of meat	62000	62000
Total revenue	7282337	6005940
Feed		
+ Concentrate	360	240
Price for 1 kg	7520	6450
Feed cost (concentrate)	2707200	1548000
+ Grass	4463	5135
Price for 1 kg	500	500
Feed cost (grass)	2231438	2567625
Total feed cost	4938638	4115625
Income	2343700	1890315

Brahman crossbred cattle were fattened with a mixture of high-quality protein concentrate with a protein content of 15.1% giving an additional income of VND 2,343,700 compared to the control of VND 1,890,315 (The difference of income between two groups was VND 453.385). Therefore, through diet improvement of fattening cattle, efficiency of farming in the farmer's livestock situation in Dak Lak province increased. Our result was higher than the study implemented by Cuong et al. (2005) when fattened Brahman crossbred cattle (an increase of VND 279.968); Van et al. (2009) used silaged peanut leaf for fattening cattle got an increase of 119.100 VND. Our result is lower than that of Hue (2017) who used agricultural by-products to fatten cattle giving income from 683.478 – 982.473 VND.

Conclusion

Treatment Brahman crossbred cattle fattened was high weight gain, appropriate feed consumption, higher profit than control cattle. Fattened Brahman crossbred cattle had good meat stalls, higher carcass percentage, percentage of pure meat than traditional fattening cows. Crossbred beef colour and pH were within acceptable limits. Fattened beef had higher levels of fat in muscles than control beef.

7.1.3 Improving management of forages for production and quality

Tolerance to waterlogging studies

Single waterlogging events had little effect of the number of live tillers of *Brachiaria* hybrid cv. Mulato II. However, repeated waterlogging events reduced the number of live tillers and the above ground dry matter over time. Similar results were found for *Brachiaria ruziziensis* with the number of live tillers and above ground dry matter significantly affected by repeated

waterlogging events. *Panicum maximum* cv. TD58 showed similar responses to *Brachiaria* hybrid cv. Mulato II, recovering from single waterlogging events. However, DM production and number of live tillers declined when exposed to repeated waterlogging. These cultivars therefore may persist in areas where short seasonal waterlogging occurs, but not for areas that remain waterlogging for extended periods.

In contrast, *Brachiaria humidicola* and Paspalum atratum cv. Ubon were not affected by the waterlogging treatments (not difference between the treatments and the control). However, tiller number and DM production declined overtime and may be in response to the short cutting interval. These species remain the best options for waterlogging prone areas. Results for Pennisetum purpureum cv. VA06 were inconclusive. Further research is required around the best management practices for smallholders to use during periods of waterlogging including adjusting the cutting height and cutting interval to improve tiller survival and DM production.

Detailed results will be provided in the journal article.

7.2 Objective 2: Develop stronger integration with markets for beef cattle producers in Central Vietnam.

Objective 2 was addressed by investigating the following research questions:

7.2.1 What are the most appropriate markets with the greatest opportunity for the smallholder farmers in the three focal provinces, Bình Định, Phú Yên, and Đắk Lắk?

Background

The market opportunities for farmers are changing quite rapidly because the beef cattle supply system across South East Asia is inter-linked. Cross border movement of livestock in Vietnam is dominated by unofficial movements. Routes are shaped by long-term relationships among traders, in some cases based on ethnicity, language and kinship which transcend modern national borders.

South East Asian beef production and marketing is driven by the Chinese demand. Vietnam is also a gateway for both the formal and informal or 'grey' market[2] imports of frozen beef and live cattle into China some of which is sourced from Australia (Waldron et al. 2015).

In this project the research questions related to two different subspecies of *Bos taurus, Bos taurus indicus*, and *Bos taurus taurus* (Integrated Taxonomic Information System 2017). The indigenous Vietnamese 'Yellow Cattle', whilst exhibiting high genetic variability are classed as *Bos taurus indicus* and the majority of imported cattle consumed in Vietnam are currently Australian cross-breeds from *Bos taurus taurus*. Yellow Cattle are slaughtered at 200-230 kg with a boning percentage of approximately 37% and the Australian cross-breeds weigh 400-500 kg and have a bone-out of around 50%, thus being preferred by modern slaughterhouses because of their relative carcase conversion efficiency. The relative importance of quality attributes varies with indigenous human culture and time as consumption preferences are rapidly evolving (Hocquette et al. 2012).

The volume, breed and source of animals fluctuates according to prices which themselves are shaped by local and regional supply and demand, biosecurity measures at border and so the trade is highly responsive to market conditions.

[2] *The import of commodities through distribution channels that are technically legal but enable either the avoidance of tariffs of 12-25% and Value Added Taxes or the substitution of product inferior in quality to a high quality brand.*

Consumption of beef in Vietnam has increased 6.0% annually, from 3.2 kg in 2007 to 4.7 kg in 2010, and subsequently increasing to 9.92 kg in 2016 (General Statistics Office, 2017), particularly in the larger, more affluent urban centres like HCMC. However, within this there is a great disparity in consumption of up to 2.54 times between the large urban centres of HCMC, Ha Noi and Đà Nẵng compared to the rest of the population.

The average annual population growth rate from 2017 - 20 is estimated to be 1.02% per year, yet meat consumption is growing at 3-6% per year, probably reflecting variations in the rate of growth in living standards between urban and regional and differences between regional growth areas.

Total beef cattle and buffalo meat consumption in the two largest markets, Hà Nội and HCMC is 580 head/day and 750 head/day respectively with Đà Nẵng consuming 80/day.

There is currently a shortfall of approx.150,000 tons in domestic beef production capacity appears to be made up from informal trading across Vietnam's porous border and imports of live cattle and frozen beef. However, it should be noted that the nature of the market is highly volatile and linked to geo-political changes as well as the market forces highlighted above.

Since 2012, the importation of live Australian cattle for fattening and slaughter in Vietnam has increased from 3,353 head to 308,676 in 2015. In part, this is due to the lower taxation of live cattle (5%) over imported frozen beef (15-30%) but also because of the lower fattening costs in Vietnamese feedlots which makes Australian cattle more competitive than either Vietnamese traditional breeds or other sources of imports (NIAS 2014). Australian beef is about 7 – 12% cheaper than Vietnamese beef.

The Government of the Socialist Republic of Viet Nam has robust plans for the development of the domestic beef industry. In their most recent Livestock Development Plan decided (Decision No 9664/ BNN-KH, 01 December 2016) they plan to:

- Transform from small scale to large scale farming model for livestock;
- Employ high-technology in livestock production;
- Strengthen the relationship among parties in value chain to reduce the cost, increase the efficiency/ effectiveness and the value of product;
- Achieve 6 million cattle of which 70% are crossbreed through the use of Artificial Insemination for at least 40% cattle;
- Produce 19.34 million tons of beef meat and by 2020.

Further, the decision No 984/QĐ-BNN-CN on 09 May 2014 on re-structuring the livestock sector indicates that the Central Coast has ideal conditions to develop beef cattle, and development targets will focus on:

- Using high quality and high productivity bulls;
- Developing cross-breed cattle, focusing on Zebu cattle, using more Artificial Insemination;
- Provide the training for veterinarians and extensionists to improve the livestock services for farmers;
- Improve the efficiency and effectiveness of beef value chains.

All developing countries exhibit change from traditional wet marketing systems to modern supermarket-based systems (Reardon et al 2012), however it is difficult to obtain accurate statistics regarding fresh produce trends for specific countries. The retailing system in Vietnam is developing rapidly with trend rates from traditional wet markets to modern supermarkets of up to 1 – 1.5% market share per annum (AC Nielsen, 2012), however, this

figure includes dry, packaged foods. All the modern supermarkets are rapidly developing regional distribution systems with centralised facilities.

It appears from this research that less than 10% of beef is sold through supermarket due to the packaging[3], inconvenience, lack of social interaction, poor marketing and the A$2 - 3 higher price for beef. The mark-up for beef from Abattoir to Wet Market is about 3.7 times and to the Supermarket about 4.5 times.

Vietnamese beef prices are reasonably stable over the short run (within year) but over the long term have been trending upwards. This is in part due to a quite stable command economy, the small number and interconnectedness between traders in supply chains, poor information flows (particularly price and demand information) and the lack of competition in supply chains.

Findings regarding the opportunity for Đắk Lắk Province to supply HCMC

Đắk Lắk is the largest province of Vietnam with a total area of 1,312,537ha of which 599,908 ha is forest, 533,404 ha is agricultural land and 77,394 ha unused land. Provincial statistical data indicates there were 180,807 cattle in Đắk Lắk in 2014.

The main market opportunities for marketing cattle from Đắk Lắk Provincial production are the provincial capital Buôn Ma Thuột and Ho Chi Minh City (HCMC). Buôn Ma Thuột has a population of 502,170 and a growing Vietnamese and regional tourism industry based on its moderate climate and high-quality coffee production (*Coffea canephora* known as "Robusta"). HCMC, the largest city in Vietnam, (HCMC) has approx. 8.76 million people and the market share of beef is around 5-6% compared to other meat. The retailing system in HCMC requires higher standard of technique, quality and the safety of beef. Vissan, the largest processor in Vietnam, sets the benchmark the quality of supply in HCMC. In total, approximately 1,150 cattle are slaughtered per day in HCMC, 800 – 1,000 by Vissan, who then deliver to supermarkets and wet markets across the city and neighbouring provinces.

High transportation cost and insufficient volume of 450+ Kg cattle has made it difficult for Đắk Lắk cattle to compete with Australian beef. On average, a truck which transported 20 beef cattle from Đắk Lắk to HCMC costs VND 15 million per trip which means approx. VND 750 thousand per animal for the 400 km trip.

Đắk Lắk beef cannot compete with imported beef and the reasons are well-known to everyone in the industry, including farmers:

- Modern processors (e.g. Vissan) want cattle weighing 450 kg or more because of the greater meat to bone ratio (54%) compared to Yellow Cattle (33-37%);
- Insufficient and inconsistent volume of supply from Đắk Lắk in the 450^{+} kg category;
- Đắk Lắk cattle have a higher delivered cost in HCMC due to higher costs of production from a less efficient system and the transport cost to HCMC;

In recent years, due to increased consumer demand for beef, the fluctuation of cattle herd and the reduction in marketing to HCM city, the prices for beef cattle in Đắk Lắk has also dropped.

There is no doubt that there is a significant latent capacity for Đắk Lắk Province to supply HCMC. There is a very experienced base of smallholders who have the capacity to respond quickly to changes in market demand. However, over the last 10 years, the nature of demand has changed from a more traditional type of meat supply to a more international standard that is very focused on food safety, quality and price competitiveness, largely through the efficiency of on-farm and supply chain efficiency.

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[3] The Vietnamese consumer prefers to touch, smell and feel the beef before purchasing. Trust in the vendor is an important factor and this is developed through social interaction and the hygiene performance of the meat.

In summary, the conclusions are:

- The retailing system in HCMC requires higher standards of processing, quality and the safety of beef.
- Vissan, the largest processor in Vietnam (800/day), sets the benchmark for the quality of supply in HCMC.
- Australian cattle preferred because of their known provenance versus Thai, Cambodian or Myanmar cattle
- Wholesale buying prices have varied from VND65-74,000/kg over the recent couple of years.
- The price per kilogram of Australian Cattle is approx. 7-12% lower than local Vietnamese Yellow Cattle.
- 400-450 Kg cattle are required for efficient processing in modern slaughterhouses - meat:bone ratio of Aus cattle ~54% versus Yellow cattle ~37%
- Đắk Lắk has:
    - ✓ Insufficient supplies of 450kg cattle
    - ✓ Transport costs are approx. VND750,000 per head to HCMC
    - ✓ Opportunity for transporting live Đắk Lắk cattle to Long An for slaughter for the HCMC market.

Findings regarding the opportunity for Phú Yên and Bình Định Provinces to supply Đà Nẵng

Đà Nẵng is one of five independent (centrally-controlled) municipalities in Vietnam and is a leading industrial and tourism centre with a population of 1.347 million (2016) and has the third largest port system in Vietnam (after Saigon Port in Hồ Chí Minh City and the port of Hải Phòng).

Đà Nẵng is a medium sized, quite competitive traditional market (80/night) on the central coast of Vietnam and is the fifth largest city and enjoys a booming tourist industry with approx. 6.6 million visitors in total (2017) including over 1.43 million international visitors annually (increasing at over 15% p.a.). These tourists stay in 747 3 – 5 star hotels and 82,325 rooms per night in Đà Nẵng and Quy Nhon (increasing at over 15% p.a.) Further, the demand from the traditional Vietnamese accommodation sector dwarfs that of the international and high-income Vietnamese segment of the market (18,800 establishments and 355,000 rooms with an approximate average 58.8% occupancy and overall growth rate in rooms of 8%) (Vietnam Administration of Tourism, 2018).

Historically, the main source of cattle for Đà Nẵng has been Phú Yên Province (average of 20,000 p.a. and peaking at 28,000 in early 2010) but, because of the competition from Australian cattle, this has dropped to approx. 4,000 head in late 2014. Modern supply chains, where calf-raising and calf growing/fattening are separate, specialist operations adding value appear to be emerging from Phú Yên and Bình Định. Cattle from Đắk Lắk Province are only a small component of supply due to the distance of approximately 15 hours' transport;

The total cattle from outside of the Đà Nẵng Special Economic Zone are 1,800 per month. Cattle sources outside the province are:

- Phú Yên 40% (720/month or 26 head/day)
- Bình Định 30% (540/month or 19 head/day)
- Quảng Ngãi 20% (360/month or 13 head/day)
- Đắk Lắk ~5% (90/month or 3 head/day)

- Gia Lai ~5% (90/month or 3 head/day)

Hybrid and imported breeds fattened in Vietnam comprise 80% of the beef consumed despite the misleading information supplied to consumers (and possibly retailers) that claim the beef is sourced from traditional 'Yellow Cattle'..

There are eight wet markets in Đà Nẵng. The largest, Chợ Còn (Con Market) has 14 beef stalls comprised of 8 wholesaler/retailers[4] and 6 retailers[5] selling about 1 tonne/day beef. An average size for the remainder, such as Hàn Market has six beef stalls with possibly 3 resellers/retailers and 3 retailers. None have a butcher with a cold cabinet.

Đà Nẵng has two main Western style supermarkets. *Metro Cash & Carry* (Warehouse format) is the leader in meat supply importing frozen (Temp 0^0C; Shelf life 1 year) and chilled (Temp 5^0C; Shelf life 7 days) beef. Historical frozen imports from Australia and USA have been:

- 2011 = 22,208 kg
- 2012 = 16896 kg
- 2013 = 14,815 kg
- 2014 (YTD[6]) = 25,571 kg

The meat section in Metro Đà Nẵng has approx. 20 times the shelf space of Big C in HCMC and was more attractive with cryovac packed meat as well as trays. Metro sell imported beef mainly to the restaurants and hotels serving foreigners. Local meat is about 70% of their turnover and is from Bình Định (60%) and Quang Nam (40%) and is generally sold as fillet cuts in 0.5 kg packs and (Brahman) hump in 1 kg packs.

Big C Supermarket is another major supermarket chain with a large, hypermarket format store in Đà Nẵng. Beef represents about 25 – 30% of their meat sold and they sell 800 kg/month or an average of 28.6 kg/day (2014) as packed beef in a 200g pack (30%) (because their middle-high income clientele usually purchase less than 500g) or fresh beef sold by the kilogram (70%). They acknowledge Metro is the leader and believe they don't supply imported beef. Big C's prices are 2-5% higher than the Wet Markets and they mainly sell the more expensive cuts such as fillet, hump, leg and minced meat. Big C focus on selling 'traditional beef' so have a 'wet market stall' with a butcher to cut up the consumers' meat allowing consumers to touch the meat before purchase.

Most 3 – 5 star hotels buy frozen or chilled beef on annual contracts from *Metro Cash & Carry* supermarket or *Classic Fine Foods*, a market leading, multi-national importer and distributor of fine foods. Classic Foods is owned by Metro Cash & Carry and serves the vast majority of five-star hotels and high-end restaurants in Asia, with an expanding presence in the Middle East and Europe. It has standing premium meat supply arrangements with producers such as *Stanbroke Pastoral Company*, *Harvey Beef* and kangaroo meat producer *Paroo Kangaroo* and premium NZ lamb producer *Coastal Lamb*. The volume purchased weekly is quite low (typically 3 - 5 kg per day) and this is apparently because international tourists usually leave the hotel to experience the local cuisine in local restaurants. Further, purchase prices are high, around VND 240,000/kg and the purchase drivers are:

- Quality – tender, marbled;

[4] *Resellers supply other retail stalls in the market and typically sell 70-80 kg/day.*

[5] *Retailers sell approx. 15 kg/day.*

[6] *Year-to-Date which also includes chilled beef (previous year's figures do not include chilled)*

- Food safety;
- Guaranteed supply;
- Branding – usually Australian;

Therefore, 3 – 5 star hotels have little incentive to change and even if there was a high quality, hygienic local beef supply, they are not interested in purchasing it.

On the other hand, the large number of Vietnamese hotels serve traditional meals based on low-cost beef pieces and minced beef and offal where the meat is thoroughly boiled or braised, therefore not requiring the large cuts of 'steak' which may be served somewhat more rare (raw).

The major constraints for smallholder farmers to supply HCMC and Đà Nẵng`

The Vietnamese food retailing system is modernising rapidly, pushed by the influx of international tourists to the major cities and many other areas in the country. Retailers are concerned about supply risks and in particular three major concerns:

1. Consistency of supply volume;
2. Consistency of supply quality (including food safety and other value attributes);
3. Consistency of price.

The retailing system in the major centres such as HCMC requires higher standards of processing, quality and the safety of beef and Vissan, the largest processor in Vietnam (800-1,000 head/day), sets the benchmark for the quality of supply in HCMC. Đà Nẵng is similar except the demand is not for domestic consumption but for the tourist market.

These concerns are behind the main constraints for the project provinces in supplying the major target markets:

Insufficient capacity to maintain a consistent supply of quality cattle at a competitive price

Currently, traders and retailers define 'quality' as size (weight) but increasingly in the future, this will be about marbling, meat tenderness (often called 'softness), non-pumping with water and meat safety.

The price per kilogram of Australian Cattle is approx. 7-12% lower than local Vietnamese Yellow Cattle and Australian cattle are preferred because of their known provenance versus Thai, Cambodian or Myanmar cattle. Wholesale buying prices have varied from VND65-74,000/kg over the recent couple of years.

The Vietnamese domestic industry is modernising, particularly in the major cities and their immediate catchment areas of production. Both HCMC and Hà Nội already have a number of modern abattoirs some of which are state-owned enterprises but increasingly are private initiatives establishing abattoirs with the latest in Western slaughtering equipment.

However, fundamentally, this problem stems from three issues:

1. Insufficient provincial production of 400-450 Kg cattle with a meat:bone ratio of 52% to 54% (Australian cattle ~ 54% versus Yellow cattle ~37%) which is the nature of demand for the modern market. This has its genesis in the breeds of cattle being raised and animal husbandry practices, especially animal nutrition;
2. Lack of processing standards, particularly meat hygiene in processing – this includes the lack of control of 'water pumping'[7];

[7] *An important weakness in the marketplace for Vietnamese beef is the common practice of pumping water during slaughter. Those engaging in this practice insert a tube down the animal's throat and pump 30-50 litres of water to increase weight. 'Pumped' beef can be visually identified by discerning consumers due to excess juiciness and a poor taste and has approximately 30% lower price than non-pumped beef. Unfortunately, this*

3. The small scale of the animal production system results in higher production costs which is exacerbated by the transport costs of approx. VND750,000 per head to HCMC, both of which make Đắk Lắk Province less competitive to feedlot-raised Australian cattle from provinces closer to the key markets.

Lack of marketing and cool chain infrastructure

One of the main constraints to system improvement is the lack of downstream infrastructure capable of supporting beef cattle production, transport, processing and marketing. Reardon (2015) identified that 'hard' (e.g. wholesale markets, cool-chain investment) and 'soft' (e.g. policies and regulations) infrastructure forms two of five critical factors in food chain development. The development of the mid-stream of supply chains has been recognised as being just as important as the development of the primary production end of the chain. Indeed, increasing standards of living, urbanisation and diet change provide the demand conditions that drive the technological transformation of the production, mid-stream and downstream components with accompanying factor market development (labour, credit and land) have been identified as the pre-cursors of food chain improvement and food security (Reardon 2015).

Some modern, efficient and hygienic infrastructure to support beef processing, transport and marketing is concentrated around the largest cities but is insufficient to support the development of a modern beef production and marketing system.

This, the lack of food safety regulations to enforce food hygiene and the lack of information flows along the supply chains appear to be constraining change from traditional supply systems. Đà Nẵng and HCMC are the only economic zones to have successfully implemented such regulatory control of meat safety. The Đà Nẵng Department of Veterinary Health & Quality Assurance enforces regulations with severe penalties. Achieving system-wide change at a provincial level requires a systematic whole-of-government approach such as has been used in these cities. The lack of ability to control the practice described above of 'water pumping' of animals before slaughter exemplifies the problems of policing existing or required regulations.

The Australian Exporter Supply Chain Assurance System (ESCAS) for beef infrastructure probably provides us with a benchmark for assessing the availability of international standard beef marketing infrastructure. It is an assurance system based on four principles: animal welfare, control through the supply chain, traceability through the supply chain and independent audit (Department of Agriculture and Water Resources 2015).

Whilst ESCAS standard feedlots and slaughterhouses are clustered around HCMC, there are only four registered abattoirs and one feedlot in the Đắk Lắk, Phú Yên, Bình Định Provinces and Đà Nẵng City (Vietnam Administration of Tourism, 2018).

Lack of coordinated, targeted marketing of larger volumes of cattle

The individual marketing of 1 – 2 cattle per year from 0.5 – 1.5 ha traditional farms significantly adds to the cost of production and marketing. For example, in quite long, complicated traditional supply chains, cattle are marketed through a multi-tiered trading system comprising at least Level 1 (Local Commune) and Level 2 (Regional or Provincial) Collectors and then abattoirs (who either charge a service fee or engage in trading themselves) where each level adds a 12 – 15% margin. A typical Level 2 Trader may employ 40 – 80 Level 1 Collectors.

Shortening these chains and trading in larger groups of cattle will reduce marketing costs. This can be achieved by coordinated planning and management of production at a

practice is so widespread that retailers believe that all Vietnamese cattle are pumped with water to increase their weight.

commune level and accessing markets through a single Level 2 trader or even going direct to a larger abattoir. The incentives do adopt this approach are the cost savings that can be shared between the trader and the farmers in the form of higher prices/fee. From the consumer and retailers' perspective this will enable improved signalling back up the chain about the type of product required

A Porter's Five Forces comparison of the competitive characteristics of the focal markets

Porter's Five Forces Analysis (FFA) was used to highlight key aspects and differences between the three markets with respect to the characteristics of a market, particularly the relative competitiveness, attractiveness and profitability, by analysing at the interaction of five forces: the threat of new entrants, competitive rivalry between the actors, the bargaining power of suppliers, bargaining power of consumers and the threat of substitute products (Porter 2008) (Figures 5, 6 & 7).

The FFA was applied to three alternative target markets:

- Ea Kar to Buôn Ma Thuột market
- Đắk Lắk to HCMC market
- Phú Yên/Bình Định to Đà Nẵng market

It provided unique insights into the relative power of the actors in the chain and for this project, some indications of the issues that might be faced in development efforts to improve chain performance and coordination:

- Farmers are relatively powerless due to:
    - The farmers are not competitive amongst themselves but are also not exploiting the potential to use collective bargaining power in the chain;
    - A lack of bargaining powers with buyers;
    - A lack of bargaining power with suppliers;
    - The threat of substitute protein sources and other farmers whom they don't regard as competitors;
- There is less competition for the traders and abattoirs than for the farmers and retailers;
- Wet Market and other retailers are subject to:
    - Rivalry amongst competitors
    - Bargaining power of buyers (consumers)
    - Threat of new entrants (low barriers to entry)
    - Threat of substitutes protein sources (pork & chicken)

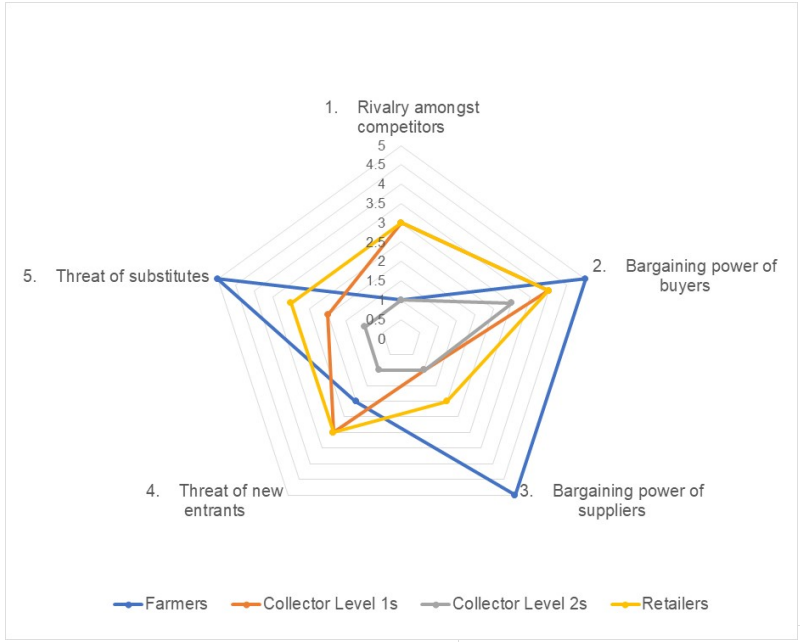

Figure 6: Porter's Five Forces Analysis of the Ea Kar to Buôn Ma Thuột chain

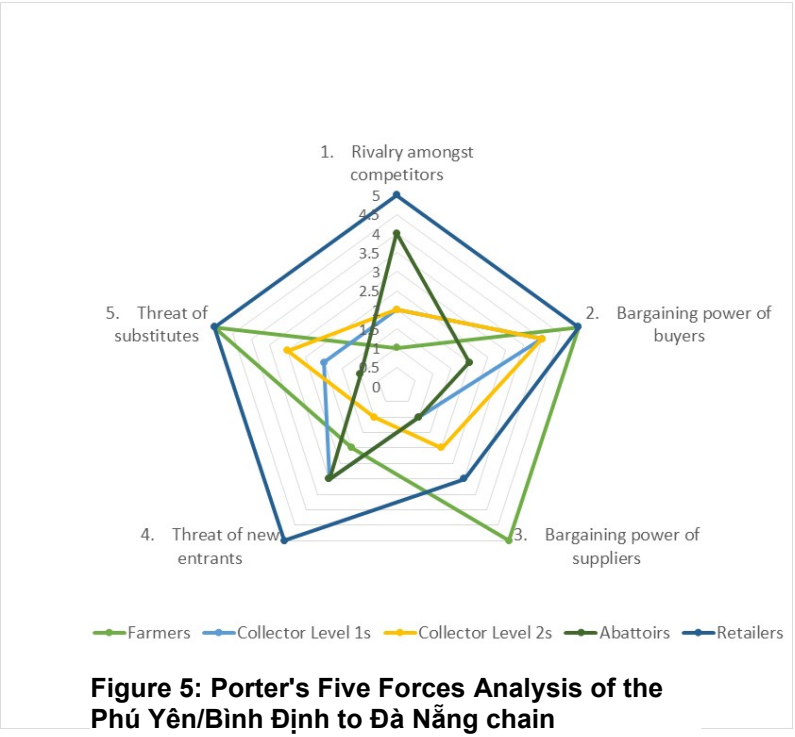

Figure 5: Porter's Five Forces Analysis of the Phú Yên/Bình Định to Đà Nẵng chain

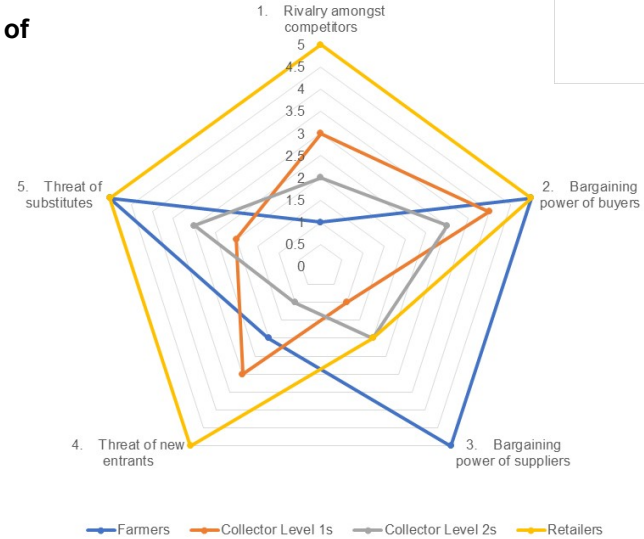

Figure 7: Porter's Five Forces Analysis of the Đắk Lắk to HCMC chain

Conclusions

Consequently, the recommendations are to:

1. Develop a staged developmental response to the market opportunities in the two major cities, HCMC and Đà Nẵng. In both instances, provincial authorities need to focus first on increasing the number of desirable breeds in the production base and improving the collaboration and coordination of supply chains to local abattoirs. This response requires different strategies for each market:
    a. For Đắk Lắk Province supplying HCMC, consideration should be given to:
        i. Establishing an ESCAS standard abattoir in Buôn Ma Thuột to slaughter for HCMS thus saving the cost of transporting 50% waste to HCMC. Chiller trucks currently used to transport frozen goods to Buôn Ma Thuột could be backloaded with chilled beef on the return journey to HCMC;
        ii. Establishing cattle finishing arrangements with ESCAS registered feedlots near HCMC.
    b. For Phú Yên and Bình Định Provinces:
        i. In the short to medium term, the marketing focus should be the Vietnamese style of low-cost accommodation and restaurant outlets as this is by far the biggest market segment still focusing on traditional style meat products. The 3-5 star hotels require the most rigorous quality and should be the long-term target for marketing.
        ii. Improving an emerging calf raising and growing/fattening chain appears to be the best option. More data is required on the Phú Yên and Bình Định collectors involved so that the options for reducing the complexity of the chain by removing one level of collectors is become clearer.
        iii. More modern supply chains, where calf-raising and calf growing/fattening are separate, specialist operations adding value at each stage appear to be emerging from Phú Yên and Bình Định. This should be the focus for development.
2. Given the traditional nature of the consumers, there may be a niche for a “Thịt bò núi truyền thống” (Traditional Mountain Beef) product from Đắk Lắk Province and/or “Thịt bò ăn cỏ truyền thống từ Trung tâm bờ biển của Việt Nam” (Traditional Grass Fed Beef from the Central Coast of Vietnam).
3. Establish hygienic abattoirs and cold chain protocols (and government policy) because of the growing consumer trend towards demanding food safety and soft or ‘tender’ meat.
4. Use Cattle Clubs to:
    a. Introduce coordinated production using production protocols which produce ‘tender’ or ‘soft’ beef as the demand for these characteristics is a growing consumer trend;
    b. Coordinate and target marketing to specific outlets to increase the bargaining power of farmers and reduce supply risk for buyers.
5. Remove market distortions due to institutional factors (e.g. regulations).
6. Shorten chains to take cost out of the system thus making beef protein more competitive.

7. Introducing more competition into chains from farmers through to abattoirs e.g.
    a. Establish wholesale markets to increase price/quality competition, & real-time market feedback to farmers;
    b. Increase real-time market information throughout the chain;
    c. Because the distribution function of the traders is critical to the efficiency of the marketing system, authorities should consider increased monitoring and control of the trader's activities to remove collusive practices.

7.2.2 What are the critical consumer value attributes that drive these focal markets?

Understanding and creating consumer value of beef product is a core principle for analysing the project supply chains. To achieve this knowledge, consumer value research was carried out in order to provide information on the acceptance and preference of consumers of beef product attributes and bio-physical characteristics that create value.

In this project the research questions related to two different subspecies of *Bos taurus*, *Bos taurus indicus*, and *Bos taurus taurus* (Integrated Taxonomic Information System 2017). The indigenous Vietnamese 'Yellow Cattle', whilst exhibiting high genetic variability are classed as *Bos taurus indicus* and the majority of imported cattle consumed in Vietnam are currently Australian cross-breeds from *Bos taurus taurus.* Yellow Cattle are slaughtered at 200-230 kg with a boning percentage of approximately 37% and the Australian cross-breeds weigh 400-500 kg and have a bone-out of around 50%, thus being preferred by modern slaughterhouses because of their relative carcase conversion efficiency. The relative importance of quality attributes varies with indigenous human culture and time as consumption preferences are rapidly evolving (Hocquette et al. 2012). The initial Rapid Value Chain Analysis conducted in this research project identified that consumers claimed to be able to identify meat from Australian cross-breeds and to have a preference for the meat from Yellow Cattle.

Qualitative interviewing informed the design of hedonic or affective sensory evaluation as well as physical and chemical composition analysis. The attributes shoppers consider when buying beef are summarised in Table 17. Ho Chi Minh City and Đà Nẵng consumers evaluated meat's origin, freshness, colour, tenderness and dryness when making a purchase decision.

The findings in Table 17 are consistent with similar research in other countries for fresh produce. It should be noted that price is absent from the top six purchase drivers.

Table 17: Summary of qualitative consumer priorities of value attributes used for making purchasing decisions for beef products

Criteria	Ho Chi Minh City	Đà Nẵng
Attributes of product	1. Origin: Australia 2. Freshness/smell 3. Meat colour (light red) 4. Tenderness (the more tender, the better) 5. Dryness	1. Origin: Vietnam 2. Freshness/smell 3. Meat colour (light red) 4. Tenderness (Not too soft) 5. Small fibre 6. Dryness
Attributes of the way product is sold	1. Convenience 2. Able to touch 3. Hanging 4. Cold shelves	1. Convenience 2. Able to touch 3. Hanging 4. Cold shelves

Pricing is also an important factor in the purchase decision. It should be noted that not only meat but also other parts of slaughtered cattle were consumed on markets. Beef products in the markets are categorized into 3 meat classes and bi-products mainly based on body part.

Table 18 summarises the classes of beef products and their price range in Ho Chi Minh and Đà Nẵng cities.

Table 18: Beef products and their price in Ho Chi Minh and Đà Nẵng cities (2014)

Class	Ho Chi Minh	Đà Nẵng
#1 (short loin, tenderloin and back-leg shank)	VND 280-400 thousand/kg	VND 250-270 thousand/kg
#2 (sirloin, chuck, plate, round, front-leg shank)	VND 210-230 thousand/kg	VND 180-190 thousand/kg
#3 (rib, brisket, flank)	~ VND 170 thousand/kg	VND 100-150 thousand/kg
Bi-products: - Tail - Leg - Bone - Internal organs	 VND 170-175 thousand/kg VND 80 thousand/kg VND 60 thousand/kg VND 100-120 thousand/kg	 VND 130 thousand/kg VND 60 thousand/kg VND 40 thousand/kg VND 80-100 thousand/kg

In general, beef price in Ho Chi Minh City was higher than that in Đà Nẵng. This difference was possibly due to the meat quality, market size and income per capita. Firstly, majority of beef in Ho Chi Minh City was Australian and Cambodian which was considered by consumers as good quality (tender) and highly hygienic (for Australian products). Alternatively, most of beef in Đà Nẵng was domestically produced which was regarded as tougher and less hygienic than imported products. As a result, consumers were normally more willing to pay high price for Australian beef than Vietnamese products. Secondly, the bigger size of Ho Chi Minh City market was a possible cause of price difference. Ho Chi Minh City has a concentrated market of more than 8 million of people while the population of Đà Nẵng was only around 1 million. Therefore, the beef demand of Ho Chi Minh market was much higher than Đà Nẵng which might lead to a higher price. Thirdly, people living in Ho Chi Minh City have a higher standard of living and superior incomes to the population in Đà Nẵng. In 2014, the income per capita of Ho Chi Minh City was US$5,131 meanwhile this number was only US$2,283. The higher income possibly resulted in a greater willingness and capacity of Ho Chi Minh City consumers to pay premium prices for beef which was widely considered in Vietnam as a luxurious product.

Conclusions

1. Wet markets will persist as the dominant market outlet for commodity beef into the medium term;
2. The perceived origin of meat is a major purchase driver but there is little provenance information of any integrity so purchasers believe what they are told by the retailers.
3. It is not at all certain that consumers can ACTUALLY identify the difference between Australian or local hybrid beef by sight, smell or taste, ;
4. Hygiene and freshness are major purchasing drivers;
5. Convenience and social aspects are important to the purchasing decision;
6. The purchasing decision is a ‘trust-based’ decision. If the purchaser has a bad experience with hygiene, they simply change retailers.

Recommendations

Therefore, it is recommended that the project also investigate the ability of consumers’ to:

- Distinguish between Australian and local hybrid beef;
- Identify preferred attributes of those two types of beef;

- Establish the physico-chemical differences between Australian and local hybrid beef;
- Distinguish between local Yellow cattle sample and Brahmin hybrid cattle
- Identify preferred attributes of those two types of beef.

These recommendations led to the subsequent quantitative research employing the following questions:

- Can Vietnamese consumers identify imported beef from its physical and taste attributes?
- Do Vietnamese consumers vary in their preferences to different samples based on:
    - Breed?
    - Feed regime?
- Can consumers be segmented based on their preferences?
- What are the distinct patterns among these consumer segments?
- Is there any difference among the segments in rightly identifying source breed of beef meat?

Data were collected using face to face market intercept surveys associated with Hedonic Sensory Testing based on the Meat and Livestock Australia (MLA) sensory testing protocol (Watson et al. 2008) in Đà Nẵng Coop-Mart and Buôn Ma Thuột wet markets.

The findings from all three forms of data were consistent in demonstrating that only a small segment of the population can discern the difference between Australian and local hybrid beef.

The qualitative interviewing of 115 respondents and key industry people across the chains investigated appeared to indicate that origin (imported/domestic) freshness, smell colour, tenderness, small fibre and dryness were (in rank order) the most important value attributes. This research raised questions about consumers (and chain actors') ability to identify the difference between meat from Australian, hybrid and yellow cattle. This informed the design of the subsequent hedonic and physical testing of beef.

The hedonic sensory testing appears to show that in the consumers' discernment of the physical appearance attributes of smell, freshness, texture, dryness and colour, the only attribute where that is statistically significant is for 'Dryness'. For the discernment of experience-based or 'taste' attributes of juiciness, fatness, sweetness, and flavour the analysis suggested that the only statistically significant attribute was for flavour.

Whilst the research questions were different between the two centres, there appears to be some similarity between the two segmentation outcomes (Table 19). In both the markets, consumers can be segmented into three different groups based on their value preferences. However, these segments, which are based on product attributes, were not different based on other socio-demographic characteristics.

Table 19: Segments identified by hedonic sensory testing in Đà Nẵng and Buôn Ma Thuột

Đà Nẵng *(n = 126)*	**%**	**Buôn Ma Thuột** *(n = 121)*	**%**
Local meat lovers (discerning consumers)	14	Discerning for Yellow Cattle	8
Meat lovers (non-discerning consumers)	55	Meat Lovers (non-discerning consumers for quality)	64
Australian Meat Lovers (discerning consumers)	31	Demanding Consumers (discerning for quality beef of any source)	28

The largest group of consumers in both markets were meat lovers who value product attributes highly irrespective of the breed sources of the beef. There exists better opportunities for the quantitative growth of the meat in these markets for meat lovers who represent higher percentage of the consumers and prefer every tested attributes above the mean.

Small number of consumers have strong preferences for one sources of meat over others. They have very contrasting yet distinct preferences. Identifying and targeting those discerning consumers can be an opportunity for producers looking for niche markets. These segments of consumers demand differential branding, promotional and packaging activities. Particularly the sample from local Yellow cattle does possess some branding value for niche local consumers who have strong preference to its attributes.

This research also conducted an evaluation of the physical quality of beef samples sold in the Đà Nẵng with regard to pH, colour, shear force (toughness), drip and cooking loss and chemical composition. This was to contribute to the investigation of the claims by wholesalers, retailers and consumers that they could by visual, olfactory and gustatory perception identify locally grown beef from Vietnamese and Australian cattle. The results showed that show that there were only slight differences between some key physical and chemical parameters is a slight difference between the sources of meat regarding colour after 24 hours and Crude Protein.

Majority of the consumers in the study area have failed to correctly identify the source of the meat based on physical and experience attributes. This suggests Consumers are not good at differencing the products based on physical attributes. Branding and packaging have huge significance among these consumers to receive premium price.

Conclusions

This study develops value profiles for three different consumer segments in Đà Nẵng and Buôn Ma Thuột markets as suggested by Macharia, Collins and Sun (2013) for the development of sustainable agrifood chains in developing countries. Profiling these clusters using the clustering variables shows that consumers in the largest cluster segments in both the studies have higher preferences against all variables compared to other clusters. Although their preference among the samples is quite indifferent, they scored high in each variable compared to other clusters. They are the meat lovers for which the meat value chain should primarily target. They represent majority of the total sampled consumers in both studies.

That majority of consumers are indifferent to product attributes of different samples, however, at the same time rate various beef product attributes highly suggests that beef as a commodity will dominate the livestock production and marketing systems in Vietnam.

Unless, livestock producers are aligned in specific value chains targeting niche markets and or consumers, efficiency in production and supply chain would remain key sources of profitability. Competition would mainly boil down to reducing cost of production and increasing efficiency and productivity. Presence of small but very distinct consumer segments with strong preferences to local cattle breed means niche markets are available for value chain integration and co-innovation.

However overall, this project's focus on improving the efficiency of production and marketing is justified.

Recommendations/implications for other activities

The recommendations for other Research Activities in this project are as follows:

1. Efficiency of production will be a critical research activity as it relates to the efficiency of production which is likely to remain the most important aspect in determining competitiveness for most producers;

2. Finding efficiencies in the management of coordinated marketing in the value chain will also be a critical element for farmer competitiveness;
3. For some producers, there may be an option to develop a brand for Yellow Cattle, raised naturally and not pumped with water. This however, needs to be undertaken professionally and with care and integrity rather than simply allowing some farmers to continue the poor husbandry and marketing practices they are currently engaged in.

These findings then link to all Objective 1 work relating to efficient husbandry practices and Objective 3 with regard to the focus of extension activities.

7.2.3 Activity 2.2.2: Undertake a Rapid Value Chain Analysis

This employed the following three research questions:

> *What are the pre and post-project chain efficiencies and distribution of economic value?*
>
> *What are the priority bio-physical and social constraints on chain performance in delivering the identified consumer value?*
>
> *What interventions are recommended, based on the models of adoption and adaption developed in Objective 3, to improve production and marketing practices that will improve smallholder livelihoods and chain participant value sharing?*

The economic and social environment for beef production is changing rapidly and traditional Vietnamese beef producers are being outcompeted by imported beef. This Activity in ACIAR Project LPS/2012/062 is focused on investigating two key supply chains in three provinces in Central Vietnam. It employed a Rapid Value Chain Analysis top understand the dynamics of the two chains and found long, complex, highly transactional supply chains characterised by a lack of market information and communication between key participants, with opportunistic, sometimes exploitative behaviours permeated with distrust (Figure 8).

Several points need to be kept in mind about Vietnam's traditional beef supply chains:

- The supply chains do not conform to rigid typologies. There are as many types of ways to get animals to market as innovative human minds can devise. Therefore, there are always farmers and traders doing things not described in a 'typical' beef supply chain.
- Supply chains are highly dynamic and are very responsive to price and demand. Hence, if the prices drop suddenly then a supply chain that exists today may not be operating next week.

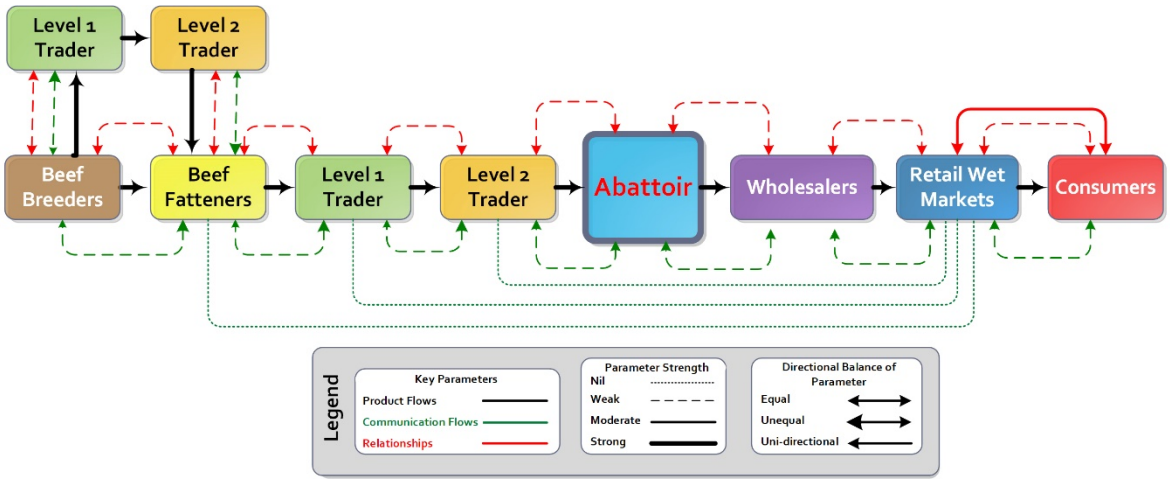

Figure 8: A typical VCA map for Đắk Lắk and Phú Yên to Bình Định to Đà Nẵng beef cattle chains (noting the dynamic and diverse nature of beef supply chains)

While a focus on producing a critical mass of finished 400-500kg LW animals for selling to big traders or preferably abattoirs is certainly a way of keeping smallholders in the game and helping to shorten the chain (both worthwhile aims) there will be many smallholders and cattle producing communities who will not be able to follow that model, due to limited land to develop forages, cost-labour pressure or other factors.

For cow-calf producers with limited land for new forages and decreasing access to common land grazing, the cost/benefits of feeding males from calves to finishers will become less and less viable as the retained revenue charts indicate. Such producers face 2 main choices under that CC/VC model:

1. Go out of business due to competition pressure (which might happen anyway);
2. Switch to male only fattening/finishing for 3-4 months max using on-farm commercial crop bi-products and concentrates;
3. Specializing in on-selling pre or post weaned calves to other growers.

The 3rd option is already happening in Phú Yên and Bình Định.

In communes such as An Chan it is not surprising then that smallholders are choosing either option 2 or 3, which are both an indication of increasing specialisation. While option 2 (male only fattening) fits well with the 'one size fits all' Cattle Club/Value Chain model suggested (Figure), option 3 (calf production and early selling) may not, because it in effect maintains or in some cases lengthens the value chain by perpetuating the number of chain actors. Yet in developed countries like Australia it is common practice for beef producers to specialise, with some producing weaners or stores for on-selling to growers and feed-lotters.

The Waterfall Chart in Figure 9 illustrates the margins at each stage of the chain. However, there are some conditions associated with developing and interpreting this chart that were outlined for the similar chart for Đắk Lắk Province. This section also needs to be read in conjunction with *Activity 2.1.4 Baseline Economic Study*.

As noted in Section 5.1, there is an important difference between Bình Định/ Phú Yên and Đắk Lắk in how chain actors quote their prices. In Bình Định/ Phú Yên, the output price is the price for estimated amount of boned-out beef. In Đắk Lắk all actors in the chain estimate the live weight and the price of the whole animal 'on the hoof'. Thus, the team converted Đắk Lắk data into price per kilogram for consistency.

Thus, 'retained revenue'[8] indicates the difference between output and input price in which the majority come from (intermediate and opportunity) cost. This has significant weaknesses for comparison within the chain because cow-calf farmers require 18-24 months to generate retained revenue, fatteners approx. 3 – 4 months and traders or wholesalers just require one night. It is therefore recommended that comparisons be made only for the similar actors (i.e. Level 1 Trader to Level 1 Trader or Farmer to Farmer) rather than comparing say retailers to farmers. This section also needs to be read in conjunction with *Activity 2.1.4 Baseline Economic Study*.

[8] *Retained revenue is the difference between the total input and output costs without consideration of the details of the cost of production. This is because few farmers keep detailed records of their cost inputs so any data in this regard would be unreliable.*

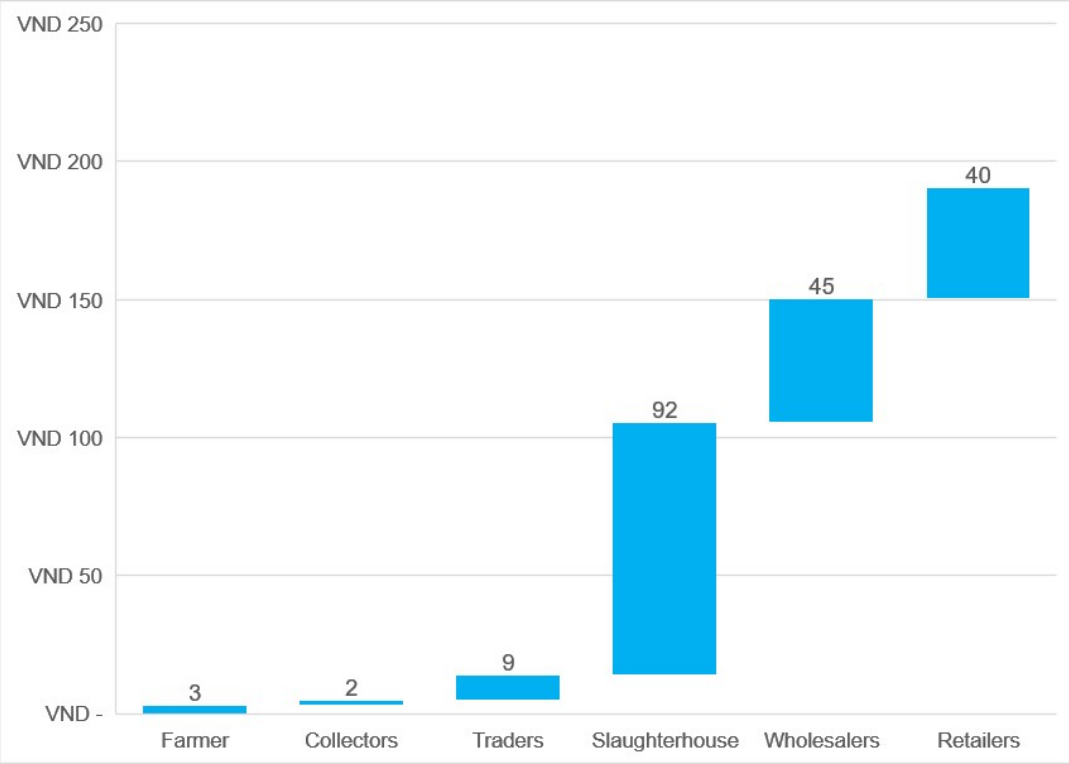

Figure 9: Retained revenue per kg of fattened beef cattle from Phú Yên and Bình Định to Đà Nẵng City (Unit: 000 VND/kg)

We concluded that supply chains in all project provinces are:

1. Price-driven with short-term, transactional purchasing with little trust or long-term commitment;
2. Too long leading to unnecessary transactional costs and other process inefficiencies;
3. Lack coordination between demand and supply;
4. Lack sufficient market information for the upstream actors in the chain to be able to make marketing decisions;
5. Lack competition in the distribution and processing system to increase efficiency, reduce costs, improve quality and safety and, importantly, drive innovation, entrepreneurship and market orientation. Indeed, there may well be significant collusion because there are only a few Level 2 traders in the system and the price appears to be very stable;

Consequently, it was recommended that the Best Practice (BP) Value Chain Model be as follows in Figure 10. Type 1 is a BP chain for supplying Wet Markets and Type 2 is where a hotel group or single large outlet can be targeted. It should be noted that the shortening of the chains is not the only changes proposed in these diagrams. The efficiency and effectiveness of any chain is built on having strong information and communication flows as well as strong, open, transparent governance relationships between the members of the chain. These are designated in these diagrams by the thick red and green lines between dyads (adjacent people/businesses in the chain) and with the final customer and consumer. Timely, accurate, understandable information is the life-blood of a value chain and is the basis for building trust and coordinated effort to market products in competitive markets.

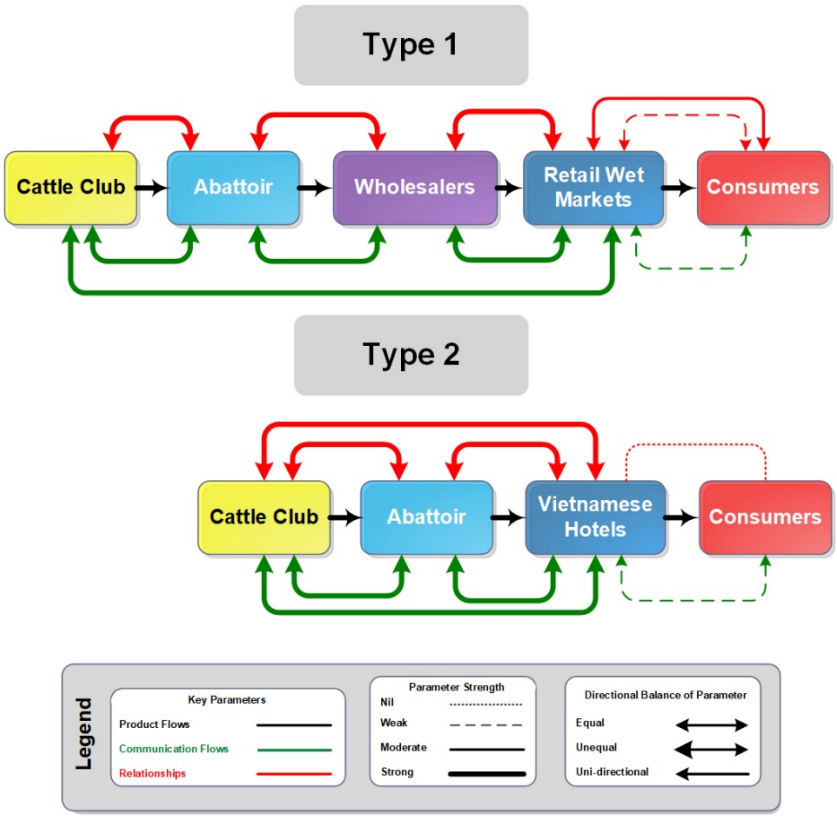

Figure 10: Recommended Best Practice Model Value Chain for Đà Nẵng and Buôn Ma Thuột

To achieve this, the following are recommended:

1. Establish cattle clubs in all communes with coordinated production and marketing processes combined with animal husbandry and business management training for farmers and ensure that there are incentives built into all stages of the chain to motivate the types of behaviour required to upgrade the efficiency and effectiveness of supply;
2. Investigate ways of introducing competition into the distribution and slaughtering system.
3. Introduce a policy of using weight tapes or scales at all stages of the upstream chain to reduce exploitation and conflict and train farmers and traders for condition scoring;
4. Shorten the chain by Cattle Clubs going direct to abattoirs or direct to a single outlet such as a group of hotels through an abattoir.
    a. Cattle Clubs should strive to reduce the complexity of transactions/trading making it as simple as possible for customers and reducing their costs and risk.
    b. Shortening the chain will not be easy and cannot be accomplished until there is sufficient volume of consistent quality and a diversity of cattle types to give the chain sufficient capacity and flexibility.
    c. However, in practice, not all cattle clubs (or indeed club members) will produce exactly the same product.

Clubs need to accommodate the diversity of capability of their farmer members and their business aims. It may be more appropriate that some members fatten whilst others on-sell their calves or yearlings in response to cost-price signals. It is the view of the Project Team that the growing/fattening/finishing phases of Vietnamese beef production is likely to become more and more commercialised and specialised over time, leaving calf production mainly to smaller producers. Smallholders have the capacity to adapt rapidly to changing market circumstances, which we believe is even more reason to develop and promote production

options or organisational strategies that allow smallholders not only the flexibility to respond quickly, but the resilience to cope with such changes. The point we are making with these BP Models is that overall chains should be shortened by coordination and cooperation, improve information flows and improve the governance relationships along the chain.

The findings suggest that there are opportunities to build the production capacity of the provinces concerned to produce the specific types of beef cattle being demanded by retail customers and changing consumer preferences. These opportunities start with a focus on making chains more efficient and effective for local markets through improving production and coordinated marketing. Then, when capacity of production and marketing processes have improved, making arrangements to move progressively into larger, more competitive markets. However, this will require long-term policies and strategies to be put in place which facilitate the improvement of meat processing with hygienic abattoirs and effective cold chains to market.

During the course of conducting this research, the team was informed about some examples of modern, integrated beef supply chains; one from 2008 – 11 which has now failed and three that were investigated in October 2017. They were:

- Green highland" beef from Đắk Lắk to HCMC;
- Nam Sanh "Bo To Tay Ninh" Restaurants;
- Thanh Nhan Abattoir (Long An Province);
- Sinh Thái Viet Company, (Cần Thơ) and Hải Sản Biển Đông ở Seafood Bistro (Cần Thơ).

The beef industry is changing rapidly with new innovative business models and integrated, specification-driven supply chains being developed (Refer *Activity 2.2.2 Rapid Value Chain Analysis, Section 5.3, Page 24*). These all based on the principles identified and employed by this project were investigated and provide exemplars for the stakeholders in Đắk Lắk, Phú Yên and Bình Định of the innovative thinking and entrepreneurship that is rapidly entering the Vietnamese domestic beef industry. These chains are committed to:

- Shortening the value chain to reduce cost;
- Integrating the steps in the chain to increase coordination and control over processes;
- Using processes that maintain quality and food safety e.g. overhead chain conveyor in abattoirs and a cold chain;
- Differentiating and branding their products;
- Investing in the integrity of the claims made for their competitive difference e.g. quality and safety;
- Targeting markets with a specific product value proposition.

They provide exemplars of the endogenous development of modern integrated business models based on value chain management principles that may provide motivation and stimulate ideas amongst the project participants.

The recommendations/implications communicated to the other project activities were, firstly those that needed to be considered by Objective 1:

1. Modern abattoirs require a 400 – 450 kg animal with a meat:bone ratio of 54% for slaughter efficiency;
2. Marbling is preferred to an outer layer of fat as in Western style carcasses;

The following findings needed to be considered by Objective 3:

1. Farmer information and training in the following areas is necessary immediately:
    a. Animal nutrition and husbandry

b. Animal health
c. Condition scoring and the use of weight tapes;
d. Farm business management.

2. Other training priorities will be determined by the demand from the Cattle Clubs as they are formed.

7.3 Objective 3: Identify and develop knowledge exchange and adoption pathways for expanding impacts within smallholder beef cattle enterprises.

The research question was posed as: "How can knowledge exchange and adoption pathways for expanding impacts within smallholder beef cattle enterprises in the South-Central Coast and Central Highlands be developed?" This was answered by employing four subsidiary research questions (SSRQs). The reporting against these SSRQs is outlined in the following sections.

7.3.1 What are the socio-economic characteristics that affect knowledge transfer, adoption and adaption?

What can be learned from the literature on the focal smallholder cultures to assist the development of change protocols?

An initial review of the literature dealing with adoption and knowledge transfer pertaining to smallholder forage and cattle production systems in focal communities was undertaken. This and the cultural/ gender information derived from subsequent farmer and stakeholder interviews by Objective 3 team members provided important insights to guide development of case studies and associated on-farm activities. Key findings included:

- The primary importance of farmer to farmer learning in new knowledge and skills transfer;
- The critical importance of engaging all key stakeholders (including commune, district and provincial government and extension agencies, farmers unions / women's unions, traders, researchers) for successful cattle club development;
- The need to identify and engage local farmer champions (focal farmers) for successful scale-out;
- The key role played by women in cattle raising across different cultural and geographic boundaries;
- The value of using stepwise participatory-adaptive research and extension methods to improve adoption outcomes.

What were the mechanisms of adoption & scale-out in previous Đắk Lắk and SCC smallholder studies and / conduct exposure visits, reflection meetings and other on-farm activities to extend outcomes to non-participants?

Important information about gender roles in focal communities was obtained from both the literature review and farmer interviews associated with the various case study activities. It was evident that:

- Women were often the primary livestock managers within households, not just in matriarchal minority cultures such as the E'de[9], but across all focal communities. This is not always apparent from the demographic attending farmer workshops or

[9] *Pronounced 'Ee-dee'.*

participating in farm-based research and extension activities. Yet, of 31 farmers identified as having scaled out from 3 farmer champions in Phu Kim village, Cat Trinh commune, Bình Định in 2015, 17 (55%) were women.

- Likewise, in interviews to gauge farmer response to participation in calf early weaning and feeding demonstrations in An Chan, 81% of those who responded were women, because they were the primary cattle managers while their husbands worked in the fishing industry. This knowledge led the project team to actively encourage female participation in farmer workshops, on-farm forage and cattle feeding and management activities and cattle club development opportunities throughout the life of the project. Table 20 indicates the proportion of women who participated in various Objective 3 activities. The overall participation of women was 37%.

Table 20: Number and percentage of women participants in various Objective 3 activities

Activity	Total participants	Women participants	% Women
Case study 1A scale-out farmer interviews	31	17	**55**
Case study 1B Tây Giang best bet farmers	15	2	**13**
Case study 2 in-depth adoption interviews	15	4	**27**
Case study 3 new cattle clubs (all)	30	10	**33**
VNA workshop in Ea Kar, Đắk Lắk	34	14	**41**
VNA workshop Tây Giang and An Chan	56	11	**20**
Cow-calf feeding studies Tây Giang, An Chan	26	21†	**81**
Training activities (Bình Định and Phú Yên)	28	7	**25**
TOTALS	**235**	**86**	**37**

† Includes wives who managed jointly with husbands but solely while husbands worked away

The overnight nature of cross visits used in case study 1B restricted opportunities for female participation in the initial best bet farmer group of 10 – an issue also noted in previous studies. However, 3 of the 5 additional best bet farmers (60%) selected 6 months later were women. The higher percentage of women members of new cattle clubs (37.5% in Tây Giang and 28.5% in An Chan) reflected an increasing trend in willingness and desire of female members of smallholder households to participate actively in learning and organizational opportunities, in response to on-farm activities. The primary focus in Tây Giang and Ann Chan was to encourage active participation of women in such activities rather than foster gender specific groups, on commune advice. However, in An Chan, where husbands worked seasonally in the local fishing industry, women participants in on-farm cow-calf studies expressed interest in forming their own common interest group.

Following an initial exploratory survey of former study communities in Bình Định, Phú Yên and Đắk Lắk provinces, key elements of activities 3.1.2 and 3.1.3 were re-formed into 3 complimentary case studies aimed at better assessing existing knowledge transfer pathways and developing and testing appropriate participatory extension to improve adoption and scale-out. Details of these three case studies were included under subsection 5.4. Key results from these case studies are included here.

Case study 1 - Farmer to farmer learning: using reciprocal cross visits with farmer champions to accelerate smallholder new forage development Tây Giang Commune, SCC Vietnam.

Improving traditional smallholder adoption outcomes for newly introduced forage, feeding and management technologies has proved a major challenge for research and extension workers over many decades. Case study 1 aimed to use insights about farmer to farmer learning gained from activity 3.1.1 to explore options to improve knowledge transfer and thus, adoption

and scale-out outcomes in the focal communities. The case study had two components: part a) exploring the role and influence of farmer champions (focal farmers) in the previous Cat Trinh study commune and part b) testing the impact of using reciprocal cross-visits between these farmer champions and selected farmers from the new Cat Trinh study commune, on adoption and scale-out of new forages and associated feeding practices.

Part a) of Case Study 1 used data from the previous SMCN/2007/109/3 study to define the key characteristics of 3 farmer champions from Phu Kim village, Cat Trinh commune who emerged from the original group of 15 Best Bet Farmers (BBFs). The strong relationship (R2=0.079, P<0.001) between number of new practices taken up and number of Scale Out Farmers (SOFs) generated is evident in Figure 11, with the 3 identified farmer champions indicated by red diamonds.

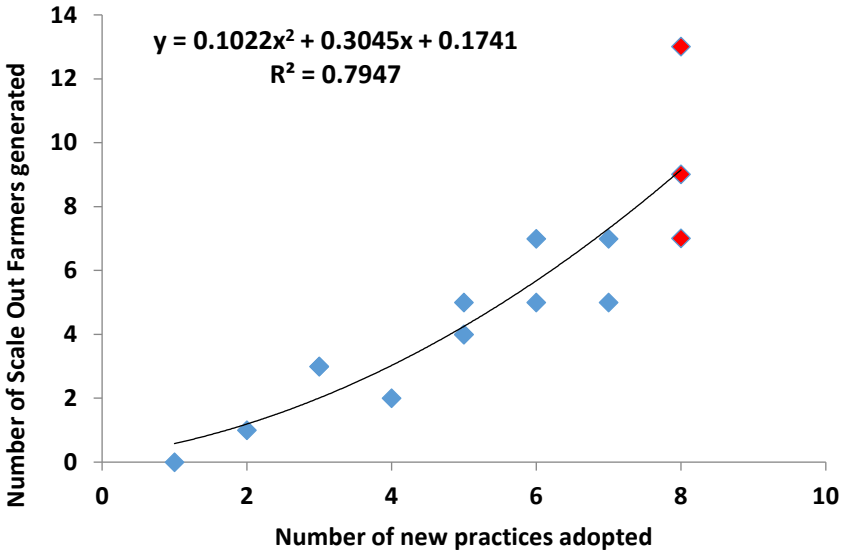

Figure 11: Relationship between adoption of new practices and generation of SOFs by Farmer Champions and other BBFs from Cat Trinh commune, Binh Dinh, in March 2013 (*Red markers denote farmer champions and blue markers denote other BBFs).*

Identified farmer champions took up almost twice the number of new practices offered, while generating between 2 and 3 times the number of scale-out farmers at each monitoring point during the previous study. There was also a strong relationship between the number and type of new practices taken up by these farmer champions and the number and type of practices scaled out to other farmers. 100% of Identified scale-out farmers from these farmer champions identified farmer to farmer learning as their most important and trusted source of new knowledge, while 35% identified media and only 13% identified local extension staff.

Farmer to farmer learning was identified by women as of particular importance, because of their traditional lack of representation in formal extension activities, farmer workshops and such. Of the 31 SOFs interviewed in this study, 17 were females who had learned directly from the male Farmer Champions.

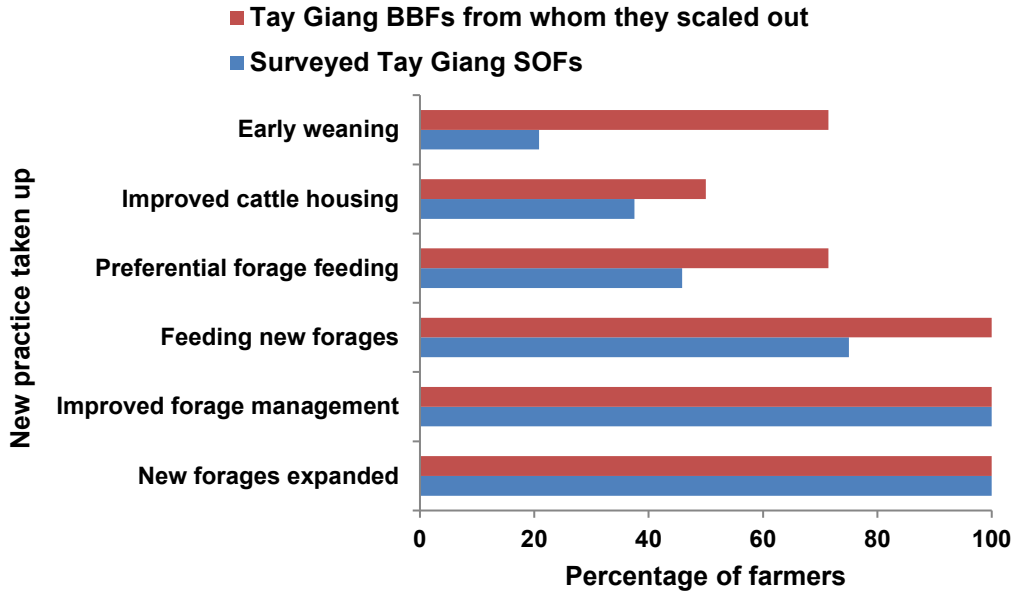

Figure 12: Percentage of surveyed Tây Giang SOFs who tried new forage and animal management practices and the percentage take-up of the same practices by study farmers from whom they scaled.

A similar comparison for previous Cat Trinh SOFs and their associated BBFs (Figure. 13) shows much lower associations between the percentage uptake of the same practices over a similar time period, especially for uptake of improved forage management and feeding practices.

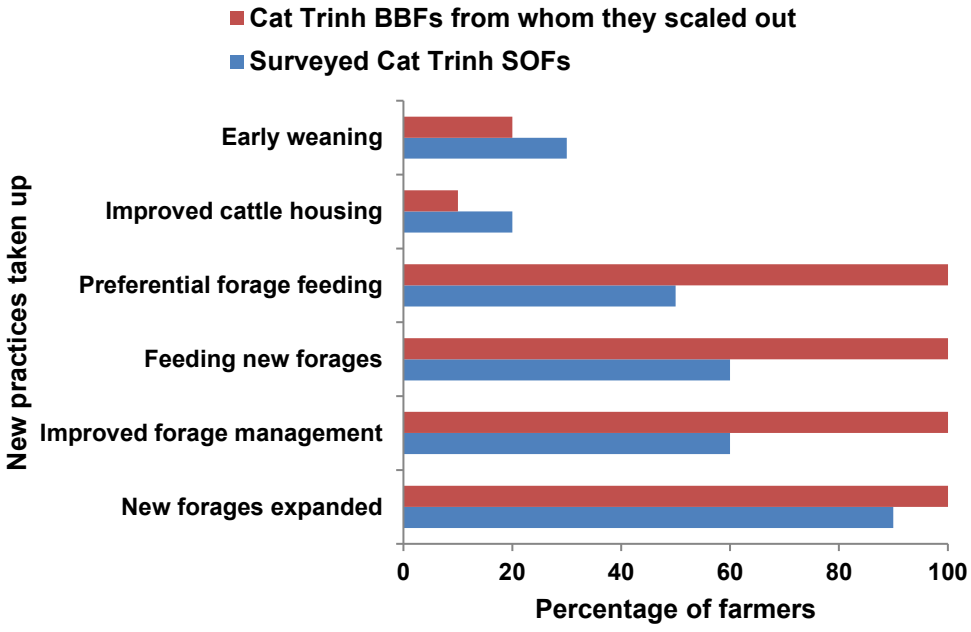

Figure 13: Percentage of surveyed Cat Trinh SOFs who tried new forage and animal management practices and the percentage uptake of the same practices by Cat Trinh BBFs (BBFS) from whom they scaled out.

Key benefits observed by SOFs of new forage and feeding practices learned from Farmer Champions included labour saving, greater convenience, improved cattle condition and household income and increased confidence to try new things (Table 21). Monitoring the high quantity and quality of scale out from Farmer Champions led to the suggestion that their active engagement in further forage development activities could help fast track scale out and improve overall adoption outcomes. SOFs preferred to learn from Farmer Champions because they were more respected and experienced. Part b) of Case Study 1 sought to test this by actively engaging the 3 Cat Trinh farmer champions in reciprocal cross-visits with selected best bet farmers from the new study commune of Tây Giang in the Tay Son district of Bình Định.

Table 21: Percentage of Tây Giang study farmers and SOFs who rated key benefits from new forage development as of medium to high importance.

Perceived benefit	% of BBFs (both cohorts)	% of surveyed SOFs
Labour saving	90.9	79.2
More income/ lower costs	54.5	66.7
Household wellbeing	36.4	37.5
New knowledge	54.5	41.7

As a consequence, 92% of surveyed SOFs reported that they intended to further expand their new forages (compared to 82% of all study farmers) while 58% planned to increase their cattle numbers following new forage development (compared to 36% of study farmers).

In part b) of Case Study 1 Ten Tây Giang BBFs were selected for participation in an overnight cross-visit with the 3 Cat Trinh farmer champions in April 2015, to learn first-hand about new forage development and associated cattle feeding and management practices. Famer Champions then returned to Tây Giang to work with these farmers on new forage establishment on their farms. Subsequent forage development, management and use by the original 10 best bet farmers, 5 new farmers selected 6 months later and those who scaled out from them was monitored over an 18 month period. Resultant expansion of new forages was up to 4 times greater than that achieved by a similar group of BBFs in the previous Cat Trinh study ($P<0.05$) with 77% of Tây Giang BBFs planting >600m^2 or new forages (compared to only 7% of Cat Trinh BBFs) and 33% planting >800m^2. Uptake of associated cattle feeding and management practices by BBFs was also faster and greater in the Tây Giang study, while scale out of new forages to other Tây Giang farmers was twice that achieved in the earlier Cat Trinh study over the same time period. The percentage uptake by SOFs of new practices learned from BBFs was also higher in Tây Giang. As with previous studies the vast majority of scale-out in the first 18 months (71%) was within the same village, of which 67% was within 800m of the source BBF. 50% of this scale-out went to neighbours, similar to previous studies, while the remainder went to relatives and friends from other villages.

Important learnings which arose from Case Study 1 included:

- The importance of farmer to farmer learning in new knowledge acquisition
- The influence of Farmer Champions and their value in scaling out new practices
- The value of reciprocal cross visits with Farmer Champions in accelerating scale-out
- The importance of early labour-saving benefits in encouraging subsequent adoption
- Recognising the link between good feeding and opportunities for regular selling and
- Through this, providing a clear pathway from cattle keeper to cattle producer

Case study 2 - Understanding drivers and issues influencing adoption / non-adoption decisions for development of new forage options in South-Central Coastal Vietnam – a Taramba Leucaena case study.

Smallholder cattle producers in South-Central Vietnam have been constrained from taking advantage of rising beef demand and prices due to poor productivity. Improving cattle nutrition and management are key steps to improving cattle condition and productivity. The second case study drew on previous ACIAR project SMCN/2007/109/3 survey data from January 2011 to March 2013 and follow-up in-depth interview data from May 2015 to assess key issues influencing adoption of selected forage grasses and the tree legume *Leucaena leucocephala* cv Taramba introduced simultaneously to a group of 41 farmers across three study communes. Five years after initial introduction (and 2 years since the end of the SMCN/2007/109/3) 75% of farmer participants were still actively using one or more of the new forage grasses, while only 24% were still actively using Taramba Leucaena. 41% of Taramba plantings failed at seedling stage due to uncontrolled grazing and weed competition, while only 44% of participants harvested mature stands for regular cattle feeding. Farmer interviews indicated that lack of previous experience with growing, managing and feeding tree legumes and restrictions on available land to grow and manage them were key factors influencing Taramba adoption outcomes.

The Theory of Planned Behaviour (TPB) (Figure 14) was then applied to contextualise adoption findings, and to compare and contrast how farmer attitudes, community social norms, farmer perceived control and actual constraints influenced adoption of the two forage types over time.

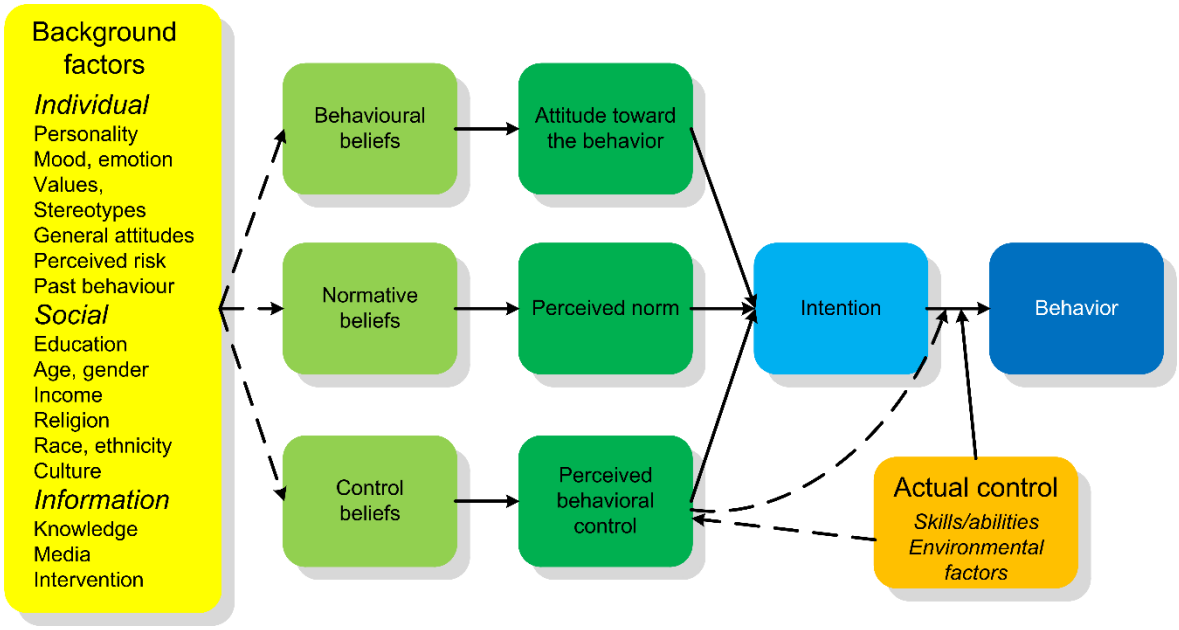

Figure 14: Theory of Planned Behaviour (Fishbein & Ajzen, 2010)

Learnings from this process enabled development of key criteria, closely linked to TPB factors (Figure 15), that could be applied when considering introduction and development of new technologies to improve adoption outcomes and therefore smallholder cattle production in the future.

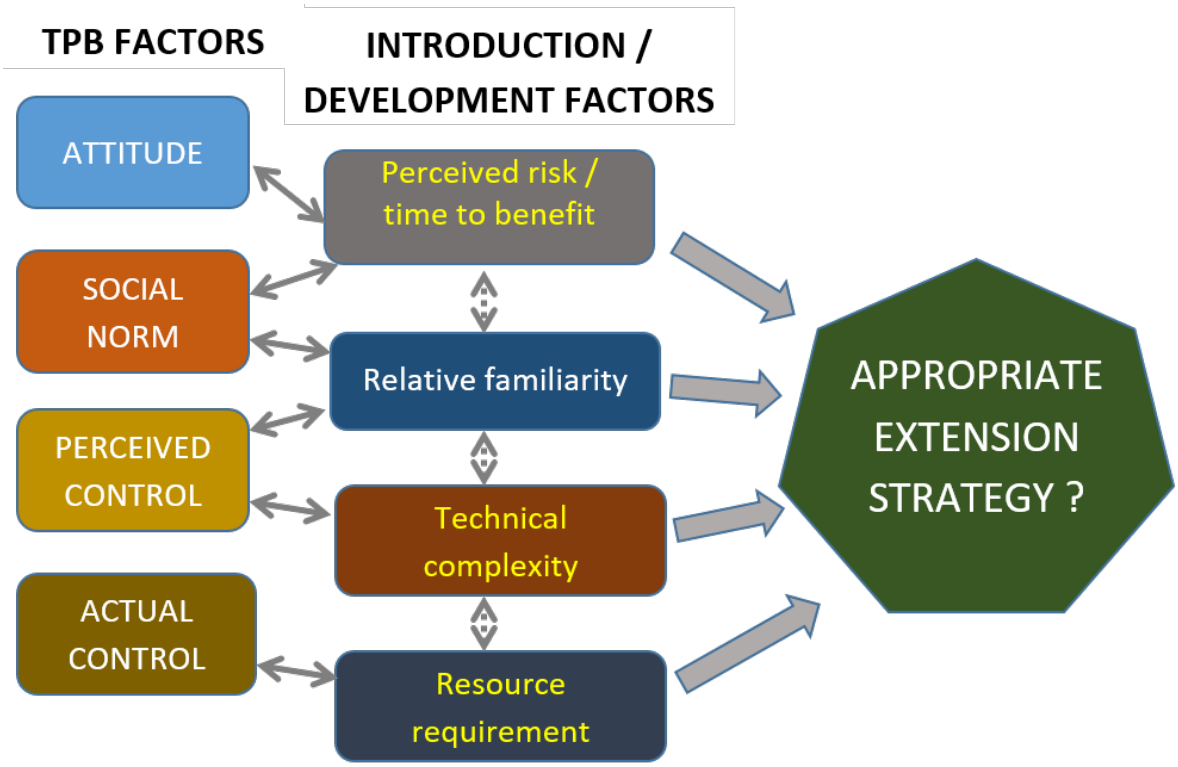

Figure 15: Using TPB factors to better align extension strategies with new technology introduction and scale-out challenges

Table 22: Suggested levels weighting scores for key introduction and development parameters listed under the 4 TPB categories.

Actual control		*Perceived control*		*Social norm*		*Attitude*	
Resource requirement	**Score weight**	**Technical complexity**	**Score weight**	**Relative familiarity**	**Score weight**	**Perceived risk (including time to benefit)**	**Score weight**
Low	1	Low	1	High	1	Small < 6 months	1
Medium	2	Medium	2	Medium	2	Medium 6-12 months	2
High	3	High	3	Low	3	Large >12 months	3

Based on assumptions in Table 22, new technologies that are simple (requiring little additional knowledge and skills); have low perceived risk (e.g. short take-up to benefit times); are relatively familiar (or build on existing practices) and involve minimal resource allocation, would generate low overall scores, indicating the need for relatively simple extension strategies to achieve positive adoption behaviours. At the other end of the scale, new technologies which are complex; have long take-up to benefit times; are unfamiliar and offer relativley high risks for resource allocation, would generate larger overall scores, indicating the need to consider more complex, multi-faceted step-wise extension strategies. Table 23 provides some examples of technologies with different combinations of the 4 introduction criteria and weightings outlined in Table 22 and suggests some relevant extension strategies based on experience in recent ACIAR studies within the region.

Table 23: Examples of technologies with different combinations of introduction parameter levels outlined in Table 22 and suggested extension strategies which might address these combinations.

Introduction parameter levels			Example technologies	Suggested extension options
Technical Complexity	Low-med	1-2	✓ New forage grasses ✓ New vaccine ✓ New crop cultivar	✓ Simple on-farm ✓ Demonstrations ✓ Cross-visits to see real farm application ✓ Fact sheets and videos
Perceived risk /Time to benefit	Small	1		
Relative familiarity	Medium	2		
Resource Requirement	Low	1		
Overall score		**5-6**		
Technical Complexity	Medium	2	✓ Post-partum cow supplementation ✓ Other segregated feeding options ✓ New cattle house options	✓ Cross-visits to see real farm application ✓ Structured on-farm demonstrations ✓ Use of local champions
Perceived risk /time to benefit	Small-med	1-2		
Relative familiarity	Med –low	2-3		
Resource requirement	Medium	2		
Overall score		**7-9**		
Technical Complexity	Med-high	2-3	✓ Early weaning ✓ New feed processing / storage (e.g. hay / silage) ✓ Cattle finishing with commercial supplements	✓ Structured on-farm demonstrations or cross visits to see application ✓ Use of local champions
Perceived risk /Time to benefit	Medium	2		
Relative familiarity	Medium	2		
Resource Requirement	Med-high	2-3		
Overall score		**8-10**		
Technical Complexity	High	3	✓ Tree legume forages ✓ New crop or animal farming options	✓ Structured on-farm demonstrations or cross visits to see application ✓ Use of local champions ✓ Assess social impacts assessment
Perceived risk /Time to benefit	Large	3		
Relative familiarity	Low	3		
Resource Requirement	High	3		
Overall score		**12**		

Better understanding of the complex interaction of technical, environmental and socio-economic drivers of adoption, including farmers' own reasons for adoption, non-adoption, slow adoption and dis-adoption is critical to better design and target extension strategies to improve adoption outcomes. In the case of tree legume introduction, greater awareness about how such longer-term perennial forage options interact with and impact on land and

other resources within mixed crop-livestock smallholder systems is also essential to develop an effective extension plan for their introduction.

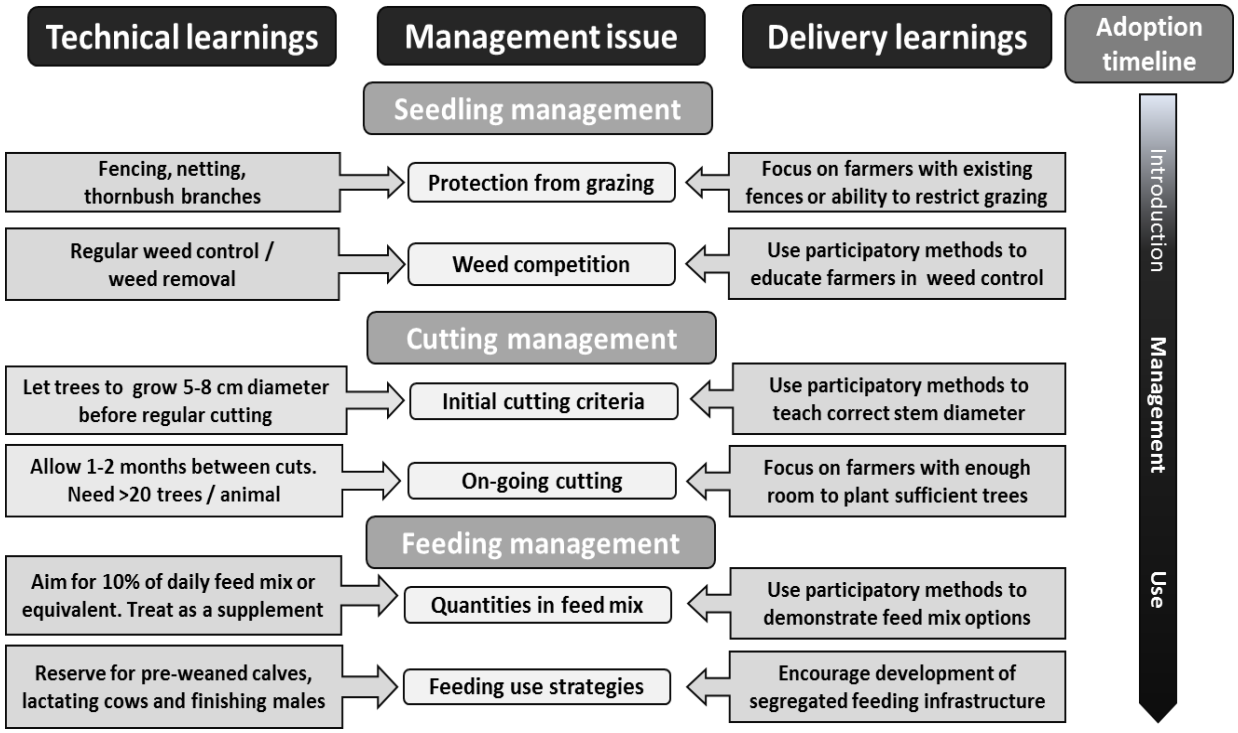

Figure 16: Schema of relationships between smallholder-identified issues affecting adoption of *Taramba* and suggested technical and extension delivery responses for use in future introduction activities in this region, based on learnings from this study.

This case study clearly demonstrated that:

a) Adoption intentions and behaviours are often influenced by a complex combination of interacting actual (technical and resource) and perceived (*attitude* and *social norm*) issues and
b) Technical information and training alone cannot always ensure successful adoption outccomes, even where participatory-adaptive delivery methods are used.

Smallholder cattle producers in South-Central Vietnam have been constrained from taking advantage of rising beef demand and prices, due to poor productivity. Improving cattle nutrition and management are key steps to improving productivity. Previous studies have focused on research for development of improved forage cultivation, feeding and cattlle management strategies to meet these challenges, with variable adoption outcomes. Better understanding of the complex interaction of technical, environmental and socio-economic drivers of adoption, including farmers' own reasons for adoption, non-adoption, slow adoption and dis-adoption is critical to better design and target extension strategies to improve adoption outcomes.

The case study approach of reviewing and analysing data on establishment and utilisation of two contrasting introduced forages, using the TPB conceptual framework, proved highly effective in identifying the technical, environmental and socio-economic interactions influencing adoption intentions and behaviours. The learnings generated from this approach in turn enabled development of key criteria for consideration when introducing new technology options to smallholder communities. The contextualised criteria, aligned with TPB factors, provide a simple method of assessing the characteristics of the technology to be introduced, and how subsequent adoption behaviours of farmers are likely to be influenced.

Application of key learnings and approaches arising from this case study should assist extension agencies and policy makers to develop better targeted extension strategies for successful introduction and scale-out of new forage, cattle feeding and management technologies to smallholder communities in South-Central Coast Vietnam and elsewhere.

Case study 3 – Developing a Cattle Club formation model

For smallholders, the progression from traditional cattle keeper to cattle producer involves a stepwise process of new knowledge and skills acquisition and application to improve feed supply and quality, cattle condition, feeding and breeding management and marketing. In 2015-16 a third stepwise case study approach was used to explore the development of cattle clubs in Ea Kar, identify the characteristics of successful and unsuccessful clubs and assess the transferability of the Ea Kar cattle club model to other regions, starting with the South-Central Coastal provinces of Vietnam. In the process key learnings essential to successful cattle club development were identified (Table 24). From these a set of cattle club establishment and operational guidelines (Figure 17) were developed and field tested with key stakeholders, then successfully applied to help establish new cattle clubs in Tây Giang commune (Bình Định province) and An Chan commune (Phú Yên province).

Table 24: Key learnings about successful cattle club development emerging from Case Study 3 stakeholder interviews and workshops.

Community engagement with the cattle club concept
Engagement and support of all levels of government essential for successful development
Specific endorsement from commune and village officials essential before farmers will engage
Involvement of local farmer champions critical to gain farmer respect and motivation
Cross-visits by farmers and community leaders to successful cattle clubs is a critical early step
Provision of clear information on benefits and challenges to farmers via workshops, meetings
Adapting cattle club models to local cultural, farming system and resource s is essential
Important that potential cattle club members look past initial benefits to long term benefits
Facilitating new cattle club development
Choose communities which already share close relationships and knowledge networks
Common interests (relatives, friends, neighbours) more critical to early success than critical mass of cattle for marketing. So start small and build up.
However, the chosen community still needs sufficient resources (land, labour, cattle and infrastructure) to support viable cattle club activity.
CC membership criteria and operational rules must be clear, easily understood and agreed to by all potential members and local officials, to ensure community ‘ownership’
Thus, the target community and local officials should be involved in their development at all stages.
Choosing the right leader is critical for successful CC development. Where possible leaders should be respected and active local farmer champions capable of inspiring other members.
Initial CC focus depends on development stage of existing production/selling system and knowledge base. Choosing the right ‘entry point’ for will be critical for early success
However early engagement with other stakeholders across the value chain is also important.
Use participatory methods to help facilitate new cattle club establishment and transfer essential technical and operational knowledge to support cattle club development.

Figure 17: Seven Step Cattle Club Development Model developed from Case Study 3

The step-wise approach used in this case study was a highly useful and informative process, enabling the study team to move smoothly from system understanding and distillation of key stakeholder learnings, leading to development, testing and application of key cattle club guidelines. Based on this experience we would recommend the use of this stepwise case study approach for application to similar applied research tasks in future projects. A key question for this case study was whether the Đắk Lắk cattle club model could be successfully transferred to other locations in the South-Central Coastal (SCC) region of Vietnam. Experience from the Beef Common Interest Groups set up by the *Livelihoods for Sustainable Development* (LSD) project funded by the New Zealand government in Cat Trinh communes, Bình Định was mixed. So SCC farmers and extension officials remained uncertain and in some cases highly sceptical of the potential for cattle club development there.

However, experience with this case study process, led to the successful establishment of small but enthusiastic cattle club groups in Tây Giang and An Chan communes. The Nam Giang Cattle Club in Tây Giang, established in late 2016, focusses on improving their cow-calf production systems and is actively engaged in scaling out new forages and knowledge about improved cattle management practices. The An Chan Farmer Extension Club (established in 2017) focussed on male cattle finishing and is collaborating with local feed companies to develop suitable supplements for this purpose. Both clubs have set up contributory micro-finance funds for the benefit of members and are led by emerging farmer champions. Importantly both clubs have significant female membership (38% in An Chan and 29% in Nam Giang). The early success of both clubs has convinced farmers and DARD officials alike of the potential for further cattle club development there. Only time will tell how these fledgling cattle clubs develop and prosper. However, in Tây Giang commune there is already strong interest in setting up a new cattle club in another village, which is very encouraging.

Activity 3.1.3 in the original project plan to 'Conduct and monitor exposure visits' was merged into case Study 1 and 3 in the previous Activity. The use of reciprocal exposure visits between Tây Giang farmers and Cat Trinh farmer champions formed the basis for the main research activity under Case Study 1 in Activity 3.1.2. Exchange visits were also used within Case study 3 to expose farmers from newly formed cattle clubs in Tây Giang to new cattle production technologies being applied by emerging An Chan cattle club farmers. The benefits and practicalities of exposure visits were also demonstrated as part of on-the-job train the trainer activities associated with Activity 3.3.2.

7.3.2 What are the knowledge pathways in focal chains to identify key people, businesses and organisations for each stage of the chain that influence farming and business practices?

Supply chains are a series of businesses with seamlessly integrated functions, processes, and activities both within and between those businesses that create and deliver products that end-users/consumers value and will pay for. However, it is now recognised that modern

commercial supply chains are in fact dynamic networks of interconnected firms and industries. The analytical methods to investigate the dynamics of chain networks appears to have developed little further than the earlier efforts around the turn of the millennium.

This project investigated how a concept called Value Network Analysis (VNA), a qualitative method for value network analysis pioneered by Allee (2003, 2008) and Schiffer (2007); Schiffer and Waale (2008), to provide useful research outcomes in a developing country context. It then extended this with the first known application of quantitative multilayer and visualisation network analysis functions of the software packages 'R' Statistical Analysis and the new social network analysis software called Muxviz (Domenico, Porter & Arenas, 2015) to value network analysis to provide a visualisation of the networks used by cattle producers to create economic value in the form of beef cattle.

The implementation of the qualitative stage of research was somewhat curtailed by factors beyond the research team's control such as the funding available from the project. This restricted the investigation to the farm production stage of the supply chain from Bình Định Province to Đà Nẵng City whereas the power of this value creating network analysis is to apply it to all stages of the supply chain from farm to retailer.

Never-the-less, useful analyses resulted including the identification of the most important resources for farmers, the distances over which they obtain those resources, a number of influencers or fixers and the centres of influence in these networks.

The diagrams and focus group data generated in the four very participative workshops involving approx.100 farmers generated a large amount of data and diagrams were used to:

1. Visually assess differences both within a cattle club/group regarding the manner in which they networked to obtain and exchange resources;
2. Visually assess differences between cattle clubs regarding one specific resource. For example, such an analysis of knowledge/information/techniques is facilitated by Figure 16;
3. Ranking resources based on their importance;
4. Identify the key individuals who are brokers of resources or knowledge within a commune or cattle club;

The next phase of the method involved generating a preliminary 3-dimensional layer analysis (Figure 18) from a quantitative survey of 36 (HUAF) and 39 (TNU) farmer interviews analysed using the 'R' statistical package and MuxViz shows that:

- The main resources are (in rank order):
    1. Money
    2. Livestock
    3. Fodder
    4. AI breeding
    5. Veterinary services
- People in the labour network are not that present in the other networks;
- People in the money network are present in all the other networks;
- Tool provision, veterinary services, insemination services are completely money driven;
- Livestock network appears to be quite different in how they relate to farmers;
- Veterinary services and insemination service work closely together (are highly correlated), and animal nutrition and knowledge work closely together;
- Most people are in most of the networks….except for the labour and money networks….they are quite different to the other networks

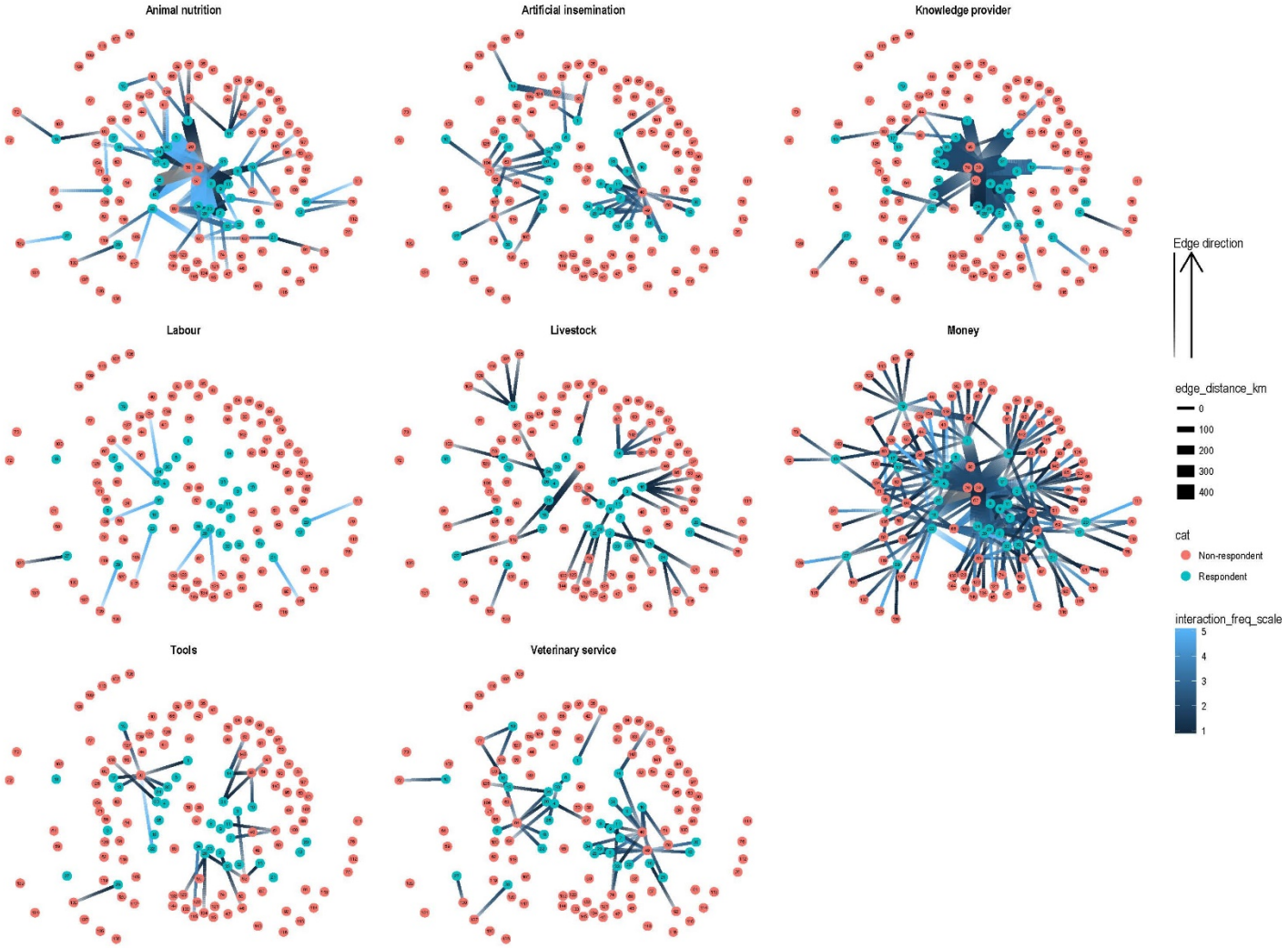

Figure 18: Preliminary 3-dimensional layer analysis with 'R' statistics and MuxViz

At this point of the development of the method we have found that:

1. The method appears to be capable of providing very detailed network and behavioural information that will be valuable for ACIAR projects and ODA research in general;
2. Need a more secure and error-free method of data collection such as that provided by coding this into ACIAR's Commcare app;
3. Cleaning the survey data took a very long time - this would be partly solved by Point 1 but requires very thorough understanding and training by the invigilators;
4. Surveys took 30-40 mins which was consistent with the piloting experience prior to implementation;
5. The output is starting to show why the 'soft' side of ACIAR projects is so important;
6. The quantitative method in particular, has potential utility not only for resource networking but also post-project scale-out impact analysis.

There appeared to be sufficient promise of the utility of the approach to proceed with further development including programming into Commcare, a software package recommended by ACIAR for facilitating secure data collection. The project concluded that the method appears to be capable of providing very detailed network and behavioural information that will be valuable for ACIAR projects and ODA research in general, and resource networking and scale-out impact analysis in particular

7.3.3 How can knowledge exchange and adoption pathways in focal communes be facilitated that support Objective 2 and the scaling-out of the adoption of project outcomes? *(Activity 3.3)*

A wide range of literature from different official development assistance (ODA) perspectives supports the formation of stakeholder groups for designing and implementing value chain interventions to assist poor, traditional farmers link to modern, sustainable markets (Best, Ferris & Schiavone 2005; Meyer-Stamer & Wältring 2007; Tschumi & Hagan 2008).

The ODA agricultural extension literature focuses strongly on Participatory Action Research (PAR) methods for adoption and scale-out of new technologies or behaviours. Mindful that PAR is the scientific method within the theoretical schools of Action Learning (Boon 2009) as distinct from the other two schools, 'experiential learning theory' and 'action research and critical humanistic orientation' (the incorporation of critical reflection into experiential learning), in Activity 2.1.8 we have focused on engaging the chain stakeholders to change their own behaviour through a cycle of action and reflection-on-action at times employing experiential learning as a learning method for both extension workers as well as farmers.

Such approaches are often portrayed as endogenous or 'bottom-up' approaches to development (Khisty 2006; Tomaney 2010) and are linked strongly into many different approaches to agricultural development such as Rural Productive Alliances advocated by the World Bank (Ekboir & Rajalahti 2012), Farmer Field Schools (Braun et al. 2006), Markets for the Poor (M4P 2008) amongst many.

Meyer-Stamer and Wältring (2007) and Collins, Dent and Bonney (2015) specifically recommend the incorporation of endogenous approaches to addressing the challenge of incorporating the outputs of value chain analysis into PAR.

More recently, there has been interest within the ODA field in the Western business concept of 'learning alliances'; the formation of 'ongoing, formal, business relationships between two or more independent organisations to achieve common goals that have had an impact creativity, absorptive capacity and alliance innovation (Bucic & Liem Viet Ngo 2013). Learning alliances are now regarded as a key part of 'multi-stakeholder platforms (Thiele et al. 2016), defined as:

> *… a space of interaction among different stakeholders who share a common resource and interact to improve mutual understanding, create trust, define roles, and engage in joint action (p.250)*

'Learning alliances' are a related concept which promotes multi-stakeholder learning for stimulating innovation and business development, but differs because it has a shared resource with a clearly bounded membership. Thiele et al. (2016) identify that learning alliances can undertake three functions:

1. Create a space for learning and joint innovation
2. Perform a governance function within the value chain to improve coordination of business activities by actors;
3. Perform advocacy functions to secure policy change or influence.

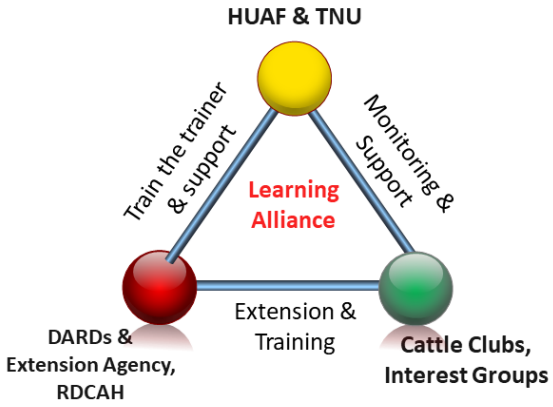

Figure 19: Multi-stakeholder platform or learning alliance to support adoption and scale-out

In this project, we have conceptualised our learning alliance as depicted in Figure 19.

Recently Spigel and Harrison (2017) have added an important dimension for the ODA field that strongly supports the learning alliance approach. In differentiating between Rural Innovation Systems (RIS) and cluster approaches, they have highlighted that knowledge about the innovation process comes from training and interaction with other entrepreneurs using the experiential and reflective learning processes and that the process needs to be led by the participants themselves. This provides explicit support for the model depicted in Figure 19.

Subsequent sections of this report will explain how this project has implemented this model across the three focal provinces in the Central Highlands and South-Central Coast of Vietnam.

Developing knowledge exchange and adoption recommendations to support the change protocol *(incorporating Activities 2.1.6 - 8).*

Recommendations from the three Case Studies for improved engagement with smallholder beef producers and beef value chain actors were incorporated into the *Working with Farmers* (use of participatory extension methods) and *Guidelines for Cattle Club Development* extension handbooks developed under Activity 3.3.2. These knowledge exchange recommendations were workshopped and refined with key commune, district and provincial DARD extension staff during the development of these guidebooks, then used as part of practical on-the-job train the trainer activities with extension staff and other stakeholders in late 2017 / early 2018.

Mr. Qua (Vice-director of Tay Son district extension office) said: "The set of extension materials is very well prepared and helpful to our tasks. I think not only in Tây Giang commune

but farmers and extension workers in other communes will be happy to have those factsheets and handbooks".

Mr.Nhon in Tây Giang commune: "Cattle club was very helpful for not only the members but also for the community. We got the technical advice from university researcher, project staffs, local extension worker. We felt confidently testing together how to cultivate and to utilize the new forage species, how to do supplementation of cow-calf in a better application, how to do beef fattening. During the learning process we had meeting to share experience among members, in addition non-members in the community also came to learn what we were doing and we were happy to share our experience and things that they need (for example, forage cuttings)".

Conducting training to build the capacity *(Activity 3.3.2)*

Conducted training to build the capacity of DARD, Extension Station & Provincial Department of Science & Technology and Extension Station officers and other private rural agents to support the project and facilitate subsequent scale-out of production and marketing best practice models.

Training materials and training packages were developed under Activity 3.3.1 from outputs derived from Activity 3.1.2 / 3.1.3 and field tested with DARD and other next users. Pilot *train the trainer* workshops were held in late December 2017 with commune and district extension staff and key farmers from Tay Son district (Bình Định) and Tuy An district (Phú Yên). Training focussed on key elements covered by the extension fact sheets and extension handbooks, including recommendations for new forage development, new cattle feeding and management, new cattle club development and use of participatory extension delivery methods. Training was both classroom based and on-the-job, engaging stakeholders in practical application of forage and cattle management and use of extension tools such as cross-visits, use of focal farmers (farmer champions) to aid scale-out of new knowledge and practices.

Following evaluation of this pilot training activity similar commune-wide training activities involving district extension staff and other key stakeholders were planned for early 2018, in partnership with provincial and district DARDs.

Establishing learning alliances and gradually transitioning to Focal Farmer leadership *(Activity 3.3.3 to 3.3.5)*

Established learning alliances associated with:

- Farmer ‘interest groups’ in the focal communes:
    - Three Đắk Lắk Cattle Clubs
    - Two Tây Giang Cattle Clubs in Bình Định;
    - One Cattle Club in An Chan
    - On-going informal learning alliances already formed within and between the Tây Giang and An Chan clubs via exchange visits in 2017 and between Tây Giang and Cat Trinh farmers / farmer champions via earlier (2015) cross-visits.
- Other chain participants included traders in Đắk Lắk where a large provincial trader is collaborating with Cattle Clubs and a local abattoir.
- Previously non-participating farmers are now engaging with the project by the endogenous formation of Cattle Clubs in Đắk Lắk and Tây Giang. In each case, their first priority is for training;
- Within and between Provincial DARD, and Extension Stations, Provincial Department of Science & Technology officers and other private rural agents.

Stakeholders of other projects, e.g. CIAT/IFAD.

- Establishment of a learning alliance of farmers, representing all 3 provinces.

- Establishment of a learning alliance of DARD, and Extension Station & Provincial Department of Science & Technology officers from all 3 study provinces.
- Inclusion of other private rural agents.

Learning alliances between stakeholders developed as part of individual activities in case study 1B (cross-visits) and case study 3B (new cattle club development) under activity 3.1.3 and as a consequence of activity 3.2.1 (VNA) activities within Objective 3, activity 2.1.6 (focal farmer identification) and activities 1.1.3 and 1.2.3 (on-farm cow-calf and male cattle feeding demonstrations). These learning alliances developed either informally in the course of conducting the on-farm activities (through bringing various stakeholders together via on-farm workshops, exposure visits, meetings and field activities or through formal targeted field days and training sessions. Specific examples include the facilitated interaction of selected Tây Giang farmers and extension staff with both Cat Trinh farmer champions and extension staff in 2015 (via activity 3.1.3 case study 1 activities) and the field day and associated stakeholder training workshop on beef cattle finishing (2016) associated with activity 1.2.3, which brought cow calf and finisher farmers, traders, extension staff and feed company representatives together.

All Cattle Clubs have been established by adapting pro-forma guidelines (developed from Activity 3.1.3 Case Study 3) to suit the needs and requirements of the participating members. This gives each Club local indigenous autonomy and ownership, with the active involvement of local farmers, extension staff and commune officials. Focal Farmers (farmer champions) emerging as a consequence of involvement in cross-visit and Best Bet activities have taken the lead in both promoting and overseeing the development of these new farmer clubs Extension of best practices to non-participants in the project. Emerging focal farmers (Farmer champions) such as Mr Nhon and Mr Hong (Tây Giang) and Mr Phuoc and Mr Hung (An Chan) have taken the lead in such local extension activities and now work closely with existing commune extension staff and representative structures to actively promote and facilitate adoption of new forage and cattle techniques

Activity 3.4.1 Review annually to project completion the implementation of the knowledge exchange and adoption framework

Knowledge exchange and adoption strategies based on learnings derived from Activity 3.1.2 / 3.1.3 case studies and Activity 3.2.1 Value Network Analysis were regularly reviewed in the course of assessing progress and outcomes for those activities. Those assessments formed part of progress reports presented to annual meetings and regular meetings with Provincial and District DARDs, commune officials and other stakeholders throughout the life of this project. Key knowledge exchange and adoption recommendations were also workshopped with stakeholders prior to inclusion in the *Working with Farmers* and *Guidelines for Cattle Club Development* extension handbooks developed by Objectives 1 and 3 teams and used in subsequent extension staff training activities.

8 Impacts

8.1 Scientific impacts – now and in 5 years

This project used participatory action research to develop improved animal nutrition techniques through the feeding of improved forages and supplementation with concentrates for smallholders using locally available resources.

An experiment on the tolerance of improved forage varieties to single and multiple waterlogging events will add to the scientific literature. Most published studies to date have focussed on single waterlogging events, whereas field conditions are presenting multiple waterlogging events (particularly during 2017 where the South-Central Coast received many typhoons). Further research to be conducted by Nguyen Thi Mui as part of a proposed Masters project is to include modifying management such as cutting height and cutting interval in a bid to increase tolerance to waterlogging. Combined, these studies are likely to have lasting scientific impacts.

Value chain research has delivered a detailed understanding of the market dynamics in the major cities of Đà Nẵng, Ho Chi Minh City and Buon Ma Thuot. The initial market research situated Vietnam within the dynamics and trends of the region, identifying the current production characteristics and capability including the key constraints on the system including a comparison of the competitiveness of alternative markets. The analysis provided the first known fine-grained analysis of market opportunities in the three focal provinces and Vietnam's third largest city. Preparation of a publication is in progress to submit in 2019 to the *British Food Journal* (refer Section 10.1 below).

The baseline economic study provided a sound basis for the assessment of impact and showed that at the present time, if all costs are taken into account, there is a negative IRR and highlighted the challenges of an ageing industry and under-skilled regarding managing their farm business as well as their cattle husbandry.

The consumer research was based on triangulating data from qualitative convergent interviewing, quantitative surveys and physico-chemical testing of meat samples and provided a very thorough understanding of consumer value attributes and the sensory acuity of modern and traditional Vietnamese consumers. The combination of methods employed are believed to be a first for Vietnam and included the development of a rigorous Affective Sensory Testing protocol reviewed by Meat & Livestock Australia (MLA). Preparation of a publication is in progress to submit to the 2020 *International Food and Agribusiness Management Review* (refer Section 10.1 below).

The VCA itself identified the competitive weaknesses, constraints and infrastructural challenges of traditional supply chains juxtaposing these with the emergence of modern, integrated, coordinated, specification-driven chains endogenously from the exploitation of opportunities by entrepreneurial individuals. It clearly highlighted the strategic and operational challenges for the transformation of traditional chains. This highlighted the importance of the work currently being carried out by two of the project's PhD students at UTAS who are working on market orientation and entrepreneurial marketing in the Central Highlands. Preparation of a publication is in progress to submit to the 2020 *International Food and Agribusiness Management Review* (refer Section 10.1 below).

The first adaptation and application of an existing Western qualitative methodology called Value Network Analysis to a developing country context provided a new means of investigating the role of social networks in value chain development. The extension of that into a more quantitative method for analysing networks using new computer software has utility for designing extension strategies and mapping scale-out. Preparation of a publication is in progress to submit in 2019 to the journal *Social Networks* (refer Section 10.1 below).

The project also successfully developed and tested cattle club formation and operation protocols in three provinces that have utility for other research projects.

This project researched and detailed the significance of farmer champions in the scale out process. It also investigated the use of reciprocal cross visits between farmer champions and smallholders wishing to increase their knowledge. The ***four (4) extension manuals*** and ***nine (9) extension factsheets*** generated by this work are listed in Section 10.1 below. Planned journal publications will add to the literature on such extension methods and provide methods for like projects in the region to adopt.

Adapted the 'Theory of Planned Behaviour', a mainstream marketing theory that explains how and why individuals who have technical knowledge don't apply it in their own circumstances, to contextualise adoption and non-adoption and streamline the selection of extension methods. This is the first-known use of the TPB to explain Vietnamese agricultural adoption phenomena. 'The case study approach of reviewing and analysing data on establishment and utilisation of two contrasting introduced forages, using the TPB conceptual framework, proved highly effective in identifying the technical, environmental and socio-economic interactions influencing adoption intentions and behaviours. The learnings generated from this approach in turn enabled development of key criteria for consideration when introducing new technology options to smallholder communities. The contextualised criteria, aligned with TPB factors, provide a simple method of assessing the characteristics of the technology to be introduced, and how subsequent adoption behaviours of farmers are likely to be influenced. Application of key learnings and approaches arising from this case study should assist extension agencies and policy makers to develop better targeted extension strategies for successful introduction and scale-out of new forage, cattle feeding and management technologies to smallholder communities in South-Central Coast Vietnam and elsewhere.'

8.2 Capacity impacts – now and in 5 years

8.2.1 University of Tasmania researchers

Dr Laurie Bonney has been able to refine his approach to the management of ODA projects and his practice of value chain analysis including economic, market, consumer, institutional and social research. In doing so, in collaboration with his project colleagues he has been able to employ, adapt and design novel research methods (e.g. VNA and consumer research) to the developing country context. Dr Rowan Smith has expanded and adapted his knowledge in order to understand the growth characteristics and systems fit of tropical forages in cut and carry systems. The project has also led to gaining an interest and skills in waterlogging stress physiology, which are now being applied in his current domestic work on temperate grasses. The multidisciplinary nature of the project has required Rowan to gain a basic understanding of many research areas including social research, value chains and value network analysis, consumer values, animal nutrition, and bring this together in an agricultural systems context. Rowan now has a broader research knowledge that is critical when solving agricultural research challenges in developing countries and has adapted his approach to extending research in Australia. Dr Lydia Turner comments that participation in the project has involved co-learning on many levels, "While my insights have guided the case study approach to Objective 3 activities, I have learned far more than I have contributed." She lists the following areas of developing new knowledge and skills: how to apply social research methods in developing world contexts, the characteristics and challenges of participatory approaches, and the importance of building relationships within the research project team and with community participants in the research for development activities. Lydia experienced synergy in a way she had not before; the combined power of people when they are working together, that is greater than the total power achieved by each working separately. Her first-hand observations of the step-wise 'best-bet' RD&E also led to

Lydia making key contributions to the design and development of the current flagship TIA dairy project (funded by Dairy Australia, 2016-2018, $1,818,746) – the first TIA dairy project to integrate RD&E and involve participatory action research.

8.2.2 Vietnamese researchers at HUAF and TNU

Assoc. Prof. Nguyen Xuan Ba (HUAF) learnt considerably in the area of project management from Dr. David Parsons and Assoc. Prof. Laurie Bonney, particularly “how to work with different people with different perspectives”. Ba has applied his learnings in managing staff within his University as well as managing local government agriculture projects. Furthermore, Ba had little knowledge of value chain research prior to this project and has built his capacity in value chain analysis through training sessions with Assoc. Prof. Laurie Bonney. Working with Dr. Rowan Smith, Assoc. Prof. Nguyen Huu Van (HUAF) led the organisation of annual meetings, review meetings, field visits and research activities as well as managing project budgets. The multidisciplinary nature of this project meant that Van was required to learn many research fields in order to truly understand what was required in terms of planning and resourcing.

Young female researchers Ms. Nguyen Thi Mui and Mrs. Nguyen Thi Da Thao (HUAF) enjoyed the opportunities to work and collaborate with Australian experts who have helped her enhance knowledge and experience Mui has enjoyed the practical nature of the research; “I enjoyed opportunities to work with farmers because as a researcher, every year I have at least ten trips to work with smallholders in their farming systems. Through these activities I could develop my interviewing skills and collecting data”. Thao gained in-depth knowledge about the adoption pathways for expanding impacts within smallholder beef cattle enterprises. She also learnt how to develop and apply social science theories through the in-depth research processes applied during studies of project. She has improved her research skills and capacity in problem solving, critical thinking, data collection and analysis, time and project management, and scientific writing, while also improving her English language skills.Mr. Tran Cao Uy improved his knowledge and experience in Agricultural extension field when he directly participated in and implemented action research relating to knowledge delivery pathways for farmers. Mr. Le Van Nam Nam enhanced knowledge and skills in developing a research proposal as well as writing an international article. He, along with the other young staff had the opportunity to attend “The 5th International Conference on Sustainable Animal Agriculture for Developing Countries”, in Pattaya, Thailand which refined their presentation skills.

Assoc. Prof. Tran Quang Hanh (TNU) improved his English skills in speaking and writing and consolidate his professional knowledge. “My involvement and learnings from the project will partly assist me in being promoted to the title of Assoc. Prof. I feel more confident and better able to express my ideas than in the early days of the project”. Assoc. Prof. Pham The Hue has learnt methods for processing information, analysing the data of research results, investigation, market evaluation, sensory evaluation of beef, step by step building the beef brand. “I believe the use of indigenous knowledge, participatory research methods, and beef cattle production value chain research are really new methods that need to be scaled out. This research approach is new for me and important in the development of beef cattle production in the Central Highlands and Central Coast area”.

My involvement in the project has assisted in building my research capacity and contributed to me being appointed to the title of Associate Professor in 2017.

Hanh and Hue have been able to transfer some of the knowledge and skills gained in this project into parallel projects including;

- Application of technical advances in building intensive farming demonstrations of beef cattle production to contribute to economic development in Krong Bong district, Đắk Lắk province. Rural mountainous development program, Ministry of Science and Technology, 2017 - 2019

- Building a demonstrations for applying advanced technology in beef production towards high quality in Dak Nong province. - Rural mountainous development program, Ministry of Science and Technology, 2017 – 2019.
- The situation of beef cattle production and the experiment of fattening crossbred cattle in Đắk Lắk (2018 – 2019). Ministry of Education and Training, in cooperation with Lao to train masters' students.

8.2.3 Postgraduate students

Mr. Thanh Tran Hai has developed his research skills including experimental design, data collection, farmer interviews, data analysis and presentation. "I enjoyed the opportunity to study Masters at University of Tasmania from 2013 to 2015 on 'Strategic nutritional enhancement of cow-calf performance in South-Central Coastal Vietnam'. Following his Masters study, Hai has returned to play a significant role in the writing up of project activities and is exploring options for further study in the form of PhD candidature.

Mr Ho Le Phi Khanh has submitted his Mixed Methods PhD thesis entitled: 'A resource-advantage theory approach on competitive advantage and financial performance of beef cattle value chain in Vietnam Central Highlands' with two published journal articles (listed in Section 10.2) in the *Journal of Innovation & Knowledge*. The thesis has been passed by a double-blind examination process and Mr Ho will graduate in July 2019. Mr Ho said: "I received brilliant guidance, support, and encouragement. I feel extremely lucky to have worked with such a wonderful supervisory team and (their) experience and knowledge was indispensable in assisting my progression through the PhD process." Mr Ho has returned to Hue University of Economics and is currently engaged in development research and the teaching of undergraduate students.

A number of other students have gone on to postgraduate studies at the University of Tasmania through John Allwright Fellowship funding. Mr. Troung Quang Dung is studying 'How does value chain governance affect smallholders' decision to change from cattle keeping to cattle production'. Mrs. Nguyen Thi Da Thao is studying 'What is the role of women's empowerment in maximising development outcomes in smallholder beef cattle production'. Ms. Nguyen Thi Mui is studying 'The effects of waterlogging on temperate and tropical grasses'.

8.2.4 Undergraduate students

University of Tasmanian student Ms. Miriam McCormack developed her research skills including experimental design, data collection- specifically farmer interviews, analysis and presentation. Miriam enjoyed the opportunity to work in a cross-cultural, multidisciplinary team and gained experience in international agriculture for development. This experience led to being accepted into the ACIAR graduate program in 2016 and joining the Researchers in Agriculture for International Development (RAID) committee.

A number of undergraduate and graduate students from Hue University of Agriculture and Forestry assisted in project activities. Students from the faculty of Animal Production & Veterinary Medicine, and the faculty of Agricultural Extension & Rural Development had a chance to conduct their graduation project and learn about practical knowledge of cattle production and extension methods of cattle production in smallholder farming systems.

8.2.5 DARDs

Provincial and district DARD staff learnt and experienced participatory approaches of agricultural extension, conducting on-farm demonstration of cow-calf supplementation, conducting cross visit, using champion farmers, best-bet farmers in technical transfer, developing process of extension material, via direct participation in on-farm activities with

project staff and via formal training and train the trainer activities using materials produced by the project team.

Mr. Qua (Vice-director of Tay Son district extension office): "The set of extension materials is very well prepared and helpful to our tasks. I think not only in Tây Giang commune but farmers and extension workers in other communes will be happy to have those factsheets and handbooks"

David Kolb's Experiential Learning Model (ELM) (1984) and 'reflection-in-action' theory of (Schön, 1983; Mortari 2015) were used as the basis for 'Just-in-Time' training workshops for extension staff (Train the Trainer) workshops were held with the following foci (number of attendees in brackets); value network analysis training (23), forage establishment and scale out (52 extension staff and 15 champion farmers), cow-calf management (52 extension staff and 15 champion farmers), and beef finishing (46).

Laurie Bonney conducted value chain management awareness training in each of the three study provinces; 53 DARD extension staff attending across the three workshops. This was conducted within the first six months of the project to ensure that DARD operational managers and staff understood the nature of the aims and methods of the project and were able to provide informed support.

8.2.6 Smallholders

For smallholders who have participated in the research the benefits are likely to be long-lasting.

- 15 farmers in Tây Giang were involved in reciprocal cross-visits with Cat Trinh Farmer Champions as part of activity 3.1.3 case study 1 activities in 2015.
- A total of 41 Tây Giang and An Chan farmers participated in on-farm testing of new post-partum cow feeding; calf early weaning and feeding and male cattle finishing techniques during 2016-17 studies.
- Nam Giang cattle club members visited An Chan in 2017 as part of a cross visit to learn about new calf feeding, early weaning and cattle finishing techniques implemented by selected An Chan farmers as part of on-farm demonstrations there. 25 farmers in An Chan and Tây Giang were involved in cross-visits.
- Approx. 175 farmers participated in the Value Network Analysis (VNA) workshops and interviews. All the attending farmers quickly grasped the concepts and enthusiastically participated. Mr Linh commented afterwards: "This is very interesting. We have never thought about the resources we use to grow cattle. This makes us realise how much we need our neighbours and experts in the local district. Perhaps we can use this in our Cattle Club."
- Ms. Nga in Tây Giang commune: "Before I only planted local a small area of elephant grass. Since 2015ACIAR project introduced VA06, TD58 and Mulato II. After one year testing I found that those are better in term of biomass and quality. Therefore, I decided to expand the grass planting area (to replace cassava area) up to about 2000 m^2. That help my husband reduce time for grazing cattle herd, and help me reduce time for cutting native grass which is no longer not much available"

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

Mr. Hung a farmer in An Chan commune provided an insight into the economic benefits of the project to his family: "In traditional way to do supplementation for the cow and calf, we cook available concentrate with water spinach. It takes time and fuel cost. After testing the new application with project staff, we found that non-cook method is more convenient and effective. We understood that mixed-concentrate supplementation is good for cow pre- and post-partum, for early weaning calf. Furthermore, beef fattening by using commercial concentrate was very excellent demonstration. Since October 2016 to present December 2017, I did fattening 4 beef cattle that bring me good benefit. Roughly, I can get a net income of 3,000,000 - 5,000,000 VND per head of beef cattle after 2-3 months of doing fattening".

8.3.2 Social impacts

Mr. Nhon from the Tây Giang commune explained the benefits of being involved in a cattle club and how that extended beyond cattle production in bringing the community together: "Cattle club was very helpful for not only the members but also for the community. We got the technical advice from university researcher, project staffs, local extension worker. We felt confidently testing together how to cultivate and to utilize the new forage species, how to do supplementation of cow-calf in a better application, how to do beef fattening. During the learning process we had meeting to share experience among members, in addition non-members in the community also came to learn what we was doing and we were happy to share our experience and thing that they need (for example, forage tiller)".

8.3.3 Environmental impacts

Cattle management interventions such as the feeding of improved forages and use of supplementary concentrates has improved animal productivity – both in terms of reproductive performance and growth rates of growing and finishing cattle. Improving the efficiency of production has known benefits in terms of reducing methane emissions intensity per animal unit produced. However, measuring and recording such parameters was not planned as part of this project.

8.4 Communication and dissemination activities

Towards the end of the project, the project team coordinated a series of workshops to disseminate handbooks and factsheets produced by the project. As part of these workshops, DARD provincial, district and commune staff were trained in how best to use these materials when working with smallholders. Furthermore, research staff presented research papers at international and national conferences and provided awareness of our project at industry events. A summary of these activities is listed below.

Table 25: Summary of project communication and dissemination activities

Date	Title	Location	Target participants	~ Attendees
25/2/2014	Inception meeting	Quy Nhon, Bình Định	UTAS, HUAF, TNU, RDCAH, ACIAR, DARD	30+
6/5/2014	Value chain research training	Buon Ma Thuot, Đắk Lắk	Project staff	15
9/5/2014	Progress meeting and activity discussion	Phú Yên DARD Tuy Hoa, Phú Yên	Phú Yên DARD	5
25/7/2014	Progress meeting and activity discussion	Bình Định DARD, Quy Nhon, Bình Định	Bình Định DARD	5
28/7/2014	Value chain training	Đắk Lắk DARD, Buon Ma Thuot, Đắk Lắk	TNU researchers, Đắk Lắk DARD, project staff	20
30/7/2014	Value chain training	Phú Yên DARD, Tuy Hoa, Phú Yên	HUAF researchers, Phú Yên DARD, project staff	20
1/8/2014	Value chain training	Bình Định DARD, Qui Nhon, Bình Định	HUAF researchers, RDCAH researcher, Phú Yên DARD, project staff	20
29/7/2014	Progress meeting and activity discussion	Phú Yên DARD Tuy Hoa, Phú Yên	Phú Yên DARD	5
10/11/2014	Presentation of manure paper from SMCN/2007/109	16th AAAP Conference Yogyakarta, Indonesia	Researchers in developing countries	30+
19/1/2015	Planed workshop with farmers and commune staffs for bet-best activities	Tây Giang commune, Bình Định	HUAF, RDCAH, DARD, farmers and commune staffs	20+
9/3/2015	Annual meeting	Quy Nhon, Bình Định	UTAS, HUAF, TNU, RDCAH, ACIAR, DARD	30+
14-16/4/2015	Preparation workshop and farmer cross-visit (Tây Giang commune – Cat Trinh commune)	Tây Giang commune and Cat Trinh commune, Bình Định	HUAF, RDCAH, DARD, farmers and local extension workers	20+

19/8/2015 (Đắk Lắk) 4/10/2015 (Phú Yên) 9/11/2015 (Bình Định)	Value chain management awareness training (Value Network Ânalysis (VNA) training)	Buon Ma Thuot, Đắk Lắk, Tuy Hoa, Phú Yên, Quy Nhon, Bình Định	DARD extension staff	53
27-28/7/2015	Progress feedback session and discussion of upcoming plans for on-farm research activities	Phú Yên DARD / An Chan commune/	Phú Yên DARD, RDCAH, An Chan commune leaders & key farmers, project staff	10+
27/10/2015	Presentation of 4 research papers	5th SAADC Conference, Pattaya, Thailand	Researchers in developing countries	30+
18-19/12/2015	Presentation of paper on factors effecting beef production	Sustainable Livestock Development Conference, Hanoi	Researchers in developing countries	30+
23/2/2016	Annual meeting	Buon Ma Thuot, Đắk Lắk	UTAS, HUAF, TNU, RDCAH, ACIAR, DARD	20+
17/8/2016	Field day on early weaning / calf supplementation and cattle club information session	An Chan commune, Phú Yên	An Chan farmers and commune staff, Phú Yên DARD, local traders	20+
19/8/2016	Field day on post-partum cow supplementation and cattle club information session	Tây Giang commune, Bình Định	Tây Giang farmers and commune staff, Bình Định DARD, local traders	20+
29/10/2016	Extension planning	Tây Giang Commune DARD	Commune extension staff	10
28/12/2016	Beef finishing field day and workshop	An Chan	An Chan farmers and officials. DARD extension staff, traders, farmers from fattening communes, feed company reps, Phú Yên Radio & Television	30+
12/1/2017	Training workshop (ToT) on cow/calf feeding and beef	An Chan commune, Phú Yên	DARD, Provincial extension workers, District	46

	finishing for key stakeholders		extension workers, Leaders of Agricultural cooperatives, Famers from Bình Định, Animal Feed purchase company, Animal Feed produce company	
14/2/2017	Annual meeting	Quy Nhon, Bình Định	UTAS, HUAF, TNU, RDCAH, ACIAR, DARD	20+
16/2/2017	Cow calf extension planning	Tây Giang DARD Office	Commune extension staff and champion farmers	20
17/2/2017	Paper writing workshop	Đà Nẵng	UTAS, HUAF, TNU, RDCAH	15
8/3/2017	Project awareness and networking	Beef and Dairy Livestock Asia Expo, Ho Chi Minh City		
22/4/2017	Presentation of paper on cow-calf production systems	1st Vietnam Animal Reproduction Conference, Hanoi	Researchers in developing countries	
25/12/2017 (Bình Định) 27/12/2017 (Phú Yên) 3/3/2018 (Đắk Lắk)	Forage establishment and scale out workshops	Tây Giang (Bình Định); An Chan (Phú Yên); Ea Kmut (Đắk Lắk)	Extension staff and champion farmers + commune and district DARD extension staff	52+15
26/12/2017 (Bình Định) 28/12/2017 (Phú Yên) 4/3/2018 (Đắk Lắk)	Cow-calf management and scale out workshops	Tây Giang (Bình Định); An Chan (Phú Yên); Ea Kmut (Đắk Lắk)	Extension staff and champion farmers + commune and district DARD extension staff	52+15
26/3/2018	Final meeting	Quy Nhon, Bình Định	UTAS, HUAF, TNU, RDCAH, ACIAR, DARD	20+
11/4/2018	Project awareness and networking	Market Place: 25 years of ACIAR in Vietnam, Hanoi	ACIAR, MARD	

9 Conclusions and recommendations

9.1 Conclusions

The following conclusions reflect the original objectives but are expressed as research questions:

Objective 1: How can more efficient smallholder cow-calf and cattle growing systems be achieved through improved feeding and management?

Our research has shown that the cow-calf production systems can be improved with the use of concentrates to improve animal nutrition. Although this was inconclusive across a number of production factors in the on-station experiment, both the on-station and the on-farm demonstration work showed that calving interval is strongly influenced by animal nutrition and body condition. Cows fed appropriate levels of concentrates maintain body condition through lactation and return to oestrus at a much faster rate. Faster return to oestrus then results in earlier conception of the following calf. Improving the production system to the point where a cow is producing a calf each year has advantages in matching calving time to feed supply, potentially reducing the amount of concentrates that need to be fed.

Improvements can be made in beef finishing systems where the current amount of concentrate being fed is low. High levels of concentrates can improve live weight gains and overall income, provided they are then sold at the completion of the finishing period. Keeping finished livestock for extended periods of time results in wasted resource that could be being invested into the next animal.

Use of improved forages is an important component of stall feeding, being of high nutritional value than rice straw. Choosing the right forage species for the growing situation and managing the species appropriately in terms of cutting heights and intervals are imperative to survival and persistence of plants. Using waterlogging tolerant species in areas that are known to be periodically waterlogging during the rainy season will ensure greater survival and production during and after the waterlogging events and improve the resilience of the farming system. Using alternative forms of feed such as crop residues should be evaluated in terms of nutritional value, with high nutritional value feeds prioritised to pregnant/lactating cows and finishing cattle.

Objective 2: How can stronger integration with markets be developed for beef cattle producers in Central Vietnam who already have a production orientation?

We concluded that supply chains in all project provinces are:

1. Price-driven with short-term, transactional purchasing with little trust or long-term commitment;
2. Insufficient provincial production of 400-450 Kg cattle with a meat:bone ratio of 52% to 54% (Australian cattle ~ 54% versus Yellow cattle ~37%) which is the nature of demand for the modern market. This has its genesis in the breeds of cattle being raised and animal husbandry practices, especially animal nutrition;
3. Too long leading to unnecessary transactional costs and other process inefficiencies;
4. Lack coordination between demand and supply;
5. Lack sufficient market information for the upstream actors in the chain to be able to make marketing decisions;
6. Lack competition in the distribution and processing system to increase efficiency, reduce costs, improve quality and safety and, importantly, drive innovation, entrepreneurship and market orientation. Indeed, there may well be significant

collusion because there are only a few Level 2 traders in the system and the price appears to be very stable;
7. Lack of processing standards, particularly meat hygiene in processing – this includes the lack of control of 'water pumping'[10];
8. The small scale of the animal production system results in higher production costs which is exacerbated by the transport costs of approx. VND750,000 per head to HCMC, both of which make Đắk Lắk Province less competitive to feedlot-raised Australian cattle from provinces closer to the key markets.

Objective 3: How can knowledge exchange and adoption pathways for expanding impacts within smallholder beef cattle enterprises in the South-Central Coast and Central Highlands be developed?

We conclude that:

1. It is imperative to identify and engage local farmer champions (focal farmers) for successful scale-out;
2. Women play a key role in cattle raising and in leading behavioural change across different cultural and geographic boundaries. They are often the primary livestock managers within households, not just in matriarchal minority cultures such as the E'de[11], but across all focal communities and are quick to adopt new practices;
3. Stepwise participatory-adaptive research and extension methods is important to improving adoption outcomes;
4. Adoption intentions and behaviours are often influenced by a complex combination of interacting actual (technical and resource) and perceived (*attitude* and *social norm*) issues;
5. Technical information and training alone cannot always ensure successful adoption outccomes, even where participatory-adaptive delivery methods are used;
6. Employing a systematic model for cattle club development that:
    a. Engages with and gains the support of all levels of government;
    b. Gains specific endorsement from commune and village officials;
    c. Local farmer champions are engaged and endorse the initiative;
    d. Cross-visits by farmers and community leaders to successful cattle clubs are used to motivate new clubs;
    e. Clear information on benefits and challenges is provided to farmers via workshops/meetings;
    f. Cattle club models are adapted to local cultural, farming system and resources;
    g. A focus on the long-term benefits is used to promote membership

    will facilitate successful adoption and scale-out.

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[10] An important weakness in the marketplace for Vietnamese beef is the common practice of pumping water during slaughter. Those engaging in this practice insert a tube down the animal's throat and pump 30-50 litres of water to increase weight. 'Pumped' beef can be visually identified by discerning consumers due to excess juiciness and a poor taste and has approximately 30% lower price than non-pumped beef. Unfortunately, this practice is so widespread that retailers believe that all Vietnamese cattle are pumped with water to increase their weight.

[11] Pronounced 'Ee-dee'.

9.2 Recommendations

Consequently, the recommendations are to:

1. Develop a staged developmental response to the market opportunities in accessing the markets in the two major cities, HCMC and Đà Nẵng. In both instances, provincial authorities need to focus first on increasing the number of desirable breeds in the production base and improving the collaboration and coordination of supply chains to local abattoirs. This response requires different strategies for each market:
    a. For Đắk Lắk Province supplying HCMC, consideration should be given to:
        i. Establishing an ESCAS standard abattoir in Buôn Ma Thuột to slaughter for HCMS thus saving the cost of transporting 50% waste to HCMC. Chiller trucks currently used to transport frozen goods to Buôn Ma Thuột could be backloaded with chilled beef on the return journey to HCMC;
        ii. Establishing cattle finishing arrangements with ESCAS registered feedlots in provinces near HCMC.
    b. For Phú Yên and Bình Định Provinces:
        i. In the short to medium term, the marketing focus should be the Vietnamese style of low-cost accommodation and restaurant outlets as this is by far the biggest market segment still focusing on traditional style meat products. The 3-5 star hotels require the most rigorous quality and should be the long-term target for marketing.
        ii. Improving an emerging calf raising and growing/fattening chain appears to be the best option. More data is required on the Phú Yên and Bình Định collectors involved so that the options for reducing the complexity of the chain by removing one level of collectors is become clearer.
        iii. More modern supply chains, where calf-raising and calf growing/fattening are separate, specialist operations adding value at each stage appear to be emerging from Phú Yên and Bình Định. This should be the focus for development.
2. Given the traditional nature of the consumers, there may be a niche for a “Thịt bò núi truyền thống” (Traditional Mountain Beef) product from Đắk Lắk Province and/or “Thịt bò ăn cỏ truyền thống từ Trung tâm bờ biển của Việt Nam” (Traditional Grass Fed Beef from the Central Coast of Vietnam).
3. A basic system of hygienic abattoirs and cold chain protocols (and government policy) should be established as a priority in all project provinces because of the growing consumer trend towards demanding food safety and soft or ‘tender’ meat.
4. Cattle Clubs should be used to:
    a. Introduce coordinated production using production protocols which produce ‘tender’ or ‘soft’ beef as the demand for these characteristics is a growing consumer trend;
    b. Coordinate and target marketing to specific outlets to increase the bargaining power of farmers and reduce supply risk for buyers.
5. Remove market distortions due to institutional factors (e.g. regulations).
6. Shorten chains to take cost out of the system thus making beef protein more competitive. That is, coordinated supply chains should where possible focus on selling direct to abattoirs that supply the retail buyers.

7. Introducing more competition into chains from farmers through to abattoirs e.g.
    a. Establish wholesale markets to increase price/quality competition, & real-time market feedback to farmers;
    b. Increase real-time market information throughout the chain;
8. Because the distribution function of the traders is critical to the efficiency of the marketing system, authorities should consider increased monitoring and control of the trader's activities to remove collusive practices.
9. The cattle clubs and learning alliance established be expanded using the approach outlined in this report.

9.3 Recommendations for further research

The team believe that the local researchers and DARDs now have a clear understanding of the focus for research and extension to improve the beef production system in their respective provinces. Many of the methods and techniques have been demonstrated to all stakeholders, it's now a case of scale out and scale up. The team are of the view that the current set of research questions have been thoroughly investigated.

A discussion was held at the final meeting of the project to identify areas that required further research and also identify the characteristics of what a new project could be. It was noted by the group of the priority being given by the Vietnamese Government to developing agriculture in the highland regions. Thus, the central highlands was identified as a priority area, more specifically Dak Nong province due to the higher level of minority groups there. Potential areas of research were listed as;

- Cattle nutrition and filling feed gaps with by products and supplementary feeding
- Shortening the value chain – how to intervene
- Smallholder minority groups and the establishment of cattle clubs
- The persistence of Cattle clubs in Ea Kar, Đắk Lắk
- Enhancing women's role and eco contribution
- Policy alignment
- Yellow cattle to local markets – volume of animals
- House and cold survival of animals

Further work is required to test the legitimacy of these research issues with provincial DARDs, researchers and smallholders in Highland provinces. A scoping study may be required to elucidate these issues.

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10.2 List of project publications

Journal papers

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Additional related journal papers (Students with integrated research)

Ho, KLP, Nguyen, CN, Adhikari, R, Miles, MP & Bonney, L (2017), 'Exploring market orientation, innovation, and financial performance in agricultural value chains in emerging economies', Journal of Innovation & Knowledge. Published online http://dx.doi.org/10.1016/j.jik.2017.03.008

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Youtube and training videos

Two videos were produced for Vietnamese audiences on the methods employed for the Hedonic Sensory Testing and Physico-chemical Testing of beef undertaken for the consumer research – one by Hue University of Agriculture & Forestry and the other by Tây Nguyên University (Buôn Ma Thuột).

These were combined into a single, shortened version with English commentary for training and promotional purposes by the Tasmanian Institute of Agriculture.

Two further short videos on Value Chain Systems Analysis and Value Network Analysis methodology are planned to be edited from video footage taken during the project.

Planned and/or submitted papers

Smith. R.W., Mui, Ba, N.X., N.T.Van, N.H., Corfield, J.P., Parsons, D., (2019) Effect of single and repeated waterlogging events on tropical forages for cut and carry systems. Submitted for review to Grass and Forage Science (May 2019).

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Papers from Case Study 1 (A and B)

Turner L, Thao NTD, McCormack M, Corfield JP, Smith, R and Bonney, L, Farmer to Farmer Learning: Farmer Champion Characteristics Influence Extent of Adoption in South-Central Coastal Vietnam, *Rural Extension and Innovation Systems* (In Progress) [Journal Paper, December 2019]

Uy TC, Corfield JP, Thao NTD, Nam LV, Mui NT, Smith, R and Bonney, L, Farmer to Farmer learning: using farmer champions in reciprocal cross-visit activities to enhance smallholder adoption intentions in South-Central Coastal Vietnam, *Rural Extension and Innovation Systems Journal* (In Progress) [Journal Paper, December 2019]

Note: The intention would be to submit the above papers as linked papers for publication within the same issue or as a series, provided we can develop a paper of sufficient quality from CS1 B material. If not, then the intention is to just submit the first paper

Papers from Case Study 2

Corfield JP, Turner L, Nam LV, Smith, R and Bonney, L, Understanding and predicting adoption of agricultural technologies using the Theory of Planned Behaviour - a South-Central Coastal Vietnam case study, *Journal of Agricultural Extension and Education* (In Progress) [Journal Paper, December 2019]

Note: Final order or co-authors not yet determined and dependent on final contributions Papers from Case Study 3