



Australian Government
**Australian Centre for
International Agricultural Research**

Final report

<i>Project full title</i>	Intensification of beef cattle production in upland cropping systems in Northwest Vietnam
<i>project ID</i>	LPS/2015/037
<i>date published</i>	08/03/2023
<i>prepared by</i>	Stephen Ives
<i>co-authors/ contributors/ collaborators</i>	Le Thi Thanh Huyen, Pham Van Hung, Tran Thi Bich Ngoc and Duong Nam Ha
<i>approved by</i>	Dr Anna Okello
<i>final report number</i>	FR2023-009
<i>ISBN</i>	978-1-922787-76-7
<i>published by</i>	ACIAR GPO Box 1571 Canberra ACT 2601 Australia

This publication is published by ACIAR ABN 34 864 955 427. Care is taken to ensure the accuracy of the information contained in this publication. However, ACIAR cannot accept responsibility for the accuracy or completeness of the information or opinions contained in the publication. You should make your own enquiries before making decisions concerning your interests.

© Australian Centre for International Agricultural Research (ACIAR) 2023 - This work is copyright. Apart from any use as permitted under the *Copyright Act 1968*, no part may be reproduced by any process without prior written permission from ACIAR, GPO Box 1571, Canberra ACT 2601, Australia, aciarc@aciarc.gov.au.

Contents

1	Acknowledgments	3
2	Executive summary	4
3	Background.....	7
4	Objectives	11
5	Methodology	12
6	Achievements against activities and outputs/milestones	16
7	Key results and discussion	33
8	Impacts	37
8.1	Scientific impacts – now and in 5 years	37
8.2	Capacity impacts – now and in 5 years	37
8.3	Community impacts – now and in 5 years	37
8.4	Communication and dissemination activities	38
9	Conclusions and recommendations	42
9.1	Conclusions.....	42
9.2	Recommendations	43
10	References	44
10.1	References cited in report.....	44
10.2	List of publications produced by project.....	45

1 Acknowledgments

“Xin-chào tất-cả các-bạn,

Chúng-ta hãy-zành mọi-chút thời-zian để-tưởng nhớ-tới cội-nguồn và ông-cha chúng-ta. Những người-đã xây-zựng tổ-quốc và giữ-zìn chủ-quyền đất-nước Việt-Nam.”

“Hello to all of you,

Let us take a moment to remember our roots and our fathers. Those who built the country and preserved the sovereignty of Vietnam.”

We acknowledge with respect the original custodians of the land on which this research project was undertaken and recognise the deep history and culture of Vietnam. Before we can even begin to understand issues of smallholder households in marginalised areas, we need to walk in the shoes of others who have. We came to Vietnam as foreigners, always respectful of the first people and our Vietnamese colleagues.

We acknowledge, with gratitude, the journey we have been on as a cross cultural research team. Through our time in Vietnam, we shared meals together, we drank together, but always we listened to their stories. Stories of struggle, identity and sacrifice. But also, stories of joy, happiness and a future full of hope for the role agriculture does and will continue to play in improving the health and wellbeing of women, children and whole farming communities and the prosperity of Vietnam.

We thank Professor Le Duc Ngoan and Associate Professor Peter Lane for their contribution to the project as advisors. Their collective wisdom and experience enabled the project team to critically review activities and amend, improve as required.

We also thank the Department of Agriculture and Rural Development (DARD) in Dien Bien for their commitment to the project and their proactive approach to interacting with the whole research team and undertaking activities. The DARD are the direct connection to next users of project outputs and have been a critical partner in the research team.

We would like to thank CIRAD, who were a strategic partner in the project and continued to provide additional benefits and outputs for the project through student projects.

Finally, we acknowledge the willingness and amazing efforts of the Vietnam based research team to adapt and pivot their activities in response to travel restrictions and limitations presented by the global pandemic. Specifically, we thank Associate Professor Le Thi Thanh Huyen for leading the team in Vietnam and ensuring milestones were achieved, and Associate Professor Tran Thi Bich Ngoc for her adaptability and versatility in running field trials remotely.

2 Executive summary

The Northwest region of Vietnam is one of the poorest areas in the country and is dominated by ethnic minority groups in remote, mountainous areas. Smallholder farmers in the region often keep cattle to increase their wealth and assets, but face challenges such as limited feed and forage availability and competition with expanding crop production. The government aims to increase beef cattle production in the highland regions to alleviate poverty and address environmental issues, but these efforts are hindered by the complex topography, remoteness, and limited infrastructure in the area. Despite the country's overall growth, the mountainous northwest region has fallen behind in agricultural development and most of its residents are considered poor. There has been a rise in domestic demand for beef, but the domestic supply cannot meet the demand, leading to imports from neighbouring countries. The expansion of cattle production requires an increase in feed and forage, which raises land use issues and puts pressure on the environmental sustainability of the farming system.

A previous ACIAR project (LPS/2008/049) aimed to overcome the technical and market constraints to cattle production in the region. It emphasized the strong partnerships and capacity building achieved by the project and recommended a follow-on project with a focus on integrating cattle production with cropping and improving the cattle production system. The project had limited adoption due to its focus on identifying solutions to the constraints of beef cattle production in the highlands. There was a strong request for support for a follow-on project from the Provincial Department of Agriculture and Rural Development (DARD) and the National Institute of Animal Science (NIAS), driven by a desire to transform livestock production from extensive to intensive systems and improve farmers' livelihoods. Key stakeholders concluded that the current cattle production system was no longer viable and that there was an opportunity to integrate and build on the current project's research outcomes into a follow-on project that focused on livestock within the farm system and consolidating market linkages.

The overall aim of this project was to improve the income of smallholder cattle producers through intensification of beef cattle production and increased market linkages in mountainous crop-livestock systems in the Northwest of Vietnam. The project was conducted in two districts in Dien Bien province, focusing primarily on Tuan Giao district. Farmer interest groups were formed and used to drive farmer participation in on-farm experimentation and market-oriented interventions. The goal was to demonstrate success at the commune level and engage with at least 270 households in Tuan Giao by the end of the first year, with a target of 450 households by the end of the second year. The potential outreach in Tuan Giao was expected to be at least 1080 farmers over the life of the project. The project also introduced the interventions to a second district and made 60 farmers aware of the new cattle production techniques by the end of the project. Gender equity was considered throughout the project, addressing the traditional and potential roles of women and girls, and monitoring the effect of interventions on them.

The first objective of this project was led by Vietnam National University of Agriculture (VNUA) and researchers from (Centre for Agrarian Systems Research and Development) CASRAD and the University of Tasmania (UTAS). The project used a participatory approach, combining findings from previous studies, to understand the transition to intensification in cattle production. This involved site selection based on criteria such as accessibility, farmer willingness, and market access, participatory livelihood analysis with 300 households across three communes, and peer-to-peer knowledge exchange to enable farmers to see the potential of intensive cattle production systems. The livelihood analysis provided a baseline of the current situation, farm typologies, and aspirations of smallholder cattle farmers. A peer-to-peer exchange was carried out in Dak Lak as part of a collaboration with researchers involved in a related project and used to incentivise project farmers and the extension services.

The second objective was led by a group of organizations including NIAS, Thai Nguyen University of Agriculture and Forestry (TUAF), Tay Bac University of Agriculture (TBU), DARD, UTAS, and the Centre for International Research in Agricultural Development (CIRAD), with support from the extension service. They carried out a literature review to come up with strategies for intensifying production systems and held a farmer review workshop to discuss the feasibility of these strategies. The treatments included options for forage, targeted feeding, nutrition, animal shelters, health, movements, and market specifications. Forage nurseries were established, and links were strengthened with the DARD and the International Council for Research in Agroforestry (ICRAF). The focus was initially on fattening production systems and later expanded to incorporate outcomes from other projects. The monitoring activities were led by the on-ground team, with measurements such as cattle weights. The project also developed a range of conservation and preparation feed options based on available farm resources. An outreach program was delivered to Quai Nua primary school, and a workshop was held for farmers and extensionists to assess management scenarios based on profitability and return on investment.

The third objective aimed to improve farmers' access to markets and enhance their capacity to establish efficient linkages between production and marketing functions. It used a value chain management approach and had a whole-of-chain focus, covering all actors involved in the production and marketing of beef cattle. Farmer interest groups were formed based on shared interests and willingness to participate in trials, and they were trained on group mobilization and market-oriented production planning. A Rapid Value Chain Analysis was conducted to assess the existing value chains and identify opportunities for improvement. The project also incorporated the establishment of cooperatives, which were promoted at a national level and included farmers, traders, retailers, and slaughterhouses. The cooperative was established with the support of DARD through the facilitation of training and regular interaction between farmers' interest groups and market actors and was monitored and evaluated by the project team.

The final objective of the project was to build the capacity of the staff at the District and Provincial DARDs and Extension Agencies, with a priority on engaging staff from minority ethnic groups such as the H'mông, Dao and Thái. The project took a systems approach, engaging with stakeholders in the production and marketing sub-systems and other stakeholders including service providers, development partners, private sector actors, and social networks. A workshop was conducted for key stakeholders to establish long-term goals for the beef cattle industry, and a stakeholder coalition was formed to provide advice for the project team. The project team provided trainings for provincial and district DARD on topics such as policies, communication, foresight, market-based information system, and value chain development. An up-scaling strategy was developed with the help of a consultant and an action plan was put in place to engage farmers, extension staff, and advisors in the project activities.

A total of ten (10) interest groups with diverse membership have been maintained and empowered with several common activities around growing forage grasses, biomass maize, making silage, increasing herd size; and visiting demonstration farms with the support of VNUA and CASRAD and the help of NIAS and DARD. The groups were reformed, and activities were updated quarterly, and common activities among the groups were facilitated and maintained. Training was provided on technical and market activities, and disease treatment was provided to champion farmers of the groups. The initiative also helped the Dien Bien cooperative to apply for and access government funds and established linkages between the interest groups and local authorities. The initiative also included capacity building activities, such as supporting the reorganization of a cooperative and introducing the solution of better utilization of crop by-products as feed for fattening beef cattle. The initiative was supported by regular consulting and implementation of up-scaling programs with the support of the Provincial and local DARD. The initiative has also supported young researchers and guided students in conducting research on cattle raising and livestock market research.

This project has disseminated research results through international and national publications, including an international article (English), 5 national articles (Vietnamese), two guidebooks, 13 media articles, 17 undergraduate and master theses, as well as many presentations and technical factsheets, all in Vietnamese.

The project team has also facilitated exchanged /shared practices between farmers/members of the cooperative in Tuan Giao and Dien Bien districts, and local authorities with members of interest groups. The Dien Bien cooperative has successfully accessed government funds to develop a beef value chain with the help of Dien Bien DARD and related local authorities with linkages established between Interest Groups, Dien Bien Cooperative, Slaughterhouse and Hoa Ba supermarket.

During the project, intercropping methods have been trialled, with forage production and feed processing introduced to more than 400 households within the study villages and farmers in the surrounding villages and communes and districts. The solution of better utilization of crop by-products by processing as feed for fattening beef cattle under household and farm conditions in Dien Bien province was approved (and recognised) as an innovation by the People's Committee of Dien Bien province in April 2021. The Dien Bien DARD was also successfully awarded strategic funding by the People's Committee of Dien Bien province for a program of ruminant production development.

The results of technical experiments, livelihood analysis, and market and stakeholder network analysis in the project have shown positive impact in changing behaviours, knowledge, and practices of farmers, researchers, and local authorities. Farmers have adopted new innovations in forage production and processing, and some have increased the number of cattle sold and kept. The local authorities have been involved in developing research plans and strategic planning for livestock production. The researchers and champion farmers have developed their skills and knowledge in conducting experiments and communicating with stakeholders. The formation of the beef cattle interest groups and co-operative has facilitated the exchange of knowledge and strengthened relationships among stakeholders. Whilst the project has not focused on reducing environmental impacts, the collaboration with another project has led to the testing and development of forage hedge rows for soil erosion control.

3 Background

The Northwest of Vietnam is one of the poorest regions in the country. Dominated by ethnic minority people in the mountainous and remote region considered poor, one pathway out of poverty for these smallholder farmers is to increase livestock production. However, increased production in the region has constraints of feed and forage availability and animal exposure through the long cold winters. Furthermore, current grazing-based livestock systems are in competition for land with the expanding crop production on the hill slopes. The expansion of crop production, such as maize and cassava, has also increased soil erosion and sedimentation of waterways. Subsequently, the local Government sees this existing crop-livestock system as highly unsustainable. Although some cattle feeding and management solutions have been identified in ACIAR project LPS/2008/049, and forage hedgerows introduced as erosion control in maize production through ACIAR project AGB/2008/002, adoption and scale out remain limited.

Cattle¹ are currently kept by farmers to increase their asset, with husbandry practices and sale of animals linked to culture, ethnicities, and the isolation of communities. This isolation is often synonymous with poor linkages to urban markets, misunderstanding of market demand/supply dynamics and limited information exchange up and down the beef cattle value chain. Consequently, small holder farmers in these regions are not capitalising on the recent increased domestic demand for beef.

Decisions by the Vietnam government to concentrate beef cattle production in the highland areas of Vietnam as a means for alleviating poverty among smallholder farmers and address environmental issues of intensified cropping such as erosion, provided the impetus for developing this project. However, the Northwest region of Vietnam is a complex topography of steep hills and river valleys that feed into the Red River delta. Due to its remoteness and limited infrastructure the region is less urbanised than other parts of Vietnam, with 80% of households deriving their income from agriculture and forestry (Tran *et al.* 2014).

Despite Vietnam being in its third decade of growth, and moving from a developing economy into an emerging middle class economy (Coxhead *et al.* 2010), the mountainous Northwest continues to fall behind in agricultural development compared with the lowland regions. A recent study has shown that 66 % of the ethnic minority people dominating the Northwest region are considered poor (at USD \$13/person/month based on the national rural poverty line for period 2011 – 2015 of USD \$20/person/month) with 42 % considered extremely poor (Tran *et al.* 2014). There are twenty ethnic minorities in the North West including Kho Mu, Laos, Khang, Phu La and Tho, with the largest of the minorities, Thai, dominating the lowland and the second largest ethnic minority, H'mông, inhabiting the highland areas (ILRI 2014). The small holder farm of the Northwest is generally a mixed farming enterprise incorporating rain fed crops (i.e., maize and cassava) on steep hillsides, paddy rice and fishponds in mostly irrigated valleys, and poultry, small and large ruminants (goats, buffalo, and cattle) and pigs. Maize is grown for animal feed, whilst cassava is used to produce starch (tubers) and fish feed (leaves). Thai farmers have traditionally kept their cattle and buffaloes under their houses of a night and then left grazing without supervision during the day, whilst H'mông households keep their cattle in enclosures overnight and then supervise the grazing through the day (Duong *et al.* 2014). Although there are some households with over 100 head of cattle, a large farm generally has 5 – 9 head of cattle, whilst a small farm has 2 – 5 head of cattle (Le *et al.* 2011). All cattle are almost exclusively raised by grazing common property feed resources.

Many small holder farmers keep cattle to build wealth and as an asset to sell when money is required, rather than as a production entity for income generation (Duong *et al.* 2014)

¹ For this report the term cattle also include buffalo

2014). This may partly explain why the number of cattle in Vietnam has increased from 3.1 million head in 1990 to 5.2 million head by 2013. However, concomitant to the increase in kept cattle, the domestic demand for beef has also increased from 1 kg/person/year in 2001 to 3.3 kg/person/year in 2012 (Journal of Vietnamese Animal Husbandry, 2015) with domestic supply unable to meet this rapidly rising demand. The shortfall has been satisfied by live cattle imports from neighbouring countries such as Thailand, Cambodia and Laos, and chilled and frozen beef imports from countries such as New Zealand and the USA. In recent years, live cattle imports from Australia have increased dramatically from 128 head in 2009 to 272,947 head in 2015 (Jan-Oct period only; <http://statistics.mla.com.au/reports/>).

Increasing cattle production requires an increase in feed/forage supply, which in turn requires available arable land. This raises a land use issue in that any proposed expansion of livestock production concomitant with an increase in forage production is in direct competition for land resources with annual food and short-term cash crops. Recent expansion of annual crops, particularly maize, on steep sloping land has increased soil erosion and reduced access to previously available land for grazing livestock. This is ultimately putting pressure on the environmental sustainability of the farming system.

A previous project, LPS/2008/049, conducted between March 2011 and September 2015 identified and implemented a range of strategies and technologies to overcome technical and market constraints to cattle production in the Northwest highlands of Vietnam.

A summary of baseline information collected for the project by Thai Nguyen University in September 2011, showed both similarities of, and differences between Ethnic minorities regarding keeping cattle. The similarities were that both Thai and H'mong groups kept ~ 2 cows and ~1 calf, cattle breeding was uncontrolled, they practiced tethered/free grazing and feed shortage occurred between January and March. The differences were that 100% of Thai farmers kept cattle for commercial production compared to only 22% of H'mong farmers. This may reflect proximity to market as Thai farmers were located at low elevations (~ 600 m ASL), compared to H'mong farmers (~1600 m ASL).

The project:

- identified new forage and feeding options (Mai *et al.* 2014, Nguyen *et al.* 2014, Nguyen *et al.* 2014, Nguyen *et al.* 2014);
- increased farmer knowledge and adoption of cattle management techniques to improve resilience of cattle to cold snaps in the winter period (Vu *et al.* 2014). The following email was received from Dr Mai Anh Khoa, Thai Nguyen University of Agriculture and Forestry:

“At the end of 2015 (around mid-December to end of January 2016) abnormal cold weather occurred in the North of Vietnam, with temperature sometimes dropping to 1 - 4 degree below zero in some mountainous regions, said to be the lowest temperature observed in the last 30 years. As a result, a total of 773 ruminants died including buffaloes and cattle. Concerned about whether our best bet farmers were also affected by this extreme weather, I made some phone calls to our farmers in Toa Tinh, Tuan Giao Dien Bien. The first farmer I got in contact was Mr Ly Sai So, he has 7 cattle in is stable by that time. He sounded very happy telling me that despite having snow in this village, which he barely saw in his life, his cattle were safe in the barn. He was able to provide enough Guatemala grass with ensilage cassava chips which he prepared a month earlier. He also mentioned that he should have had more of forages, because what he had was just enough for 2 weeks cut and carry, if it wasn't for the cassava chip silage he prepared earlier, he could have had ended up losing his cattle. When I asked if he is going to expand his forage areas and prepare cassava chip silage his answer was firmly "Yes". Other thing he also mentioned was that after cutting Guatemala for these cattle, some grass died (which our project teams had also seen in our trials). However, the survived grass continues to regrow after the weather got warmer.

The second farmer I made a call was Mr. Pao, He was also very happy that he could supply his cattle with some extra forages apart from what he found from forest. He also mentioned that he will be planting more forages for his animals. I asked him whether there were any cattle died in the village, the answer was none, but in whole Dien Bien Province, the total animal fatal was 68, which was only 3 cattle, the most vulnerable animal to cold stress was buffaloes.”

- increased capacity of extension staff and researchers to undertake field research and extension activities,
- established cattle raising interest groups in 4 villages, and
- developed an extension/education programme including in primary schools (Ives *et al.* 2014).

The project also identified limitations and constraints of the current beef value chain and recommended further work required to facilitate policy and regulatory change and to better connect farmers with markets (Duteurtre *et al.* 2014).

Baseline information related to the beef value chain was obtained from the Tuan Giao district in September 2011. Figure 1 derived from survey information and a discussion with commune officials shows that beef cattle in Tuan Giao are sold to collectors from other provinces and transported out of the district. However, it also shows that **supply does not meet local demand**, so local collectors and slaughters must collect cattle from outside for slaughtering and selling to local consumers. The main reason was found to be that district farmers often only sell their cattle during the season of the Lunar New Year festival and infrequently through the rest of the year. The current marketing system in the project area largely features arms-length spot market transactions.

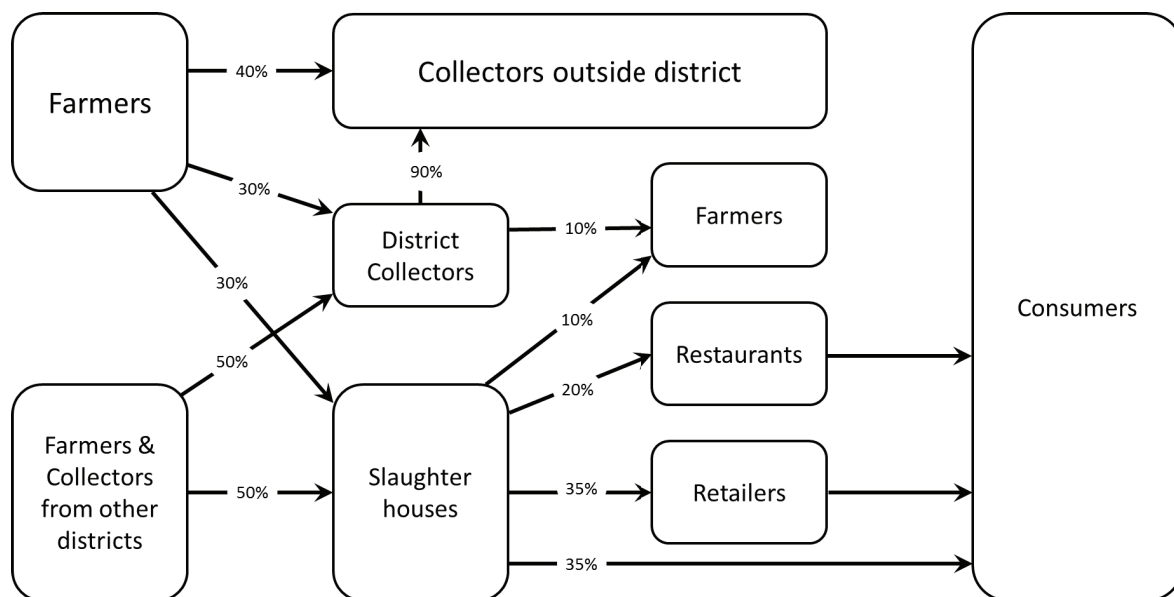


Figure 1 Beef value chain in Tuan Giao district (source: (Pham and VNUA 2012))

The external end-of-project review of LPS/2008/049 in July 2015 highlighted the strong partnerships among the research and implementation partners, capacity building and knowledge bank that was developed by the project and recommended a follow-on project, with an emphasis on integrating cattle production with other farm activities (i.e. cropping), peer to peer learning, segmenting the cattle production system (i.e. cow-calf, growing or finishing cattle) to match farm resources and facilitating collective information flows. A further recommendation was to focus the project in Dien Bien, with some additional activities in Son La in support of established cattle interest groups.

Adoption of project LPS/2008/049 outputs was limited over the life of the project because the focus was to identify solutions to constraints of the beef cattle production in the highlands. There were clear benefits to the research including demonstrating the potential of introduced interventions (i.e., feed and forage options to fill the winter feed gap, improved housing). Livestock are an important component to the mixed farming systems of the northern highlands of Vietnam, with this new project complimenting other research activities planned for the region (i.e., maize, agro-forestry and fruit and vegetables).

A strong request and a pledge for support for a follow-on project has also been expressed by the Provincial Department of Agriculture and Rural Development in Dien Bien and the National Institute of Animal Science. Driven by recognition of the unsustainability of the current extensive livestock system, the vision of the DARD is to transform livestock production from extensive to intensive systems, boost farmers' awareness of market-oriented production, motivate stakeholders that accept change, and build capacity of local authorities, extension workers and farmers to continually grow production in the region.

Two planning workshops undertaken in July and September 2015 with key stakeholders of the current project (DARD, NIAS, VNUA, TBU, TUAF and CASRAD) concluded that the current cattle production system is no longer viable to satisfy the local market. With the intensification and expansion of cropping, participants agreed that although many farmers are aware of the role cattle can play in improving farm profitability, integration with cropping and intensification of livestock production to stall feeding is required to improve farmers' livelihoods and reduce the competition for land use. They concluded that there was an opportunity to integrate and build on research outcomes and momentum from the current project into developing a follow-on project that focussed on livestock within the farm system and consolidating market linkages.

4 Objectives

Overall aim

The overall aim of this project was to improve the income of smallholder cattle producers through intensification of beef cattle production and increased market linkages in mountainous crop-livestock systems in the Northwest of Vietnam.

Specific objectives are to

- Objective 1: Understand the transition from extensive to more intensive beef cattle production.
- Objective 2: Develop production technologies and practices that support more intensive, integrated crop-livestock systems.
- Objective 3: Improve farmers' linkages to urban beef markets.
- Objective 4: Build capacity of beef value chain stakeholders to support and out-scale sustainable cattle production systems in the Northwest highlands.

5 Methodology

The project undertook research activities primarily in two districts in Dien Bien province including Tuan Giao, a district that was included in the previous project, LPS/2008/049. Farmer interest groups from the previous project and newly established groups formed through objective 3 were used to drive farmer participation in on-farm experimentation (activities of Objective 2) and implementation of market-oriented interventions (activities of Objective 3). Working with larger groups of interested farmers and focussing in specific areas helped to provide proof of concept at sufficient scale to demonstrate success at commune level. In year 1, the project formed at least three farmer interest group per commune. By the end of year 1, the project engaged directly with at least 30 farmers (from interest groups) from each of the 3 villages within each of the 3 new communes (30 x 3 x 3 = 270 households) in Tuan Giao. The project also worked to re-engage with the 30 farmers from 1 village in Quai Nua commune, who were involved in the previous project (a total of 300 by end year 1). It was expected that by the end of year 2, there would have been a 50% increase in the number of households introduced to the project outputs (450 households) using the assistance of the extension staff and DARD officers, and from general 'over the fence' interest from neighbours. By the end of the project, it was anticipated that all households within half of the villages in each of the 3 communes would have adopted some or all of the introduced feeding and management techniques and other villages within the target communes would have been engaged in project activities. Each commune has up to 12 villages with approximately 30 farmers in each village. This means that over the life of the project, the potential outreach in the 3 communes in Tuan Giao district was anticipated to be at least 1080 farmers. This outreach was facilitated by the DARD and extension service, through implementing the extension strategy.

After two years, the interventions were introduced to villages in at least 1 commune in a second district by the DARD and extension service, with support from the project. In this new district a further 60 farmers were made aware of the new intensive cattle production techniques by the end of the project with scaling out continuing through DARD after the end of the project.

This project identified the traditional and potential roles of women and girls as well as men and boys in the production and marketing of cattle. Gender equity was integral to any intervention/activity undertaken and the effect of interventions on women and girls was monitored. These cross-cutting issues were addressed under each objective, in consideration of the ACIAR DRAFT gender strategy.

Objective 1 - To understand the transition from extensive to more intensive beef cattle production

This objective was led by Vietnam National University of Agriculture (VNUA), with the assistance of researchers from CASRAD, and the local DARD. It incorporated the findings of the Institutional Analysis and Cultural Analysis conducted in LPS/2008/049. Researchers from UTAS assisted the project team to develop a participatory approach to understanding the transition to intensification using the knowledge partnering methodology (a participatory methodology that brings different kinds of knowledge into dialogue). This approach facilitated stakeholder-informed site selection, participatory livelihood analysis, and targeted peer to peer knowledge exchange, identifying barriers and enablers to the intensification of cattle production.

The project followed the participatory, criteria-focused site selection methodology utilised in project LPS/2008/049, employed at district and commune level to assess communes and villages against a set of weighted criteria, including accessibility, farmers' willingness to participate, local government authorisation, and the preference to work with ethnic minorities and areas with good wholesale market access, among others. The site selection report recommended an additional district, and three communes in each of the two districts

(including Tuan Giao) for project work, as well as specific villages that best met the agreed criteria.

Participatory livelihoods analysis (Ellis 2000) was undertaken with approximately 300 households across three communes. In each commune three villages were selected to participate, incorporating the population of approximately 30 farming households per village. Two villages were involved in the project with a third village, with similar characteristics and willingness to participate, included as a control to assist with assessment of project impact. 30 households from the previous project located in Quai Nua commune were also invited to participate. The Participatory Livelihood Analysis was conducted by student researchers from TUA and TBU with knowledge of the language and social and economic contexts of the study communes, working closely with senior researchers and with farmers' groups (women and men) in the project areas. Researchers from the UTAS and CIRAD provided training and support with participatory research methods. Data collection methods were tailored to local conditions and constraints and included co-designed surveys and other participatory data collection methods and strategies for information-sharing.

The resulting livelihood analysis provided a baseline of the current situation: production strategies and logics, farm typologies, gender roles, the livelihood resources available to the smallholder farming households and their various members (men, women, children), time allocation issues related to beef production, and the resilience and adaptive capacity of the household, its resources, and its members, particularly their ability to cope with stresses and shocks that may affect their livelihood. Farm typologies of the range of farms and level of transition from extensive to intensive cattle production systems were also described. Furthermore, the livelihood analysis was used to assess aspirations of small holder cattle farmers, motivations, and enablers/ barriers to change, and potential intensification trajectories.

Peer to peer knowledge exchange enabled participating farmers to vision the potential of intensified cattle production systems by visiting farmers who had already made the successful transition from extensive to more intensive systems. A visit was planned to Xieng Khuang, a province in Laos where there had been considerable adoption of cut-and-carry of improved forages among H'mông smallholders, and where the project team already had contacts, including with two ACIAR projects (AH/2012/067 and 068). This did not occur, but a second peer to peer knowledge exchange was undertaken to Dak Lak as part of the collaboration with researchers and farmers involved in LPS/2012/062, with Associate Professor Laurie Bonney providing a link to this sister project based on the South-Central Coast of Vietnam.

Objective 2: To develop production technologies and practices that support more intensive, integrated crop-livestock systems

The activities for this objective were led by NIAS, TUA and TBU in conjunction with the DARD and extension service and supported by UTAS and CIRAD. A literature review was undertaken to provide a suite of strategies for intensification of production systems that and brought to a farmer review workshop, along with feedback from farmers who had engaged with the peer-to-peer knowledge exchange (Objective 1). The workshop discussed the feasibility of the identified strategies and provided treatment recommendations to the research team for on-farm trials. Treatments were based on the farm system components and included forage options, supplementation for targeted feeding, conserved fodder, nutrition, animal shelters/infrastructure, animal health, animal movements, and market specifications. Treatments also incorporated outputs of SMCN/2014/049 to ensure that forage/feed resource options could be integrated with cropping either as intercrop or rotations. Forages (particularly *Brachiaria spp*) were part of ACIAR funded FST/2010/034, so researchers from both the old and new agro forestry were invited to participate in the workshops and provide input into proposed forage options and integration into mixed farming systems. Forage nurseries were established in the previous project by village chiefs

and lead farmers, with cuttings sold and/or given to family members on adjacent and distant farms. This led to forage market emerging in the district outside of the control/management of the project. Stronger links were established through facilitating improved networking within the DARD and ICRAF (i.e., forestry and livestock sections), particularly in Toa Tinh where experimental sites were in proximity. A study tour of the FST project sites in the area was also incorporated into the inception meeting of the livestock project and included DARD, researchers, and stakeholders. This helped to establish early links, knowledge sharing and experiences and reinforce connection between all three projects (Agroforestry, Maize, and Livestock) for cross-invitations to annual meetings.

Initially the focus was on finishing (fattening) production systems assessing body condition score and live weight gain over 10 weeks prior to slaughter using direct project outcomes from LPS/2008/049. The focus was expanded in a second trial incorporating outcomes from SMCN/2014/49. The monitoring activities were led by the on-ground team (NIAS, TUAF and DARD), and involved measurements such as cattle weights (Parsons et al, 2013).

Project LPS/2008/049 developed a range of conservation and preparation feed options based on available farm resources and project SMCN/2014/049 developed cropping strategies including the incorporation of legumes. This project integrated these options into a whole farm feed management system included investigating production, packaging, storage, and best timing of use to satisfy animal health and nutrition requirements. Forage varieties included *Brachiaria hybrid* (Mulato 2), *Panicum maximum* (Guinea grass TD58), *Pennisetum purpureum x P. glaucum* (VA06), *Tripsacum dactyloides* (Guatemala grass), *Paspalum atratum*, *Setaria sphacalata var splendida*, along with the herbaceous legume *Stylosanthes guianensis* (CIAT 184).

Concomitant with the farm finishing trials was the design and delivery of an outreach program in Qua Nua primary school, where innovative extension approaches were introduced in 2013 and 2014. The outreach program involved champion farmers from the project as mentors for the children, providing an opportunity to introduce the concept of entrepreneurship and self-determination, and to enable the development and encouragement of a hand up culture (in lieu of a handout).

A workshop was delivered to farmers and DARD extensionists using game board theory and the outputs of forage, feed, and animal management to assess possible management scenarios based on overall profitability, rate of return on investment, decision to sell and opportunities.

Objective 3: To improve smallholder livelihoods by developing and improving farmer linkages to urban beef markets

This objective used a value chain management approach in identifying accessible district and provincial urban markets, enhancing farmer's access to markets, and developing the capacity of farmers and market actors to establish efficient linkages between production and marketing functions.

This objective had a whole-of-chain focus. The scope of the Objective 3 encompassed farmers in the production sites through to the market actors operating along the chains up to the markets in which most of the production from the project site ended up or the markets where opportunities to develop new linkages emerged. In each village/commune selected for the project, farmer interest groups were formed among farmers with shared interest on market-oriented production and a willingness to participate in trials for technical intervention (Objective 2). Ethnicity and proximity to traders were also considered while forming farmer interest groups. Farmers in the interest groups were trained on group mobilisation and market-oriented production planning to identify and facilitate linkages within or between communes based on family, cultural or historical affiliations.

Whilst LPS/2008/049 provided base knowledge of beef cattle marketing chains and markets, a Rapid Value Chain Analysis (RVCA) of beef cattle chains was conducted involving interest groups participating in this project to appraise the ecosystem of existing

value chains in terms of readiness and capability of prospective chain actors, opportunities for improvement, level of communications and relationships, market access and efficiency.

During the life of the project co-operatives were being promoted at a national level, so the project incorporated the establishment of cooperatives as part of this objective. Membership of the cooperative was a direct outcome of the peer-to-peer exchange and included farmers, traders, retailers, and slaughterhouses. DARD (supported by VNUA) were instrumental in the establishment of the co-operative through facilitating training and regular interaction between farmers' interest groups and market actors and monitoring and evaluation of the implementation by project team.

Objective 4: To build capacity of beef value chain stakeholders to support and out-scale sustainable cattle production systems in the Northwest highlands

The implementation of this objective was undertaken both with the District and Provincial DARDs and Extension Agencies and focused on building the capacity of their staff. As a priority, it engaged those DARD staff who were from the minority ethnic groups participating in this project (e.g., the H'mông, Dao and Thái) in training and implementation. Their engagement enhanced the diffusion and adoption of project research and intervention strategies because the minorities are strongly influenced by familial and cultural ties.

This objective took a systems perspective and engaged with stakeholders that influenced the performance of the production and marketing sub-systems within the project. Besides the direct beneficiaries such as farmers and market actors, other stakeholders were involved including service providers, development partners, private sector actors, and social networks working in the project site. In an early workshop, the key stakeholders were engaged in a strategic foresight and visioning exercise to establish long term goals/aspirations of the beef cattle industry and the community (the method developed in the Revalter project to draft foresight scenarios in selected Districts will be used in this context). During the workshop, participants were encouraged to form a stakeholder coalition and agree on their terms of reference to provide continuing industry grounded advice for the project team.

The project team conducted trainings for provincial and district DARD on awareness of existing policies, communication, foresight, and strategy development, development of market-based information system, quality certification and value chain development, monitoring, evaluation and learning, whole farm approach of livestock development and value network analysis. The trainees were then used as resource persons to train farmer interest groups and traders in the project.

Ongoing discussions with the DARD helped identify local policy options likely to support mixed livestock farming systems and beef-cattle value chain, in coherence with the local and national policy context. The project engaged a consultant to work with the DARD to design an up-scaling strategy for a sustainable crop-livestock system. An action plan for up scaling was developed as an integral component of the strategy, recognising the successful implementation depended on actively engaging farmers, extension staff, DARD and advisors and involving them in the early planning stages of the project activities; increasing their knowledge base of proposed interventions; providing skills training (i.e. train the trainer) in extension methods that are culturally appropriate; developing a scale out plan that will include the use of farm walks, field days and multi-media releases, district bodies and provincial networks; and ensuring that they remained hands on with farmers throughout the research development, extension and education process.

6 Achievements against activities and outputs/milestones

Objective 1: To understand the transition from extensive to more intensive beef cattle production

No.	Activity	Outputs/ milestones	Completion date	Comments
1.1	Site selection	<p>Secondary information collected, analysed, and summarised in a short report.</p> <p>Consultations held with district/commune DARD and extension service to discuss site selection and negotiate site access for three communes in Tuan Giao district and a further commune in a new district.</p> <p>Communes with high potential for intensification selected and the process documented in a report including selection criteria and protocol.</p> <p>Local stakeholders clearly understand project objectives and operations and have expressed interest to work with the project.</p>	July 2018	<p>Consultations have been conducted with the local DARD and extension service to determine site selection criteria, based on the previous project, a field site selection trip, the focus sites for the livelihood's analysis were identified including 6 communes in 2 districts of Điện Biên Province were selected: 3 communes of Tuần Giáo District (Chiềng Sinh, Quài Nưa and Pú Nhung) and 3 communes of Điện Biên District (Pom Lót, Núa Ngam, and Sam Mứn).</p> <p>Secondary information, site selection criteria and protocol are included in the full livelihood report.</p> <p>Local stakeholders including local DARD, different authority levels, farmers and stakeholders along beef value chain have been engaged in six communes of the two districts Tuan Giao and Dien Bien to discuss objectives and interest in the context of each site.</p> <p>Farmers are interested in working with the project to join in the IGs and apply innovations of growing forage grasses, making silage and increase cattle herd size, both famers inside and outside the study villages/ communes. The two cooperatives were established follow the real demand of core farmers and Dien Bien DARD, as well as local authorities under the support of the project. Local DARD have been applied a number of innovations introduced by the project to implement in the agricultural extension program of the province such as biomass maize production, use of silage feed to fatten cattle.</p>
1.2	Undertake livelihood analysis	<p>Students selected; research supervision arrangements (local academic staff) organised.</p> <p>Built capacity through workshops within research team including student researchers.</p>	<p>Jan 2018</p> <p>May 2018</p>	<p>A TOT in participatory social research was held with researchers with four male and four female researchers from four Vietnamese institutions (TUAF and Tay Bac Universities, VNUA and NIAS) in January 2018. Training materials were codeveloped and further training conducted for students of VNUA, TUAF and TBU.</p> <p>Participatory livelihood analysis and survey were conducted in the six target communes, with all data collected and collated. An initial summary identifies several preliminary indicators. These</p>

		<p>Local stakeholders engaged in participatory research process.</p> <p>Identification of relevant livelihood indicators and participatory data collection strategies.</p> <p>Livelihood analysis activities completed, and data analysed and summarised in a report. This provides a sound understanding of baseline livelihood indicators (e.g., income, assets), current farm types, gender and age-specific roles, and risk factors.</p> <p>Peer reviewed publication</p>	<p>Dec 2018</p> <p>On - going</p>	<p>indicators were presented at the ASAA Biennial conference in Sydney in July 2018.</p> <p>In-depth cattle production-based livelihood analysis is completed focused on evaluating local livelihood assets; production strategies, especially cattle production and marketing strategies, gender roles, and institutional processes that affect the development of local livelihood of smallholder farming households. Further, the livelihood analysis considered the variation among farm household types, particularly regarding their current level of transition from extensive to intensive cattle production systems, their resilience and ability to cope with livelihood stresses and shocks, and their aspirations, motivations, and enablers/ barriers to change.</p> <p>Technical report was completed. Major results of the survey have been engaged in a draft of an international article "Barriers and enablers to cattle production intensification for improving the livelihoods of small-scale farmers in remote regions: A case study in Dien Bien province of Vietnam" led by Dr Nhuan (VNUA) has been finalised and expected to be submitted in Q3/2021</p> <p>A paper titled "Human and Social Capital in Promoting Livelihood for Beef Cattle Production Households in Dien Bien Province" led by Ms Duong (TUAF), written in English and also available in Vietnamese was published in Feb 2021. Journal of Animal Science and Technology. Vol. 120, pp. 74-82.</p>
1.3	Undertake peer to peer knowledge exchange	<p>Visits completed and participants reported back to their communities and peers.</p> <p>Completion of a participant survey demonstrating: -</p> <ul style="list-style-type: none"> • Their level of understanding of the benefits of beef cattle intensification, and <p>Individual and corporate vision of how they would like to transition to more intensive production system</p>	A visit to Dak Lak in Aug 2018	<p>The project visit to Dak Lak involved 38 participants. This included 13 farmers, 8 local officers, and 17 researchers from all project partners. 37% of participants were woman. The participant farmers had previously been identified as leaders in their respective communities. After the visit, some farmers bought cutting machines to apply cutting grass, maize... and with training of DARD, some of them have adopted maize and grass silage. Up to now, many farmers bought cutting machine to chop forage grass for cattle; 10 farmers applied silage as regular feed for cattle.</p> <p>A training workshop on a strategy of developing multi-disciplinary and multi-institutional concept for all project partners has helped almost all researchers and DARD officers have realized the importance of the cross-boundary approach in implementing a project, the linkage between the institutions has clearly increased, as has the capacity of junior researchers.</p>

			Jan 2022	<p>Furthermore, the local DARD is actively involved in all project activities, not only in administration but also in research and in extension. A trip to Lao was cancelled.</p> <p>A domestic trip to Son La is purposed for Dien Bien farmers to learn new/more advanced cattle production model(s): a field trip for farmers in the interest groups to 3 intensive cattle production models in Son La. Farmers were very interested in the 'dwarf' Lai-Sind (hybrid) breed at the visited farms, because it has a good shape and is suitable for the size of a household; and common use of silage crop by products in the intensive farms. They took videos and pictures to make the material available to show to other members of the interest group.</p> <p>Pre- & Post-trip survey questions finalised and used for evaluation of impact of farmer visits.</p> <p>Joining activities: - Working with Obj. 3 (marketing intervention); with Obj. 4 on School program with Elya & Planning with Raj & Oleg - Supporting PhD students: Elya (Education) & Da Thao (Gender).</p>
1.4	Identify barriers and enablers to intensification of cattle production	Workshop report identifying problem areas, long term outcomes, vision, stakeholders and outcomes and outputs based on understanding of local livelihoods, existing intensification models and local reflections on what is feasible and desirable in local contexts.	Oct 2018 Sep 2021	<p>A workshop report problem area, vision and outcome based on understanding of local stakeholder was undertaken as part of the first annual meeting with the participation of different local stakeholders and partners.</p> <p>Participatory workshop to reflect on the outcomes of the livelihood analysis and the peer-to-peer knowledge exchange was combined with scoping workshop of ASSET project with representatives of different stakeholders: 4 DARD officials, 2 directors of Dien Bien and Tuan Giao cooperatives, 3 heads of interest groups; a dry beef producer, and 3 cattle keepers. Researchers and other stakeholders of the ASSET project were very interested in the out puts and outcome of the beef project those presented by Mr. Thuy (head of an interest group in Tuan Giao district). The innovations in forage production have been continued and expanded by the ASSET project in both Tuan Giao and Dien Bien districts for beef intensification. All potentials and barriers for beef development have been taken in the account when Dien Bien DARD developed the ruminant production strategy.</p>

PC = partner country, A = Australia

Objective 2: To develop production technologies and practices that support more intensive, integrated crop-livestock systems

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Review successful cattle production and management systems	Literature review	Mar 2019	<p>This review was undertaken by CIRAD, UTAS, NIAS, and TUAF. It was finalized.</p> <p>A paper with the title “Utilization of crop-by-product options in smallholder cattle production systems in Vietnam” was published in Vietnamese Journal of Animal Science and Technology – Vol 108. Feb., 2020</p>
2.2	Undertake a cattle production systems survey	A report including on-farm quantitative data of cattle production systems (180 farms surveyed) was completed.	Oct 2018	<p>Undertaken by all partners as part of the livelihoods survey. Full report is completed.</p> <p>Major results of the survey were prepared an international article with the title “Diversity of mixed crop-livestock farming systems in the mountains of Northwest Vietnam” and it was submitted to the journal of Animal Production Science</p>
2.3	Identify farmers within target communes to undertake livestock production research	<p>A minimum of 30 farmers in each of the three villages in each of the 3 communes identified to undertake on-farm research activities. Farmers will be part of the farmer interest groups established in Objective 3.</p> <p>30 farmers from project LPS/2008/049 reacquainted with the project to continue undertaking on-farm research.</p> <p>Cattle production and management system research priorities determined</p>	Completed	<p>Working closely with objectives 1 and 3 to engage champion farmers from interest groups to participate in research activities.</p> <p>- 2018: 16 farms on grass (8 in Dien Bien, 8 in Tuan Giao); 14 farms on biomass maize (7 in Dien Bien, 7 in Tuan Giao); 14 farms on maize silage (7 in Dien Bien, 7 in Tuan Giao).</p> <p>- 2019: 29 farms on grass (15 DB, 14 TG); 14 farms on biomass maize (8 DB, 6 TG); 14 farms on maize silage (8 in Dien Bien, 6 in Tuan Giao).</p> <p>- 2020: 42 farms on grass (19 DB, 23 TG); 11 farms on biomass maize (9 DB, 2 TG) and 5 farms on biomass maize intercrop with legumes (4 DB, 1TG); 8 farms on maize silage and 2 farms on maize silage with legumes.</p> <p>- 12/2021: 78 farms with 51.2 ha on grass (28 households and 6.05 ha in DB, 50 households with 45.15ha in TG), 4 farms on biomass maize (TG)</p> <p>- Many farmers outside the piloted commune have applied the above demonstration models.</p> <p>- Report listing farmers involving</p> <p>- The objective 4 identified and reported the impact stories of some champion farmers</p>
2.4	Farmer review workshop	Report prepared and recommendations made for cattle management and production	Sept 2018	<p>This review workshop was held to coincide with the annual meeting in 9/2018.</p> <p>A report on participants was done.</p>

		strategies to test on farm		
2.5	Undertake on farm trials to investigate techniques and practices for finishing (fattening) cattle in both extensive and intensive cattle production systems	<p>A suite of forage/feed options endorsed by farmers that fit their respective systems, including nutrient management to maintain feed quality.</p> <p>In collaboration with SMCN/2014/049, simple visual erosion measures installed at trial sites with planted forages.</p> <p>Identified locally available feed supplements.</p> <p>Stall structures identified for shelter and/or intensive feeding installed on farms.</p> <p>Manure management plans designed and implemented.</p> <p>Defined feedings systems that result in improved live weight gain and contribute to farm profitability.</p> <p>A minimum of 2 peer reviewed publications</p>	<p>Mar 2018</p> <p>Dec 2020</p> <p>Completed</p>	<p>- Oat experiment within two crop rice rotation in lowlands: started on 29th Oct 2018 at Centre of Livestock production in Thanh Yên commune (Dien Bien district) with 800 m²; and on 4th Nov 2018 on farm (800m²) in Quai Nua (Tuan Giao) with a farmer from an interest group; harvested in January. Some samples for making silage and analysis. A report was completed in Dec. 2019.</p> <p>An international paper "Effect of irrigation level on production of oats planted as ruminant in irrigated two-crop rice rotation in Dien Bien province, Vietnam" has been developed to submit Journal of Tropical Animal Health and Production.</p> <p>Feeding trial of fattening beef cattle by using maize silage in Dien Bien Centre of Livestock Development.</p> <p>-A total of 12 native breed females were used in this experiment and randomly allocated into 3 treatments: Treatment 1 (control): 30% fresh maize + 70% urea treated rice straw (DM basis); Treatment 2: 30% fresh maize + 40% Urea treated rice straw + 30% maize silage; and Treatment 3: 30% fresh maize + 20% Urea treated rice straw + 50% maize silage.</p> <p>The results indicated that MS can be a good alternative roughage source for feedlot culled local yellow cows during winter in Northwest Vietnam. It is highly recommended that smallholder farmers raising non-pregnant yellow cows use the regression equation: LW = 3.39 CG - 249 for prediction of LW in the absence of weighing scales.</p> <p>A paper with the title "Live Weight and Body Conformation Responses of Culled Local Yellow Cows Fed Maize Silage and Urea-Treated Rice Straw in an Intensive Feedlot System in Northwest Vietnam" was published on journal of Advances in Animal and Veterinary Sciences in March 2021,</p> <p>Developed demonstration models of grass planting (VA06, Ghine, Mulato II):</p> <p>-Year 2018: 14 farms (8 in Dien Bien, 6 in Tuan Giao), with 1.6 ha, of which 0.835 ha guine, 0.22ha Mulato II and 0.545 ha VA06.</p> <p>-Year 2019: 22 farms (15 DB, 14 TG), with 1.445 ha, of which of which 0.975 ha ghine, 0.27ha Mulato II, 0.2ha ruzi</p> <p>-A report was to inform the project researchers on results of the oat experiment for planning year 2 forage trials.</p>

			<p>Part of results has been published in a national article with the title “Assessment of the fresh green yield and chemical composition of LVN61 and LVN4 maize varieties planted to use as silage feed for beef cattle in Tuan Giao district - Dien Bien province. Vietnam Journal of Agriculture and Rural Development, Sustainable Agriculture development in the Northern mountainous region - November - 2019, p. 112-118.</p> <p>Another part of results also was published in a national journal with the title “Effect of planting distance on yield of biomass maize intercropping with soybean as feed for beef cattle in Tuan Giao district, Dien Bien province”, Vietnam Journal of Agriculture and Rural Development, 2021.</p> <p>Biomass maize growing as forage and making maize silage for feeding cattle:</p> <ul style="list-style-type: none"> - Year 2018: 13 farms (6 in Dien Bien, 7 in Tuan Giao), with 0.62ha. Fresh yield obtained from 40-45 tons/ha (LVN61/LVN4) - Year 2019: 14 farms (8 DB, 6 TG), with 0.886ha. Fresh yield obtained from 50-55 tons/ha (LCH9). <p>-DARD has been instrumental in introducing ensilage techniques of whole maize plant, forage, and rice straw to some champion farmers for feeding cattle in Tuan Giao and Dien Bien.</p> <p>-A part of results has been published in a national article.</p> <p>- After early ripen maize harvest, all farms were guided to ensile maize for cattle feed. In total, around 33 tons of maize were ensiled (13 tons in 2019 and 20 tons in 2020).</p> <p>-An activity report was prepared to inform the project team about the introduction of biomass maize and making silage to farmers in the study region. This is a base for producing factsheet guidelines for distribution to farmers interacting with SMCN/2014/049 and LPS/2015/037.</p> <p>Diversity of grasses forage: 4 species: TD58, Pack chong, Mulato II, VA06 grown on 3 farms / commune x 4 communes => 12 farmers in both Dien Bien and Tuan Giao districts in March 2019. A plan for expanding the most adopted ones to more farms for the next years.</p> <ul style="list-style-type: none"> - Corporately with Obj 3, 10 farmers from IGs in Dien Bien districts had field visits at the beginning and end of the feeding trial to learn silage techniques and feeding cattle.
--	--	--	--

				<p>- Experiment on intercropping biomass maize with legumes (black bean and soybean) on a willing farm was completed in March, 2021. All samples are now analysing and then an article will be developed to submit the journal.</p> <p>- Collaborated with maize project to plant guinea of 5000m2 and soybean of 2200m2 from May 2021.</p> <p>From the field activities, the capacity of researchers, Dien Bien DARD staff as well as farmers were improved in not only in expertise knowledge but also knowledge of social, communication, and attitude.</p> <p>Above works done cooperatively by NIAS, TUA, TBU, CIRAD, UTAS and DARD with obj. 3 and 4</p>
2.6	Undertake on farm trials to investigate techniques and practices to improve cow-calf production in extensive and intensive cattle production systems	<p>Animal health and reproductive plans developed and implemented with project farmers specific to their production system.</p> <p>A suite of forage/feed/management options endorsed by farmers that improve cow-calf production.</p> <p>A minimum of 2 peer reviewed publications</p>	Completed in Dec 2021	<p>This activity was replaced by another option.</p> <p>Corporate with maize project (SMCN/2014/049) to implement the feeding trial on fattening cattle using guinea, maize and legume silage at Dien Bien Centre for Crop and livestock production. All forages have been planted in May and will be harvested and ensiled in July 2021.</p> <p>The feeding trial was started in September 2021. A total of 16-20 Native yellow cattle (16-19 months old, 150-190 kg live weight) will be used in the feeding trial. The experimental calves will be randomly allocated into 4 treatments (at least 4 animals in each treatment) including: Treatment 1: 30% fresh maize (FM) + 70% urea-treated rice straw (URS) (DM basis) (Control); Treatment 2: 30% FM + 40% URS + 30% guinea grass silage; Treatment 3: 30% FM + 40% URS + 30% guinea grass-soybean silage; Treatment 4: 30% FM + 40% URS + 30% biomass maize-soybean silage. The results showed that the treatments 3 and 4 could bring highest efficiency compared to the others including the control one.</p>
2.7	Develop production guidelines for cow-calf, growing and finishing cattle in extensive to intensive systems	<p>Production guidelines developed including:</p> <ul style="list-style-type: none"> • forage/feed options for different livestock growth stages • forage integrated with cropping. • intensification techniques, 	Completed	<p>Researchers and DARD staff were trained in livestock research methodology, body condition scoring and animal welfare and ethics, particularly young researchers, and officers.</p> <p>Developing the BCS system for local buffaloes and yellow cattle are implemented; a validation workshop with different stakeholders (farmers, interest group members, slaughterers, cooperative members, DARD officers and researchers) was held in Dien Bien district to adjust the body condition scoring system developing for local Yellow cattle and buffaloes. Factsheets on techniques of biomass planting and</p>

		biosecurity awareness		<p>making maize silage or estimation BW of yellow cattle based on body conformation have been developed.</p> <ul style="list-style-type: none"> - Documentation on common grasses and forages for ruminants in Northwest of Vietnam was completed and published as a book guideline in 1/2021. - Documentation on crop by-product preservation and treatment for feeding cattle in Northwest of Vietnam is now drafting and will be completed in August 2021. - Factsheets on techniques of biomass maize intercropping with legumes and fattening yellow cattle (culled cows, 16-19 months old) by guinea, maize, and legume silages, will be developed. - The outputs of above-mentioned Feeding trial are being used to develop potential yield fact sheets for farmers that describe daily weight gain for different feed sources, together with potential yield of varieties per area of land. <p>Published two guideline books on common grasses and forages for ruminants in Northwest of Vietnam, and methods of processing and reserving forage and crop by products used as feed for beef cattle.</p> <p>A master student and 12 university students graduated in the frame of the project.</p> <p>2 Body Condition Scoring grids developed for Yellow Cattle and Buffalo (English, French and Vietnamese) by CIRAD and NIAS teams.</p> <p>Body Condition Scoring grids include in a collection of grids for tropical animals: horse, donkey, goat, camel etc. to be published on CIRAD data verse.</p> <p>Reports: Vall Eric and Mélanie Blanchard: Body Condition Scoring System for Buffalo and Yellow cattle. Report ; and a scientific paper</p> <p>Vall Eric et al., Standardized Body Condition Scoring system for tropical farm animals: cattle, buffaloes, camels, sheep, goats, donkeys, and horses (to be submitted)</p>
2.8	Design and implement outreach program in primary schools focussed on finishing cattle for market	<p>Case study completed on the role of education in instigating practice change.</p> <p>Documented community-based cattle finishing system for distribution to other schools.</p>	Completed November 2022	<p>Elya Richardson has commenced her PhD studies and has recently completed all in-depth interviews of at least 80 participants that were involved in a previous school-based program. 30% of interviews have been translated and transcribed with the assistance of two (2) University students in Hanoi.</p> <p>School children and more interest groups farmers will be organised to visit the feeding trials at the Dien Bien Breeding/Research centre in Dien Bien</p>

				<p>Elya is gathering a team of researchers in the project to assist her in developing another school-based outreach program for delivery in March/April 2021. This program was initially planned to involve researchers, farmers, and teachers from Tasmania. However, it is unlikely that overseas travel will be allowed at this time. Consequently, Elya Steel (nee Richardson) and the Vietnamese team have been preparing training materials to equip a local team to implement this program.</p> <p>The program was organized in Quai Nua school, Tuan Giao district in 24 – 25th Nov with the participation of more than 100 students, teachers, and project researchers in different activities of the program “Future Farmers”.</p>
2.9	Undertake economic modelling of intervention strategies	Practical, cultural, and economic Case Studies developed with DARD and extension staff to support and provide farmers with long-term decision-making tools.	Completed	<p>A field study was conducted in Tuan Giao district by Alice Le Trouher and supervised by Melanie Blanchard (CIRAD), to design tools. The outputs help to promote innovations in pastures management and feed cultivation in the mountainous region of North-West Vietnam. The report is completed and presented in stakeholder workshops in Dien Bien province with high interest of local stakeholders.</p> <p>CIRAD are planning to undertake a more in-depth study to further this work. Another student from France is ready to come to Vietnam when the borders are accessible.</p> <p>Melanie (CIRAD) to work on the initial modelling. Also, will develop a template for preparing infographic/fact sheets.</p>
2.10	Disseminate research outcomes	<p>At least one workshop per year that will be attended by representatives from farmer interest groups, key stakeholders, DARD, and researchers (min. 30 people for each event)</p> <p>Printed and electronic media (presented at workshops)</p> <p>Publications (specific to experiments undertaken and methodologies developed)</p> <p>Conference presentations</p>	Completed	<p>These have been occurring as part of each of the objectives in the cross-boundary research approach. The DARD have been integral in bringing all objective activities together.</p> <p>Mr. Hoai, a champion farmer in Nua Ngam informed the commune authority about the maize silage technique. The commune organised a training and visits for all the village leaders and farmers with large cattle herd (>35 persons) at Hoai’s farm.</p> <p>Farmers outside the IGs and villages of the projects were interested in grass demonstration farms and asked DARD to guide them and asked farmers in the project to share nursery plants. E.g.: 5 farmers in Thanh Yen have learnt and grown 0.17 ha of guinea grass in 2019.</p> <p>Nearly 20 further farmers were distributed grass seeds as requested (both inside and outside the project) during May to July 2020</p>

		At least one DARD facilitated field day per commune in years 2, 3, 4 and 5.		<p>A paper on “Effect of irrigation level on production of oats planted as ruminant in irrigated two-crop rice rotation in Dien Bien province, Vietnam” was presented in the conference of Animal Science held by NIAS in Nov. 2020.</p> <p>The solution of the biomass maize and oat planting as feed for cattle in the dry and cold season in Dien Bine province was approved as an innovation by Dien Bien DARD in early 2019.</p> <p>The solution of the maize silage in nylon bag as feed for cattle in Dien Bien province was approved as an innovation by People’s Committee of Dien Bien province in early 2020.</p> <p>The solution of better utilisation of crop by-products by processing as feed for fattening beef cattle under household and farm conditions in Dien Bien province was approved as an innovation by People’s Committee of Dien Bien province in April 2021.</p> <p>The DARD has transferred the forage production and reservation to a beef farm of the cooperative (Pa Khoag Safe Community - HTX Cộng đồng An toàn Pá Khoang) in Dien Bien district.</p> <p>The innovations in feeding (growing forage, making silage) have been introduced to farmers of 4 other districts (Tua Chua, Muong Cha, Dien Bien Dong, and Muong Ang) by the Dien Bien DARD (12/2021 – 5/2022).</p> <p>Trained about 100 farmers on making silage (about 200 tons of silage feed); Combined with Maize project to train 40 agricultural extension workers in Son La province in feed processing.</p> <p>A study on economic and technical performances of diversity of farms to identify the optimal male age selling to maximize gross margin have been carried out by CIRAD and NIAS team. The report is finalizing.</p>
--	--	---	--	---

PC = partner country, A = Australia

Objective 3: To develop and improve smallholder farmer linkages to urban markets.

No.	Activities	Outputs/ milestones	Due date of output / milestone	Comments
3.1	Develop and facilitate farmer interest groups for undertaking both technical (Obj 2) and market based (Obj 3) activities.	New farmer interest groups developed with self-governance. Groups identified and linked with traders, community-based development organisations and extension services.	completed	<p>Two TOT trainings have been undertaken in Tuan Giao and Dien Bien districts.</p> <p>A training needs assessment within the IGs has also been completed. (completed by Nov 2020)</p> <p>Ten (10) cattle production interest groups have been established in Tuan Giao and Dien Bien districts. Three groups include cattle keepers only, while the others also</p>

		<p>List of priority training areas developed by farmer interest groups. Training provided to farmer interest groups</p>		<p>include collectors, veterinarians, and slaughter men.</p> <p>Members of IGs participated in growing forage grasses, biomass maize, making silage, some increase herd size, and visits demonstration farms.</p> <p>These activities were facilitated by VNUA and CASRAD with help of NIAS and DARD.</p> <p>Re-form an IG in Quai Nua commune, Tuan Giao district (completed by August 2020)</p> <p>Updates of activities of other IGs have been done quarterly.</p> <p>Consulting and supporting interest groups in regular activities: VNUA builds a diary of activities of interest groups, in which project staff maintain direct or telephone contact with groups to record group activities, advise the group when necessary, and capture information about the needs of the group to develop appropriate activities.</p> <p>Supported to reorganize Tuan Giao coffee cooperative operating as Tuan Giao cattle breeding and trading cooperative, helped the cooperative to connect and buy and sell breeding cattle and buffaloes. Supported farmers including members of IGs to established Dien Bien Livestock Cooperative (Thanh Yen commune, Dien Bien district), helped the cooperative to connect with farmers, middlemen, slaughters and buy and sell cattle</p>
3.2	Appraisal of existing value chain ecosystem of the project (PC, A)	<p>Workshop completion and reflection report developed and shared. Value chain analysis report developed and shared internally and externally. One peer reviewed paper on market and value chain orientation among beef cattle producers</p>	M9/Y1	<p>Data collection at the downstream end of the chain was concluded by VNUA and NIAS. Collected data is analysed by VNUA. (completed on Apr and Aug 2018)</p> <p>A workshop on value chain thinking was organised in 2018; and a training of RVCA was conducted in Dien Bien in 2018. (completed)</p> <p>Two potential markets were identified those are supply shortage in Tuan Giao and emerging of modern retailing system, restaurants, and tourism in Dien Bien Phu city. (completed by Aug 2018)</p> <p>An outline for the peer reviewed paper has been developed. (drafting, expect to submit in Q3/2021, title "Comparing different beef cattle production systems in smallholder value chains in mountainous Vietnam: a financial analysis".</p>
3.3	Market Analysis (PC, A)	Market analysis instrument developed and administered.	M12/Y1	VNUA and NIAS working together to find synergy between Rapid Value Chain Analysis and market analysis.

		<p>Report on market characteristics, opportunities and bottlenecks to market access developed and shared among project beneficiaries for at least 2 focal markets.</p> <p>Understanding simple indicators of quality specification for trading (from farm up to processors) developed</p> <p>Market information collection, analysis and dissemination protocol developed.</p> <p>1 peer reviewed journal paper on consumer segmentation and characterisation.</p>		<p>A report has been prepared for the research team, local authority and members of cooperatives and interest groups related to the focal markets that include short supply chain of local market (beef and breeding animals) and a higher quality supply to the supermarket in Dien Bien city (completed by 2019).</p> <p>An international article is in preparation for submission.</p>
3.4	Develop and implement feasible value chain models. (PC, A)	<p>Summary report prepared and disseminated on market study and rapid value chain analysis.</p> <p>At least one training on group mobilisation and micro-saving and credit to farmer interest groups (2 persons from each farmer's interest group)</p> <p>At least one training workshop on value chain development and market access per chain per year (i.e., collaborative relations, value creating and sharing, role distribution).</p> <p>At least one training for all farmer interest groups per year (i.e., record keeping, basic financial analysis of package of practices, sources, and use of market information)</p>	Stakeholder workshop May 2019	<p>Stakeholder workshop was conducted in Dien Bien and Tuan Giao districts with the participation of interest group farmers, traders, collectors, slaughtermen, supermarket, Local DARD officers, and researchers of VNUA, NIAS and CASRAD. (completed by May 2019)</p> <p>The objective was to serve potential interventions in beef cattle value chains in Dien Bien province.</p> <p>In early July 2019, a simulation workshop was conducted in Dien Bien (preceded by a pilot study in Hanoi) to test the potential interventions using game-based scenarios. 13 people were involved in the pilot (5 women) and 36 in the stakeholder workshop (10 women).</p> <p>Training in the VC, market access, enterprise development in Tuan Giao and Dien Bien districts (completed by Sept 2020)</p> <p>Two cooperatives in Dien Bien (beef value chain) and Tuan Giao (reforming an old Coffee cooperative to work on breeding cattle value chain) districts with the involvement of slaughterhouse, supermarket, collectors, and champion member of interest groups have been established in line with livestock development strategy of the Dien Bien province; interest groups (IGs) as supported satellites. (completed by June 2019 in Tuan Giao and launch of Dien Bien Livestock Cooperative in May 2020)</p> <p>Project team supports linkages between IGs, Dien Bien COOP, Slaughterhouse</p>

		<p>One enterprise development training to women family members of the farmer interest groups.</p> <p>Development of a joint plan (production-marketing) among farmer interest group, market actors and local project team/extension staff</p> <p>Brochures of best practices in value chains along with success stories documented and disseminated within and beyond project areas (in local language)</p>		<p>(Toan The) and Hoa Ba supermarket (started from 24th Apr 2021, ongoing). Opening ceremony of selling beef in Hoa Ba supermarket was on 24 April 2021 and a tasting activity was organised on 1 May 2021.</p> <p>Some delays have been involved recently due to the different waves of Covid-19 in Vietnam in Feb-March and May-Jun 2021.</p> <p>Necessary facilities (banner, leaflet, table, and vacuum pack) for beef selling plan with Hoa Ba supermarket were prepared (completed in Apr 2021)</p> <p>Discussion with COOP and members of IGs in Dien Bien districts on market linkage with technical support from COOP (completed in Apr 2021)</p>
3.5	Investigate and upscale best practices that link farmers to markets effectively. (PC, A)	<p>Reflection meetings with communities and project staff (ensure participation of women)</p> <p>Summary report that highlights effective models and characterise (pre) conditions and pathways to upscale and out scale.</p> <p>Lessons learned published and circulated (brochure)</p>	Completed.	<p>The introduction meeting of a cooperative in Dien Bien was held to connect the cooperative with different stakeholders. (completed in Aug 2020)</p> <p>The project and DARD facilitate for the cooperative to apply and access to government funds to develop beef value chain (completed in Dec 2020)</p> <p>A series of training for COOP and IG members were conducted in Aug, Sep, Oct and Nov 2020. The contents of training include/combine market information and techniques as feed mixed, making silage, cattle breeding, and initial ideas about animal ethics (best practices have also been shared and provided).</p> <p>Exchange /share practices between farmers/members of COOP in Tuan Giao and Dien Bien districts, and local authorities.</p> <p>In Oct 2020, Prof. Su Thanh Long from VNUA provided a training on disease treatment for champion farmers of IGs in Dien Bien.</p> <p>In April 2021, VNUA supported Mr Thuong from Noong Giang IG, Quai Nua commune (Tuan Giao) to attend a 2-month training course on disease treatment/practice (2 days trained in class at VNUA and practiced in 3 local areas. He practiced 2 weeks in Vinh Tuong, Vinh Phuc and had to stop in May</p>

				<p>due to Covid). The feedback was very positive.</p> <p>Scaling-out strategies were developed, documented, and mapped together with activities of Objective 4.</p>
3.6	Value chain network/ coalition at local and district levels to sustain market linkages. (PC, A)	<p>At least two joint visits of farmers' interest groups to regional markets per year from year 2 onward</p> <p>One interaction with traders/shoppers/consumers in the market in each visit</p> <p>Regular meetings between farmers' interest groups, collectors, slaughterhouses, and traders in the project site</p> <p>Joint planning report</p> <p>Formalise network coalitions.</p> <p>Market Information Dissemination system in place in local DARD</p>	Completed	<p>Although networking and interaction is occurring between stakeholders, the restricted travel (due to Covid 19) is presenting challenges going forward.</p> <p>The project team is investigating options for this moving forward.</p> <p>Business plan for cooperatives and IGs have been developed by CASRAD and VNUA</p>

PC = partner country, A = Australia

Objective 4: To build capacity of beef value chain stakeholders to support and out-scale sustainable cattle production systems in the Northwest highlands

No.	Activities	Outputs/ milestones	Due date of output / milestone	Comments
4.1	Formation of stakeholder coalition	<p>Workshop on strategic foresight and visioning</p> <p>Stakeholder analysis report</p> <p>Stakeholder coalitions formed.</p> <p>Agreed terms of reference for the coalition prepared</p>	May 2019	<p>An institutional analysis was completed, and a report presented in a stakeholder workshop for different stakeholders (researchers, local authorities, farmers, slaughtermen, traders in the beef value chains) The institutional analysis, together with the findings from the strategic foresight workshop (4.2) and value network analysis (4.3) will be used in developing the online training platform referred to in Activity 4.4.</p> <p>DARD has supported and coordinated to form cooperatives (beef cattle value chain and breeding cattle value chain) as mentioned above. All activities supporting the cooperatives and IGs have the involvement of local DARD and local authorities.</p> <p>The workshop was held in conjunction with the annual meeting and in stakeholder workshop in May 2019 to identify intervention for development of the value chains.</p>

				<p>A working Group including crop and animal production divisions, and agricultural product quality management division under provincial DARD were formed and mobilized to support the cooperatives as well as out-scaling activities such as coordinating with the supermarket for beef market of the cooperative; Up-scaling programs reflect on Provincial and local DARD' regular program: in making silage, growing forage grasses, intercropping of forage and legumes; biomass maize; up scaling growing forage grass, biomass maize, maize intercropping with beans, in total of 223 households, in which 57 self-extended households inside and outside the study villages and communes those learn from members of IGs and DARD officers.</p>
4.2	<p>Capacity building of human resources in policy, education, extension, and MEL. (PC, A):</p>	<p>Trainings:</p> <ul style="list-style-type: none"> • Training of trainer • Quality certification and value chain development • Development and use of market-based information system • Evaluation reports of the training <p>Travel reflection report</p>	completed	<p>Organization of a strategic foresight workshop with the primary stakeholders involved in the project in June 2018 in Dien Bien and Tuan Giao districts by CIRAD, NIAS and DARD. Report for stakeholders (local authorities, farmers, researchers, actors of the beef value chain) was completed and shared in a stakeholder workshop.</p> <p>A geographic assessment of beef cattle rearing was conducted in the 5 communes of the 2 districts by Charlotte Svahn in 2018, supervised by Jean Daniel and Melanie Blanchard (CIRAD).</p> <p>A field study was conducted on local knowledge in cattle production in Tuan Giao district by CIRAD and NIAS. Report is completed.</p> <p>Farmers of interest group in Tuan Giao and Dien Bien visits cattle farms of the cooperative members in Dien Bien district</p> <p>Implemented a MEL training course for project members (9 researchers: 5 female and 4 male); prepare for evaluation of project impact. A consultant has been engaged to enable the project team to finalise the MEL and provide a framework for post project evaluation (intermediate outcomes).</p> <p>Capacity building has also been an unintended outcome of the project. The increased involvement and roles of DARD officers and local DARD in the project has enabled researchers to build social networks at farm- village and communal levels through regular field visits and contacts, organizing farmer to farmers visits, and interest group and cooperatives interactions. Champion farmers, especially female farmers have also emerged throughout the project and play a major role in introduction innovation to other farmers both inside and outside the project areas.</p>

			<p>Ms Olivia Woodiwiss (UTAS – Honours student) has completed a pilot extension mapping study, which will be expanded by the project team over the next 12 months. It is anticipated the mapping will identify what and how innovations are transferred to farmers and what avenues might be worth pursuing in the future (i.e., from project researchers, local DARD, champion farmers).</p> <p>DARD officers have learnt and introduced the innovations from the projects including biomass maize production, making silage using plastic bags and use of crop by-products by processing as feed for fattening beef cattle under household and farm conditions in Dien Bien province; these were approved as innovation by People’s Committee of Dien Bien province in 2019, 2020 and 2021. Extension mapping and stories of elite cases/ champion farmers have been recorded and mapped by DARD and NIAS.</p> <p>Young researchers and officers in implementing research, and leading in writing scientific article (e.g., Ly Thuy Duong, Nguyen thi Dung, and Vang A Me)</p> <p>With the support of the project team, Dien Bien DARD officials successfully awarded the approval from the provincial people committee for the strategic funding of 29 billion VND for a program of ruminant production development in the province.</p> <p>Up-scaled programs reflect on Provincial and local DARD’ regular program: in making silage, growing forage grasses, intercropping of forage and legumes; biomass maize; Up scaled growing forage grass, biomass maize, maize intercropping with beans, in total of more than 400 households, in which more than 70 self-extended households inside and outside the study villages and communes those learn from members of IGs and DARD officers.</p> <p>Survey and innovation extension to 4 other districts Muong Cha, Tua Chua, Dien Bien Dong and Muong Ang by DARD (2021-2022)</p> <p>QU, UTAS and DARD have developed strategy for livestock cooperative (2021-2022)</p> <p>Did updated records of extension mapping and stories of elite cases/ champion farmers (by DARD and NIAS)</p> <p>Supported young researchers and officers in implementing and monitoring research and leading in writing scientific article.</p>
--	--	--	--

				Through participating in the project, DARD extension official could extend their network to the agricultural universities and institutes to exchange knowledge and innovation for long term development.
4.3	Value Network Analysis	Report on value Network Analysis Workshop report	October 2018	Stakeholder analysis report is completed by Oleg and Cuong VNUA.

7 Key results and discussion

During the life of the project, the following objective outputs have been achieved by the project team, DARD, farmers, cooperatives, and other collaborators.

1) *Understanding the system*

- Two manuscripts have been developed from results of livelihood analysis:
 - A manuscript of “Barriers and enablers to cattle production intensification for improving the livelihoods of small-scale farmers in remote regions: A case study in Dien Bien province of Vietnam” was submitted to the journal of Rural study in July 2022.
 - A paper “Human and Social Capital in Promoting Livelihood for Beef Cattle Production Households in Dien Bien Province” written in English and available in Vietnamese was published in Journal of Animal Science and Technology.
- Completed Pre- & Post-trip survey questions to be ready to use for the coming trip to evaluate the impact of farmers’ visits.
- Several workshops, training seminars were organized combining with the objective 3 to report research results, economic, social, and even technical issues (as well as disease treatment) for farmers, sharing information within the group and between actors.
- Organized for elite farmers, champion farmers to visit 3 successful farms and livestock farmers in Son La province (Yen Chau and Mai Son districts).
- Farmers learned techniques of making silage of grass and crop by products to actively feeding animals throughout the year, especially in the cold winter season; high yielding cow breeds and farming techniques were also introduced to farmers.
- Participatory workshop to reflect on the outcomes of the livelihood analysis and the peer-to-peer knowledge exchange was combined with scoping workshop of ASSET project with representatives of different stakeholders (DARD, cooperatives, interest groups, trader, and farmers). The innovations in forage production have been continued and expanded by the ASSET project in both Tuan Giao and Dien Bien districts as well as ruminant production strategy of Dien Bien province developed by Dien Bien DARD.

2) *Developing intensification*

- Extended forage grasses (VA06, guinea, Mulato II), biomass maize and legumes intercropping with biomass maize and making silage; Increased adopters in the study villages from 120 in 2020 to 333 adopters in end of 2021 (in which more than 84 households growing biomass maize and making silage) (exclusive of the extended adopters outside project, who learned and guided by project farmers and DARD officers). Total of growing area is 131.3ha for grass and 63.36 ha for biomass maize, increased by 51.2 ha and 16.5 ha compared to the year 2020, respectively.
- Completed experiments on determination of the suitable intercropping method between biomass maize and legumes (black bean and soybean).
- Collaborated with maize project to plant guinea of 5000m² and soybean of 2200m² from May 2021. Completed 2nd feeding trial on fattening cattle by growing guinea, maize, and legume for making silage at Dien Bien Center for Crop and livestock production.

- Developed factsheets on Biomass maize planting and silage; Estimated body weight of yellow cattle based on body conformation.
- Published two guidebooks on common grasses and forages for ruminants in Northwest of Vietnam, and methods of processing and reserving forage and crop by products used as feed for beef cattle. Published two articles: an international article titled “Live Weight and Body Conformation Responses of Culled Local Yellow Cows Fed Maize Silage and Urea-Treated Rice Straw in an Intensive Feedlot System in Northwest Vietnam” in journal of Advances in Animal and Veterinary Sciences and three articles titled “Effect of planting distance on yield of biomass maize intercropping with soybean as feed for beef cattle in Tuan Giao district, Dien Bien province” in Journal of Agriculture and Rural Development.
- 2 Body Condition Scoring grids developed for Yellow Cattle and Buffalo (English, French and Vietnamese) by CIRAD and NIAS teams.
- Body Condition Scoring grids include in a collection of grids for tropical animals: horse, donkey, goat, camel etc. to be published on CIRAD data verse.
- A study on economic and technical performances of diversity of farms to identify the optimal male ages of cattle and buffalo selling to maximize gross margin have been carried out by CIRAD and NIAS team. The report was completed.
- Trained about 100 farmers on making silage (about 200 tons of silage feed); Combined with Maize project to train 40 agricultural extension workers in Son La province in feed processing.
- Shared results of forage production and fattening cattle in a Workshop organized by Maize project in Son La province.

3) *Market Improvement*

- Have been developing and facilitating 10 farmer interest groups (IGs) in Dien Bien and Tuan Giao districts with diversity of group structure; three groups with cattle keepers only, while the others also include forage producers, collectors, veterinarians, and abattoir managers/owners.
- Re-formed an IG in Quai Nua commune, Tuan Giao district and updated IGs’ activities quarterly.
- Facilitated and maintained common activities among IGs including growing forage grasses, biomass maize, making silage, increasing herd size; and visiting demonstration farms with the support of VNUA and CASRAD and assistance from NIAS and DARD.
- Completed a training needs assessment within the IGs in Nov 2020
- Conducted training courses on both technical (Obj 2) and market (Obj 3) activities; A series of training for COOP and IG members was conducted in Aug, Sep, Oct, and Nov 2020. The contents of training included/combined market information and techniques such as feed mixes, making silage, cattle breeding, and initial ideas about animal ethics (best practices have also been shared and provided).
- Provided training on disease treatment for champion farmers of IGs in Dien Bien.
- Supported a champion farmer from Noong Giang IG, Quai Nua commune (Tuan Giao) to attend a 2-month training course on disease treatment/practice (2 days trained in class at VNUA and practiced in 3 local areas in Vinh Tuong, Vinh Phuc – this was stopped in May due to Covid).

- Facilitated the Dien Bien cooperative to apply for and access government funds to develop beef value chain by Dec 2020 with the help of Dien Bien DARD and related local authorities.
- Engaged/ exchanged /shared practices between farmers/members of COOP in Tuan Giao and Dien Bien districts, and local authorities with members of IGs.
- Supported the development of linkages between IGs, Dien Bien COOP, Slaughterhouse (Toan The) and Hoa Ba supermarket to introduce beef; the opening ceremony of selling beef in Hoa Ba supermarket occurred on 24 April 2021 and a tasting activity was organised on 1 May 2021. In addition, the discussion with the cooperatives and members of IGs in Dien Bien districts on market linkage with technical support from the cooperatives was conducted in Apr 2021.
- Developed the manuscript “Comparing different beef cattle production systems in smallholder value chains in mountainous Vietnam: a financial analysis” and expected to submit in Q3/2021.
- Developed an article in English titled “Characterizing Beef Consumption Behavior of Households in Dien Bien Province, Vietnam” in Vietnam Journal of Agricultural Sciences (<https://doi.org/10.31817/vjas.2022.5.3.08>) and developed the manuscript “Transition to intensification of beef production development in Dien Bien province” and submitted to the Journal of Economics and Development (in Vietnamese)
- Scaled-out strategies to be developed together with activities of Objective 4.
- Consulting and supporting interest groups in regular activities: VNUA has developed a diary of activities of interest groups, in which project staff maintain direct or telephone contact with groups to record group activities, advise the group when necessary, and capture information about the needs of the group to develop appropriate activities.

4) *Capacity Building*

- Supported to reorganize Tuan Giao coffee cooperative operating as Tuan Giao cattle breeding and trading cooperative, helped the cooperative to connect and buy and sell breeding cattle and buffalo.
- Introduced the solution of better utilization of crop by-products by processing as feed for fattening beef cattle under household and farm conditions in Dien Bien province; this was approved as an innovation by People’s Committee of Dien Bien province in April 2021.
- Conducted A MEL training course for project members (9 researchers: 5 female and 4 male); prepare for evaluation of project impact (3-9/2020)
- Formed and mobilized Working Group including three divisions of crop production, animal production and agricultural product quality management under provincial DARD to support the cooperatives as well as out-scaling activities.
- Coordinated with the supermarket for beef market of the cooperative.
- Up-scaled programs reflect on Provincial and local DARD’ regular program: in making silage, growing forage grasses, intercropping of forage and legumes; biomass maize; Up scaled growing forage grass, biomass maize, maize intercropping with beans, in total of more than 400 households, in which more than 70 self-extended households inside and outside the study villages and communes those learn from members of IGs and DARD officers.
- Survey and innovation extension to 4 other districts Muong Cha, Tua Chua, Dien Bien Dong and Muong Ang by DARD in 2021-2022. This was funded from

unexpended UTAS travel funds. Updated records of extension mapping and stories of elite cases/ champion farmers.

- Supported young researchers and officers in implementing and monitoring research and leading in writing scientific article.
- UQ, UTAS and DARD have developed strategy for livestock cooperatives (2021-2022)
- Guided students to research on cattle raising and livestock market research in the frame of the project.
- Expanded communication about project activities and results (Dien Bien Television Station, Dien Bien Newspaper, Dien Bien District Television Station, Vietnam Agriculture Newspaper; VNUA news channel, on Facebook).
- Supported Ms Le Thi Nga from Focus Group Company to connect cooperatives and exchange development strategy. The use of in-country consultants such as FGC enabled activities to continue when international travel was restricted. This was funded from unexpended UTAS travel funds.
- A master's student and 12 university students completed their studies, using the project as a basis for their final thesis.

8 Impacts

8.1 Scientific impacts – now and in 5 years

Results from technical experiments, livelihood analysis and market and stakeholder network analysis have started to show impact in changing behaviour, knowledge and practices of champion farmers, farmers of the study villages and outside as well as researchers and local DARD officers. More farmers have adopted innovations on forage production and processing, some among them increased the frequency of selling cattle and the number of cattle kept. Farmers in Na Sang village (Nua Ngam) gradually changed from free grazing to stall fed with using grown forage and crop by products. Farmers are interested in working with the cooperatives to develop market for higher quality beef product. This is likely to be an impact over the next 5 or more years, as cooperatives become embedded into the way farmers do business going forward. Results of certain objectives have been applied in other projects by researchers (e.g., ASSET project) and local DARD officers.

8.2 Capacity impacts – now and in 5 years

The technical and market innovations introduced from the research results have been accepted by farmers, local authorities, and different stakeholders. Farmers have been trained to meet their need in technical and marketing and collective actions. Local DARD officers have been developing research plans as well as strategic planning for livestock production development in the locality (e.g., Mrs. Hang, Mrs. Dung, and Mrs. Hong). Participating in the implementation of experiments and writing reports and articles, the researchers have developed their skills in designing and implementing research experiments and writing scientific articles (e.g., Ms. Duong, Mr. Me). Champion farmers (e.g., Mr. Thuy, Mr. Kim, Mr. Hoai, Mrs. Khanh) and leaders of cooperatives (young director Mr. Thang, Mr. Trinh) have been developing their knowledge in collective action, communication with local authorities and other stakeholders as well as increasing skills in exchanging the experience to the others.

It is anticipated that the DARD will extend their knowledge of developing cooperatives and strategy to other regional areas of Vietnam within the next 5 years. The new ACIAR Agribusiness project (AGB/2020/189) will be seeking the advice of the Dien Bien DARD to work with local DARD in Hanoi.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

Thanks to training and visiting activities in the project, some farmers have expanded their grass planting areas as well as production scale and focussed more on fattening cattle. No data is available yet to evaluate the economic impacts of such changes, but exchanges with farmers reveal that the trend is continued – implying that economic benefit is tangible. Anecdotally, some inefficient production planting areas are now being used for grass production, thereby improving economic efficiency of land use.

Farmer interviews in Na Sang village in early 2021 revealed that many farmers increased the number of cattle sold per year (by 1 to 2 cattle) because stall fed cattle production using grown forage and crop by product helped to shorten time of raising cattle and reduced the time in tending cattle. Farmers in Quai Nua -Tuan Giao district relied on the potential for commercial forage production from available land. A forage market has emerged in Dien Bien, and we anticipate that over the next five years, further segmentation of the beef supply/value chain will occur. This includes forage markets in other regions and the emergence of service providers for production advice, input supplies and marketing.

8.3.2 Social impacts

The formation of the Beef cattle interest groups and co-operative has enabled the exchange of knowledge and know-how techniques in cattle production, as well as strengthened the relationships between stakeholders and built social capital among members. Some groups have raised funds from members to subsequently lend to those in need.

Linkage among researchers, local officers, farmers, and other stakeholders has increased because of the collaboration in undertaking activities during the project time.

Over the next five years, the expansion of cooperative membership and increase in interest groups (supported by the local DARD), and segmentation of the beef supply/value chain, will reduce the reliance on children, women, and the elderly to manage the livestock and enable them to undertake other activities (i.e., schooling, off farm employment, volunteering).

8.3.3 Environmental impacts

The project has not implemented any activities specific to reducing negative environmental impacts. However, the collaboration with SMCN/2014/049 has enabled the testing and development of forage hedge rows for soil erosion control in maize production systems. Farmers are also increasing their treatment and use of rice straw for animal feed, minimising the burning of crop residues and subsequent impact on the environment.

8.4 Communication and dissemination activities

The onset of Covid-19 created some challenges in the project, particularly with restricted travel. However, this increased the reliance on other communication methods. Farmers of Interest Groups are now familiar communicating with the research team via the Vietnamese Wi-Fi calling app 'Zalo' and have continued to use it in communications with each other as well as the director of the COOP when selling cattle.

The innovations introduced by the project have been disseminated widely and taken up by others (forage growing, making silage, cooperative). For example, in Muong Nhe district in Son La, farmers of Interest Groups in Mai Son and some private farmers in Dien Bien district have planned to visit the Interest Groups in Tuan Giao and Dien Bien that have taken up the innovations.

The project team were also instrumental in promoting the project through local media (Refer to Table 1)

Table 1. Print and online media communication

No	Publish Agent	Time	Languages	English Title
1	Vietnam Agriculture	2022	English	Changes happen in Dien Bien thanks to the cattle production project. https://vietnamagriculture.nongnghiep.vn/changes-happen-in-dien-bien-thanks-to-the-cattle-production-project-d320827.html
2	New rural web portal in Ha Tinh province	2022	Vietnamese	The linkage between Dien Bien Livestock Cooperative and Hoa Ba Supermarket. https://nongthonmoihatinh.vn/Nhieu-nguoi-cung-quan-tam/lien-ket-giua-hop-tac-xa-chan-nuoi-dien-bien-va-sieu-thi-hoa-ba-113335.html

3	Faulty of Economics and Rural Development, VNUA	2022	Vietnamese	Safe beef "enters" the supermarket through the value chain linkage. https://ktptnt.vnua.edu.vn/tin-tuc/thit-bo-sach-vao-sieu-thi-qua-lien-ket-chuoi-43324
4	Vietnam Agriculture	2022	Vietnamese	The linkage between Dien Bien Livestock Cooperative and Hoa Ba Supermarket. https://nongnghiep.vn/lien-ket-giua-hop-tac-xa-chan-nuoi-dien-bien-va-sieu-thi-hoa-ba-d289709.html
5	Faulty of Economics and Rural Development, VNUA	19.04.2022	Vietnamese	Australian Ambassador to Vietnam visits the implementation site of the beef cattle intensive farming project. https://www.vnua.edu.vn/tin-tuc-su-kien/hop-tac/dai-su-uc-tai-viet-nam-tham-diem-thuc-hien-du-an-chan-nuoi-tham-canh-bo-thit-52541
6	Integration Magazine	19.04.2022	Vietnamese	Australian Ambassador visits projects in the Northwest region of Vietnam. https://hoanhap.vn/chi-tiet/dai-su-australia-tham-cac-du-an-tai-vung-tay-bac-viet-nam1650332265.html
7	Australian Embassy in Vietnam		Vietnamese	Australian Ambassador visits projects in the Northwest region of Vietnam. https://vietnam.embassy.gov.au/hnoivietnamese/MR220418_VN.html
8	Ethnicity and mountains magazine	04.06.2022	Vietnamese	Intensive beef cattle farming on sloping land in Dien Bien. https://dantocmiennui.vn/tham-canh-bo-thit-tren-dat-doc-o-dien-bien/321928.html
9	Vietnam Livestock Magazine	19.04.2022	Vietnamese	ACIAR project: Changing beef cattle farming on the plateau. http://nhachannuoi.vn/du-an-aci-ar-thay-doi-nghe-chan-nuoi-bo-thit-tren-cao-nguyen/
10	Voice of Vietnam	25.04.2022	Vietnamese	Australia is committed to supporting Vietnam in sustainable agricultural development. https://vov.vn/kinh-te/australia-cam-ket-ho-tro-viet-nam-phat-trien-nong-nghiep-ben-vung-post939419.vov
11	Rural and Development Magazine	17.06.2022	Vietnamese	Project on intensive beef cattle farming on sloping land farming systems in the northwest farming region of Vietnam. LPS/2015/037. https://www.nongthonvaphattrien.vn/du-an-chan-nuoi-tham-canh-bo-thit-trong-cac-he-thong-canh-tac-dat-doc-vung-mien-nui-tay-bac-viet-nam-ma-so-lps2015037-a1180.html

12	Facebook ILRI Vietnam	17.9.2021	Vietnamese	<p>Competition: Livestock from the public's point of view. Wealth thanks to livestock raising.</p> <p>https://m.facebook.com/story.php?story_fbid=fbid02pr4psgrpAmqp66Y1zvjqEr6ufwSeocgavW4PkAA6qZxNivajXFEXc3RTqjJuHNtl&id=541882072999932&eav=AfZeXOM0QsoUL_JpdvCZOpc3NtXZZYaMXIP6n_E7eoYg4tVjeMa5W3g3a1psqw3-2g&m_entstream_source=timeline&paipv=0</p>
13	Dien Bien province TV channel, shared via Facebook by Dien Bien Livestock Cooperative	24.04.2021	Vietnamese	<p>Opening ceremony of a high-quality retail store of beef in the beef value chain of Dien Bien province.</p> <p>https://fb.watch/gpH0mdaeG4/</p>
14	Dien Bien Phu Online	26.04.2022	Vietnamese	<p>Safe beef "enters" the supermarket through the value chain linkage.</p> <p>http://baodienbienphu.com.vn/tin-tuc/kinh-te/186519/thit-bo-sach-"vao"-sieu-thi-qua-lien-ket-chuoi?fbclid=IwAR0Bo1qPy5p4IMJ-MSAcNnhlkMa9DhewLRqT6E7zzVH6hHaEbYWC4sEm02Q</p>
15	Dien Bien Phu Online	27.05.2020	Vietnamese	<p>Launching ceremony of Dien Bien Livestock Cooperative.</p> <p>http://www.baodienbienphu.info.vn/tin-tuc/kinh-te/178237/ra-mat-hop-tac-xa-chan-nuoi-dien-bien?page=1</p>
16	Vietnam Agriculture		Vietnamese	<p>Launching ceremony of Dien Bien Livestock Cooperative.</p> <p>https://nongnghiep.vn/ra-mat-hop-tac-xa-chan-nuoi-dien-bien-d265308.html</p>
17	VN Business	20.05.2020	Vietnamese	<p>Developing the cattle farming value chain in Dien Bien.</p> <p>https://vnbusiness.vn/mo-hinh/phat-trien-chuoi-gia-tri-chan-nuoi-bo-o-dien-bien-1068620.html</p>
18	Livestock Vietnam	09.06.2020	Vietnamese	<p>Intensive beef cattle rearing in sloping land farming systems in the mountains of Northwest Vietnam.</p> <p>http://nhachannuoi.vn/chan-nuoi-tham-canh-bo-thit-trong-cac-he-thong-canh-tac-dat-doc-o-vung-nui-tay-bac-viet-nam/</p>
19	Southern Livestock Sub-Institute		Vietnamese	<p>Intensive beef cattle rearing in sloping land farming systems in the mountains of Northwest Vietnam.</p> <p>http://iasvn.vn/chan-nuoi-tham-canh-bo-thit-trong-cac-he-thong-canh-tac-dat-doc-o-vung-nui-tay-bac-viet-nam-232</p>

20	Department of Science and Technology, VNUA	21.06.2022	Vietnamese	Project Overview Conference "Intensive beef cattle raising in sloping land farming systems in the Northwest mountainous region of Vietnam". http://khcn.vnu.edu.vn/vi/news/hoi-nghi-hoi-thao/hoi-nghi-tong-ket-du-an-chan-nuoi-tham-canh-bo-thit-trong-cac-he-thong-canh-tac-dat-doc-vung-mien-nui-tay-bac-viet-nam-691.html
21	Australian Embassy in Vietnam	14.04.2022	English	Twitter post. https://twitter.com/AusAmbVN/status/1514503938791276547
22	VNUA	16.12.2022	English	Future farmers festival – experience, inspiration on agricultural development. https://eng.vnu.edu.vn/news-and-events/future-farmers-festival-experience-inspiration-on-agricultural-development-53278

9 Conclusions and recommendations

9.1 Conclusions

The Northwest highlands is dominated by ethnic minorities and is considered one of the poorest regions in Vietnam. Access to services and markets is improving but remains a major limitation for smallholder households.

The overall aim of this project was to improve the income of smallholder cattle producers through intensification of beef cattle production and increased market linkages in mountainous crop-livestock systems in the Northwest of Vietnam.

The project followed on from LPS/2008/049, which provided solutions for technical constraints for cattle production in the highlands. The project also worked alongside SMCN/2014/049, which aimed to reduce erosion and retain soil nutrients on sloping lands by introducing hedgerows of forage (for cut and carry feed) and incorporating legumes to fix nitrogen in the soil. Outputs from this partner project were applied in the beef project, specifically in the feeding trials.

The project used a participatory approach in undertaking all activities and continually involved the local DARD in planning and implementation. Whilst the global pandemic caused some travel restrictions between March 2020 and May 2022, the research team managed to maintain progress in delivering scheduled outputs.

Whilst research for development projects often deliver incremental change for smallholder households, they need transformational change to keep in touch with the rate of change in the rest of the world. During the life of the project, there was transformational change. Many of these changes are described within this report, in the publications and media releases but summarised below:

- **Peer to peer farmer and extension service exchange** with livestock producers in Dak Lak resulted in an immediate change in the agribusiness system of smallholder households when farmers returned to their villages and communities in Dien Bien. An interest group was established that included all stakeholders in the beef supply/value chain, so that all participants in the chain received the benefits of improved production practices. This included the establishment of forage markets for farmers with an abundance of land and no cattle.
- **Learning by doing – A DARD initiative.** Two members of the Dien Bien DARD were finding it difficult to get any uptake of silage production in the villages closest to the city until they went into a village and started making the silage themselves. The village farmers soon joined in and become the extensionists as they shared their knowledge with fellow farmers. A peer-to-peer activity that produced unanticipated benefits.
- **Interest Groups and Cooperatives.** The project activities included the expansion of interest groups across the region. The original interest groups consisted of farmers, but in the early stages of the project, interest groups were established that contained different stakeholders of the beef supply/value chain. One of these interest groups very quickly pivoted to being a cooperative with the National Government promoting the establishment of [cooperatives](#) in the regional areas including Dien Bien.
- **School Based Intervention.** A collaboration between academics from Australia and Vietnam delivered a 4-hour intervention activity at Quai Nua primary school in the Dien Bien Province of Viet Nam in November 2023. The program, which engaged approximately 130 students and 25 local farmers, project members, and researchers, provided authentic learning experiences related to technology in agriculture, practical knowledge of fresh and stored feed, value chains, and the importance of teamwork and collaboration in the beef cattle industry.

The challenge with any research for development project is for the in-country research team to achieve autonomy and self-determination by the end of the project. Whilst this challenge was exacerbated with the global pandemic, the Vietnam based research team, led by Associate Professor Le Thi Thanh Huyen, overcame any restrictions and limitations, and assumed ownership of deliverables by adapting and pivoting activities to achieve the milestones. The team included the Dien Bien DARD, who were instrumental in maintaining connection with smallholder households and communities.

9.2 Recommendations

The project discussed herein was the second of two beef projects conducted in the Northwest highlands of Vietnam. The first phase delivered technical solutions for raising cattle in this remote region with respect to feed availability and shelter. This second phase delivered solutions for transitioning livestock production from extensive grazing to intensified production. This included forage and silage production and expansion of cattle shelters. The new cooperative was also instrumental in developing a culture of collective action for farmers and supply chain stakeholders to work together. The DARD continuously supports the activities and development of the cooperatives and extending the innovation in the province. There are policies of the central and provincial government which give priority for cattle development including buffalo and beef (goat as well) based on the availability of land for natural pastures and grown forages. The Dien Bien DARD has been building a program for ruminant development in the province.

This project was conducted concurrently with the maize project (SMCN/2014/049) with each project contributing to the activities of the other. The project team recommend that future work combine the outputs of these two projects and help communities develop management strategies for mixed cropping livestock production. Any new work needs to consider methane emissions from livestock, land use pressure, and carbon accounting, and always include the DARD and local extension staff in developing and delivering associated activities.

10 References

10.1 References cited in report

- Coxhead, I., Kim, N. B. N., Vu, T. T. and Nguyen, T. P. H. (2010). Accelerating growth in agricultural productivity and rural incomes in Vietnam: Lessons from regional experiences. A robust harvest: Strategic choices for agricultural and rural development in Vietnam. Hanoi, Vietnam, The Asia Foundation: 94.
- Duong, N. H., Pham, V. H., Nguyen, T. T. H., Bonney, L. B. and Ives, S. W. (2014). Impacts of socio-cultural factors on beef cattle value chain: a case study of producers in the northwest region of Vietnam. 16th Asian-Australasian Associations of Animal Production Societies, Yogyakarta, Indonesia.
- Duteurtre, G., Hoang, T. X., Dang, H. T., Bonney, L. B. and Ives, S. W. (2014). Policies and Institutions Governing the Beef Cattle Value Chain in the North-West Highlands of Vietnam. 16th AAAP Animal Science Congress, Gadjah Mada University, Yogyakarta, Indonesia.
- ILRI (2014). A situational analysis of agricultural production and marketing, and natural resources management systems in northwest Vietnam. Nairobi, Kenya, International Livestock Research Institute for CGIAR Humidtropics Research Program.
- Ives, S. W., Lane, P. A., Nguyen, Q. H., Phan, T. D., Le, H. T. N. and Pham, C. K. (2014). Impact of a School Based Program as an Intervention Activity for Managing Forage Production 16th AAAP Animal Science Congress Gadjah Mada University, Yogyakarta, Indonesia.
- Le, T. T. H., Herold, P., Markemann, A. and Zarate, A. V. (2011). "Resource use, cattle performance and output patterns on different farm types in a mountainous province of northern Vietnam." Animal Production Science **51**(7): 650-661.
- Mai, K. A., Nguyen, Q. H., Phan, T. D., Nguyen, H. D. and Ives, S. W. (2014). "Initial assessment on growth and yield of some grass varieties grown in the northwestern mountainous region." Journal of Science and Technology **115**(1): 27-32.
- Nguyen, Q. H., Lang, K. V., Phan, T. D., Mai, K. A. and Ives, S. W. (2014). Efficiency of processed crop by-products to grow cattle for small holder farmers in northwest Vietnam. 16th AAAP Animal Science Congress Gadjah Mada University, Yogyakarta, Indonesia.
- Nguyen, Q. H., Phan, T. D., Mai, K. A. and Ives, S. W. (2014). "Assessment of the utilization of natural grass and agricultural crop by-products in cattle production." Journal of Animal Science and Technology **46**: 30-38.
- Nguyen, Q. H., Phan, T. D., Mai, K. A. and Ives, S. W. (2014). Crop by-products satisfy the winter feed gap for beef cattle ensuring sustainable grazing of native pastures 16th AAAP Animal Science Congress, Gadjah Mada University, Yogyakarta, Indonesia.
- Pham, H. V. and VNUA (2012). Annual Report for Project LPS/2008/049, Vietnam National University of Agriculture.
- Stür, W., Khanh, T. T. and Duncan, A. (2013). "Transformation of smallholder beef cattle production in Vietnam." International Journal of Agricultural Sustainability **11**(4): 363.
- Tanaka, T., Camerer, C. and Nguyen, Q. (2010). "Risk and Time Preferences: Linking Experimental and Household Survey Data from Vietnam." American Economic Review **100**(1): 557-571.
- Tran, T. Q., Nguyen, S. H., Vu, H. V. and Nguyen, V. Q. (2014). "A note on poverty among ethnic minorities in the Northwest region of Vietnam." Post-Communist Economies **27**(2): 268-281.

VNUA (2015). Report of Intervention Response for Project LPS/2008/049 Overcoming technical and market constraints to the emergence of profitable beef enterprises in the north-western highlands of Vietnam., Vietnam National University of Agriculture

Vu, C. C., Pham, K. C., Ives, S. W., Malau-Aduli, A., Le, V. H. and Luu, T. T. (2014). Responses of Beef Calves to Temperature and Feeding Level. 16th AAAP Animal Science Congress, Gadjah Mada University, Yogyakarta, Indonesia.

10.2 List of publications produced by project

Bui Van Quang & Nguyen Thi Duong Nga (2020). Research on Beef Value Chain in Tuan Giao District, Dien Bien Province. Vietnam Journal of Agricultural Sciences; 18(1): 73-80. <http://tapchi.vnu.edu.vn/wp-content/uploads/2020/06/tap-chi-so-1.1.8.pdf> [Vietnamese]

Duong, L.T.T, Huyen L. T. T, Nhuan N. H, Hung, P.V, Quang, B.V, Stephen Ives and Robyn Eversole (2021). Human and Social capital in promoting livelihood for beef cattle production in ethnic minority households in Dien Bien Province. Journal of Animal Science and Technology; 120: 74 – 83. <https://vcn.org.vn/xuat-ban/journal-of-animal-science-and-technology-vol-120-february-2021> [English]

Nguyen Hung Quang, Nguyen Duc Truong, Nguyen Thi Bich Dao, Tran Thi Bich Ngoc and Stephen Ives (2021). Effect of growing space intercrop on biomass productivity of corn and soybean to use for beef cattle in Tuan Giao district, Dien Bien province. Science and Technology Journal of Agriculture and Rural development; 8: 76 – 82. ISSN: 1859-4581. [Vietnamese]

Nguyễn Hưng Quang, Trần Thị Bích Ngọc, Nguyễn Đức Trường, Mai Anh Khoa, Hồ Văn Trọng, Giảng A Chênh, Lê Thị Thanh Huyền and Stephen Ives (2019). Assessment of the fresh green yield and chemical composition of LVN61 and LVN4 maize varieties planted to use as silage feed for beef cattle in Tuan Giao. Journal of Agriculture and Rural Development - Special issue of Sustainable agricultural development in the Northern Midland and Mountainous regions, Nov., 2019: 112 – 118. [Vietnamese]

Nguyễn Hưng Quang, Nguyễn Đức Trường, Nguyễn Thị Bích Đào, Nguyễn Thị Thu Hằng, Trần Thị Bích Ngọc and Stephen Ives (2021). Effect of growing space intercrop on biomass productivity of corn and soybean to use for beef cattle in Tuan Giao District, Dien Bien Province. Journal of Agriculture and Rural Development - Special issue of Sustainable agricultural development in the Northern Midland and Mountainous regions, Aug., 2021: 76 – 82. [Vietnamese]

Nguyễn Hưng Quang (chủ biên), Trần Thị Bích Ngọc, Nguyễn Đức Trường, Mai Anh Khoa, Nguyễn Thị Thu Hằng, Lê Thị Thanh Huyền, Melanie Blanchard, Rowan Smith, Stephen Ives, Hồ Văn Trọng and Trần Minh Quân. (2020). Guidebook: Some common varieties of grasses and forages for cattle raising in the mountainous Northwest region of Vietnam. Publishing House of Thai Nguyen University. ISBN: 978-604-9984-70-9. [Vietnamese]

Nguyen DV, Tran NBT, Vang MA, Le HTT, Nguyen GTT, Nguyen QH, Blanchard M, Bailey A, Ives S (2021). Live weight and body conformation responses of culled local yellow cows fed maize silage and urea-treated rice straw in an intensive feedlot system in northwest vietnam. Advances in Animal and Veterinary Sciences; 9(8): 1283-1291. <http://dx.doi.org/10.17582/journal.aavs/2021/9.8.1283.1291> [English]

Pham Van Hung, Nguyen Thi Duong Nga, Bui Van Quang, Duong Nam Ha, Tran The Cuong, Pham Kieu My, Rajendra Adhikari, Le Thi Thanh Huyen & Stephen Ives (2022). Characterizing Beef Consumption Behaviors of Households in Dien Bien Province, Vietnam. Vietnam Journal of Agricultural Sciences; 5(3): 1598-1612. <https://doi.org/10.31817/vjas.2022.5.3.08> [English]

Pham Van Hung, Tran The Cuong, Ninh Xuan Trung, Bui Van Quang & Le Thi Thanh Huyen (2022). Transition to intensification of beef production development in Dien Bien province. Journal of Economics & Development; 305(2), pp 154-162. <https://ktpt.neu.edu.vn/> [Vietnamese]

Trần Thế Cường , Nguyễn Thị Dương Nga, Phạm Văn Hùng, Dương Nam Hà, Đỗ Huy Hùng, Ninh Xuân Trung & Bùi Văn Quang (2021). Research on Beef Value Chain in Chương Mỹ District, Hanoi City. Vietnam Journal of Agricultural Sciences; 19(10): 1334-1342. <http://tapchi.vnua.edu.vn/wp-content/uploads/2021/09/tap-chi-so-10.2.6.pdf> [Vietnamese]

Tran Thi Bich Ngoc, Melanie Blanchard, Rowan Smith, Nguyen Hung Quang, Stephen Ives and Le Thi Thanh Huyen (2020). Utilization of crop by-product options in smallholder cattle production systems in Vietnam. Journal of Animal Science and Technology; 108: 2 – 17. [English]

Further to the publications, several masters and undergraduate thesis were completed based on project, which built capacity of the students but also their supervisors.

Master's Thesis

Nguyen Thi Huong Giang (2020). Research on development of total mix ration (TMR) from locally available agricultural by-products supplemented with probiotics in beef cattle production in households in Dien Bien. Supervisor: Dr Mai Anh Khoa. [Vietnamese]

Tran Cong Huan (2021). Developing beef cattle production in Chuong My district, Hanoi city. Supervisor: Assoc Prof Dr Nguyen Thi Duong Nga. [Vietnamese]

Undergraduate Thesis

Dinh Phu Minh (2020). Developing dairy cattle production of farm households in Kha Phong commune, Kim Bang district, Ha Nam province. Supervisor: Dr Nguyen Thi Thu Huyen. [Vietnamese]

Doan Bich Ngoc (2020). Study on beef consuming households in Ngoc Thuy ward, Long Bien district, Ha Noi city. Supervisor: Dr Nguyen Thi Thu Huyen. [Vietnamese]

Le Thi Ha (2018). Study on beef consuming behavior of consumers in Tuan Giao town, Tuan Giao district, Dien Bien province. Supervisor: MSc Tran The Cuong [Vietnamese]

Lo Thi Thuy (2018). Study on livelihoods of beef cattle households in Chieng Sinh communes, Tuan Giao district, Dien Bien province. Supervisor: MSc Bui Van Quang [Vietnamese]

Lo Thi Uyen (2018). Study on livelihoods of beef cattle households in Nua Ngam commune, Dien Bien district, Dien Bien Province. Supervisor: MSc Bui Van Quang [Vietnamese]

Luong Nhat Hoang (2022). Study on beef consuming behavior of households in Duc Giang ward, Long Bien district, Hanoi city. Supervisor: Assoc Prof Dr Nguyen Thi Duong Nga. [Vietnamese]

Lu Thi Chinh (2018). Developing beef cattle production in Thanh Yen commune, Dien Bien district, Dien Bien province. Supervisor: MSc Tran The Cuong [Vietnamese]

Nguyen Diep Anh (2020). Developing dairy cattle production in Ba Sao town, Kim Bang district, Ha Nam province. Supervisor: MSc Bui Van Quang [Vietnamese]

Nguyen Phuong Anh (2018). Study on gender in dairy cattle production in Phu Dong commune, Gia Lam district, Hanoi city. Supervisor: MSc Nguyen Thi Huyen Trang. [Vietnamese]

Nguyen Van Luong (2020). Prevalence of cows with liver fluke disease and preventive measures for cattle raised in Quai Nua commune, Tuan Giao district, Dien Bien province. Supervisor: Assoc Prof Dr Nguyen Hung Quang. [Vietnamese]

Pham Thi Giang (2022). Study on beef consuming behavior of households in Phuc Xa ward, Ba Dinh district, Hanoi city. Supervisor: Assoc Prof Dr Nguyen Thi Duong Nga. [Vietnamese]