Australian Government

Australian Centre for International Agricultural Research

Final report

project

Smallholder farmer decision-making and technology adoption in southern Lao PDR: Opportunities and constraints

project number	ASEM/2014/052
date published	August 2020
prepared by	Dr Kim Alexander, James Cook University Dr Silva Larson, University of Sunshine Coast
co-authors/ contributors/ collaborators	Professor Peter Case, James Cook University Dr Garry Greenhalgh, James Cook University Dr Silva Larson, University of Sunshine Coast Dr Magnus Moglia, Swinburne University
approved by	Dr Jayne Curnow
final report number	FR2020-012
ISBN	978-1-922345-54-7
published by	ACIAR GPO Box 1571 Canberra ACT 2601 Australia

Contents

1 Acknowledgments

Research reported in this paper was funded by the Australian Centre for International Agricultural Research, Project no. ASEM/2014/052: “Smallholder farmer decision-making and technology adoption in southern Laos PDR: opportunities and constraints”. We are grateful to ACIAR for their generous support. The report is based, in part, on a literature review of previous ACIAR project reports and from other literature.

Fieldwork mentioned within the document was conducted for the study and was approved by James Cook University’s Human Ethics Research Committee: Approval H6109.

We would also like to thank ACIAR researchers who contributed by providing their research reports and providing other assistance - through meetings, emails and conversations – that contributed to verification and interpretation of findings.

Personnel involved in the project: Dr Kim Alexander, Dr Magnus Moglia, Dr Silva Larson, Dr Garry Greenhalgh, Prof Peter Case, Dr Anne Giger-Dray, Mr Tom Jovanovic, Dr Bountom Khounsy, Senior Prof Pascal Perez, Mr John Connell, Associate Prof Somphanh Pasouvang, Mr Khamphouvieng Phouisombath, Prof Silinthone Sacklokham, Mr Viengkham Sodahak, Mr Phomma Thammavong, Ms Manithaythip Thephavanh, Dr Phonevilay (Lanoy) Sinavong, Dr Daovy Kongmanila, Thaphavanh, Ms Khampasrt, Dr Thasaka Saphangthong, Mr Sysavanh Vorlasan, Mr Vorachit, Dr Thavone Inthavong, Mr Khanthavy, Mrs Dalivanh Samonty, Mrs Keoooudone Philangam and Ms Manivanh Phimphachanvongsod.

We would like to thank members of other ACIAR project teams for their involvement in our project, particularly: Dr Tamara Jackson, Dr Camilla Vote, Associate Prof Matthew Denton, Dr Josh Philp and Davina Boyd. Thanks also go to our project reviewers Dr Liz Clarke and Mr Khamlouang Keoka. We are grateful to ACIAR Research Program Managers Dr Caroline Lemerle and Dr Jayne Curnow for their support and guidance.

2 Executive summary

The purpose of the ASEM/2014/052: *Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints* project was to explore factors influencing adoption of new technologies and to develop 'solutions' that would enhance adoption. The research aimed to improve adoption by smallholder farmers of proven technology and management innovations. The key research questions guiding the research and objectives were:

RQ1: What influences smallholder adoption of proven technologies?
RQ2: How can stakeholder networks be engaged and mobilised to enable smallholder farmers to apply proven technologies?

Objectives 1: Identify the drivers and constraints affecting smallholder decision-making with respect to adoption of proven technologies.
Objective 2: Develop solution strategies/methods to improve use of proven innovations by farmers.

A Participatory Action Research (PAR) research strategy was employed to facilitate inclusive community-based, trans-disciplinary research working in villages and involvement of Lao institutions and local organisations.

Data from research activities were synthesised into a Research Discussion Tool (RDT) summarising adoption drivers, enablers, motivators, opportunities and barriers that influence technology uptake. The RDT was trialled as a platform for discussions between stakeholders to gain a common understanding of a given technology and to select suitable villages to introduce this technology. A second outcome of the research was the identification of 9 thematic areas deriving from a Solution Space Workshop. The 9 themes represent a comprehensive, end to end, solution to the adoption of new technologies with the potential to enhance the future probability of adoption of new technology. The broad nature of the 9 solution areas and 78 factors within the RDT tool suggests that the 'Solution Space' is comprehensive and can be adapted with relatively minor modification for use with other technologies and in other regions and countries.

Design and implementation of Project Charters, involving activities to be conducted to improve overall adoption of new technologies, within the 9 thematic areas were co-designed with – and then implemented by - our Lao colleagues. We have seen significant and effective levels of leadership, motivation, discretionary behaviour and management by those involved in the planning and implementation of the Lao projects, and we have been able to move activities between institutions, where necessary, largely due to changing personnel and limitations of research capacity within institutions.

Our research has shown that there are usually no simple 'one- or two-factor' solutions to technology uptake; rather we have found a more complex ecology of factors relating to farmers' decision drivers and farmers' decision enablers within farmers' production systems. The relative importance of each factor is dependent on the specific technology that is introduced. Hence, projects that introduce new technologies struggle to address all relevant factors and often cannot deal with the complex array of factors that are at play. A key benefit of the outcomes of this research, the RDT and the 9 thematic areas, identify solutions, factors and areas of concern for a specific technology through co-constructed knowledge that builds capacity and embeds local knowledge within projects.

Finally, this project has demonstrated the value of a broader range of skill sets and approaches in agricultural research for development. Of particular importance for future capacity building is the opportunity for in-country researchers to operate more independently and to have a strong input to design and approaches, particularly in bringing in local knowledge perspectives.

3 Background

Smallholder farmers in Lao PDR have traditionally been subsistence farmers; dependent on cultivatable land for rice and livestock production and with an array of non-timber forest and river products used as supplementary food sources and marketable goods (Alexander , Millar and Lipscombe 2010, Foppes 2008). More recently, Lao PDR is following general agrarian trends also occurring elsewhere in South East Asia towards intensified production, the territorial expansion of large actors, market integration, including urbanization of the population, escalating industrialization, increased population mobility and are facing regulatory and environmental challenges (Castella 2012, Cook 2006, De Koninck 2004, Humphrey 2006, Nooteboom 2017). In this context, to improve rural livelihoods, the Lao government is compelling farmers to move to commercial agricultural production through a range of interrelated strategies (Ministry of Agriculture and Forestry 2015). International aid organisations are also assisting with the agrarian change being pursued by the Government of Laos (Cramb et al. 2015, Cramb 2020, Stür and Gray 2014, Vote et al. 2015, WB (World Bank) and IRRI (International Rice Research Institute) 2012).

Many smallholder farmer households in Lao PDR are shifting from traditional low-yield, subsistence-oriented activities towards diversified livelihood strategies (Alexander, Miller and Lipscombe 2010, Manivong 2014). ACIAR projects in southern Laos have assisted this process by introducing technologies and management innovations, building local capacity, developing extension personnel, collaborating with universities and supporting food security measures. New technologies and agricultural practices have been introduced, such as: drought-resilient rice and crop varieties; use of appropriate inputs (e.g. varieties, fertilizer, time of planting, etc.); direct seeding of rice to reduce the labour requirement for planting; weed management; efficient irrigated water use; and more appropriate dry-season irrigated crops. Cash crops such as maize and grain legumes (mung bean and/or soybean) have also been introduced to sites with reliable irrigation. Extension systems have been targeted to scale out knowledge-based technologies such as new rice varieties, and livestock and water management techniques. Projects have also been dedicated to developing effective and supportive agricultural policies for rice-based farming systems. Yet despite these positive scientific developments and support networks, smallholder farmers – *for reasons yet to be fully determined* – are not taking advantage of the opportunities and hence adoption rates are disappointingly low.

Several previous ACIAR projects have delivered 'robust' or 'proven' technologies, yet changes to farming systems have been beleaguered by a variety of factors often outside the direct remit and control of the project, such as seeking diversified livelihood strategies, off-farm income opportunities or acquiring remittances from family members to reinvest in the farm. To understand the realities and priorities of small-scale farmers in this context of agrarian change, research was conducted based on the following research questions:

RQ1. What influences smallholder adoption of proven technologies?

RQ2. How can stakeholder networks be engaged and mobilised to enable smallholder farmers to apply proven technologies?

Adoption of new technologies and innovation

In theory, adoption of technical innovations and interventions provide a mechanism for smallholder farmers to improve household livelihoods, food security and achieve farm productivity goals. Adoption of technical innovations is more likely if the use of inputs increases overall productivity for smallholder farmers without requiring excessive labour demands (Berkhout, Glover and Kuyvenhoven 2015). When farmers contemplate adoption of new technologies and management innovations their decision-making processes are influenced by many factors including; economics, politics, technology,

social tradition and the biological environment (Feder, Birner and Anderson 2011, Jobard 2010, Manivong, Cramb and Newby 2014, Srisopaporn et al. 2015). In a review of adoption by Australian researchers, Pannell et al. (2006) found that 'adoption' stemmed from a learning process where the farmer collects, integrates and evaluates new information in situations of uncertainty. At least for relatively simple innovations, a farmer's increased probability of making a good decision that will advance his/her goals occurs through improved knowledge, practice and experiences. Hence the adoption process is continuous, uncertain and repeatedly reviewed, as new information is encountered and circumstances change (Rogers 2003). Also, farmers learn and enhance their skills when applying the innovation in situ, with a range of responses to seasonal implementation, e.g., choices in timing, sequencing, intensity, scale. Stages of adoption by farmers have been described by Pannell et al. (2006) to involve: (i) awareness of the problem or opportunity, (ii) non-trial evaluation, (iii) trial evaluation, (iv) adoption, (v) review and modification and (vi) non-adoption or dis-adoption.

Pannell et al. (2006) suggest that in the Australian context - and from a farmer's perspective - relative advantage and trialability are the main characteristics that drive adoption of technologies or practices. Factors influencing the *relative advantage* include: (i) short term input costs, (ii) yields, (iii) output prices of the innovation or other activities that it affects, (iv) medium to long term profits, (v) impacts on other parts of the system, (vi) adjustment costs, (vii) impacts on the riskiness of production, (viii) system compatibility, (ix) complexity, (x) government policies, (xi) replacement activity costs, (xii) existing beliefs and values, (xiii) family lifestyle, (xiv) self-image and brand loyalty, (xv) environmental credibility, and (xvi) time scale. Factors influencing the trialability include (i) degree of divisibility, (ii) operability of results, (iii) time lag, (iv) complexity, (v) cost, (vi) threats to trial, e.g., droughts, diseases, pests, (vii) information applied to decision making, (viii) similarity in behaviour of innovation, (ix) spillover effects from neighbours, and (x) trial performance. In addition, Pannell et al. (2006) mention several key principles that influence adoption. Firstly, communication and education activities will not induce landholders to adopt practices and innovations unless the activities are seen as advancing the landholder's goals. Secondly, proposed innovations should be good for the environment and economically superior as replacement activities. Thirdly, cost-effective financial incentives may improve the relative 'attractiveness' of the desired practice.

International perspectives on factors influencing adoption of new or improved technologies and practices in the Mexican oil palm industry by Aguilar-Gallegos et al. (2015, 123) also emphasised the complex nature of adoption. They found that adoption was directly related to gains to farmers from higher yields and also information flows between farmers and various supporting institutions. In their research paper, technologies were defined as, "devices such as machines, and inputs such as fertilizers and pesticides, and practices concerning cultivation (planting weeding) and sale of produce (e.g., through traders, or direct sales on local markets) and buy inputs (e.g., from local stores, through contracts with agri-business)". Several ways of evaluating the uptake of technologies have been propounded. The traditional approach has been to view adoption from a technology-push perspective of 'good agriculture' and 'appropriate innovation' that has been adopted according to categories of 'innovators', 'early adopters', 'late adopters' and 'laggards'. Yet other adoption evaluations have been based according to resource endowments, styles of farming and rationales for adopting new or improved technologies and practices (Gilles et al. 2013, Leeuwis and Van den Ban 2004).

Adoption and dis-adoption may occur and arise with circumstance (Kiptot et al. 2007). Technologies or practices emanating from research or agribusiness can be considered as 'finished' or 'proven' innovations. These are readymade solutions, however, there is then a requirement that the use and integration by farmers within their farming systems prove valuable (Leeuwis and Van den Ban 2004). There may be a need for further adaptation to improve fit with the farming system or adjustment of the institutional context in which it will be embedded, or complemented by farmer-generated innovations (Douthwaite, Keatinge and Park 2001, Garb and Friedlander 2014, Millar and Connell 2009). The adoption of

technologies and practices that are not incremental and easy to fit within existing farming systems rely on changes to institutional frameworks such as rules, regulations, habits, values (Hounkonnou et al. 2012, Klerkx, Aarts and Leeuwis 2010) and requires changes beyond the farming system level, e.g., the supply value chain. For learning and innovation to occur, an understanding of the evolution of farmers' demand is required to flexibly match processes with various innovation support services to achieve 'best-fit', and an awareness of sometimes competing interests of actors (Kilelu, Klerkx and Leeuwis 2014).

To deal with the complexity of agricultural production and food security, Foran et al. (2014) reviewed several frameworks, one of which was the Agricultural Innovation Systems (AIS) framework, that focus on enhancing agricultural research and extension systems. The AIS framework contends with the capacities of individuals and organisations as they translate knowledge into useful social or economic activity in agriculture (Spielman, Ekboir and Davis 2009). AIS can be used to understand how agricultural growth is influenced by complex interactions between public, private, and civil society actors, in rapidly changing market and policy regimes (Spielman et al. 2009), and how institutional dynamics across a variety of levels influence agricultural development (Basu and Leeuwis 2012). AIS is concerned with development pathways and how an innovation platform can support actor-driven system innovation (Mapila, Kirsten and Meyer 2012, Spielman et al. 2011). Innovations system frameworks use various levels and scales of stakeholder engagement to identify and attempt to alleviate some of the broader structural constraints to local adoption of new knowledge. Engagement with stakeholders, such as farmers and other local actors (e.g., traders, business owners, brokers) will enable identification of local organisational, technical, and institutional opportunities and constraints. These collaborative networks drive more rapid social and economic innovations. AIS frameworks direct efforts into capturing and utilizing different types of knowledge to achieve common goals via an 'innovation platform'. Understanding institutional structures (e.g., from government policy through to local cultural norms) with involvement of stakeholders across institutional settings, highlights constraints and opportunities for change, as well as improving the relevance of research (Biggs 2007, Nederlof, Roling and Huis 2007). Structural changes to organisational policies, management systems and incentives may be required. Communication, participatory planning, facilitation of teamwork and learning-orientated evaluation, all fostering learning, are valuable tools.

In pursuit of its aim and objectives, this project used transdisciplinary methods based on the broader AIS framework to engage with stakeholders from past and present ACIAR projects and institutions involved in agricultural development in southern Laos. This engagement process enabled the project team to use transdisciplinary approaches to engage stakeholders within the AIS framework and mobilise findings from Research Question 1 to answer Research Question 2.

ACIAR Projects

ACIAR initiated four projects situated in Savannakhet and Champasak Provinces, operational from July 2014 and July 2015, to build on project findings from CSE/2009/004. These focused on livestock (AH/2012/068), water management and forage production (SMCN/2012/071 & SMCN/2012/075) and integrated farming (CSE/2014/086). ASEM/2012/081 focussed on glasshouse vegetable production and SMCN/2014/088 on market linkages and socio-economic issues. Using these projects as case studies, ASEM/2014/052 explored means to improve smallholder adoption of proven technologies and management innovations. Using the AIS framework and transdisciplinary approaches the project trialled strategies with concurrent projects *and* in selected CSE/2009/004 sites.

4 Objectives

The project aimed to improve adoption of proven technologies and management systems by smallholder farmers.

Objective 1: Identify the drivers and constraints affecting smallholder decision-making with respect to adoption of proven technologies.

1.1 Clarify farmer perceptions at household level of a range of factors relevant to recent ACIAR projects including: project buy-in factors; project implementation factors; individual farmer motivation factors; farmer lifestyle priority factors.

1.2a/1.2b Uncover tacit and explicit beliefs, decisions and actions that lead to "pinch points" where farmers must make "go/no go" decisions regarding uptake of proven innovations using Collective Behavioural Elicitation (CBE) workshops with selected stakeholders.

1.3 Identify the causal network and probabilities (Bayesian Networks) of social dynamics at village and district levels that affect farmer adoption decision-making.

1.4 Secondary data analysis of available livelihood data from other projects in villages exposed to proven innovations. In selected villages collect data and analyse livelihood data.

1.5 Clarify other stakeholders' expectations regarding agricultural change and their perceptions of barriers and opportunities for uptake of innovations. Stakeholders include: Ministry of Agriculture (MAF) in particular NAFRI and DAEC, National University of Laos, Department of Planning and Investment (DPI), District Governor, PAFO, DAFO, NGOs, other project personnel, farmers groups, private traders, organised markets, village organisations, and other relevant government departments.

1.6 Synthesise the results of the study into a coherent answer to RQ1 using appropriate systematic methodologies (e.g., Bayesian Network Analysis) for solutions.

1.7 Schedule of integrative meetings to establish an innovation platform.

Objective 2: Develop solution strategies/methods to improve use of proven innovations by farmers

2.1 Develop solutions (principles, frameworks and tools) to assist smallholder farmers decide whether or not to adopt innovations.

2.2 Pilot several solution strategies/methods to link research outcomes with the concurrent projects and monitor effects on farmer adoption and impact on productivity.

2.3 Wider implementation:

a) Identify the most effective solution pathways (e.g., mobilisation of relevant institutions including working in multi-disciplinary teams, researchers and other resources) that will enable out-scaling of strategies and methods deriving from 2.1 and 2.2.

b) Engage all relevant stakeholders in a meaningful and productive way throughout the project.

c) Social media strategy and web presence.

2.4 Evaluation of solution strategies.

2.5 Support for Project Charter Activities

2.6 Gender analysis of survey data

5 Methodology

Our project involved 3 Lao institutions, National Agriculture and Forestry Institute (NAFRI), the National University of Laos (NUoL) and the Department of Technical Extension and Agro-Processing (DTEAP) in Vientiane and also provincial government officers (P/DAFO). Various stakeholders involved with ACIAR research, supply chains and other experts were involved and sources of information. The research questions, objectives and research processes are presented in Figure 1

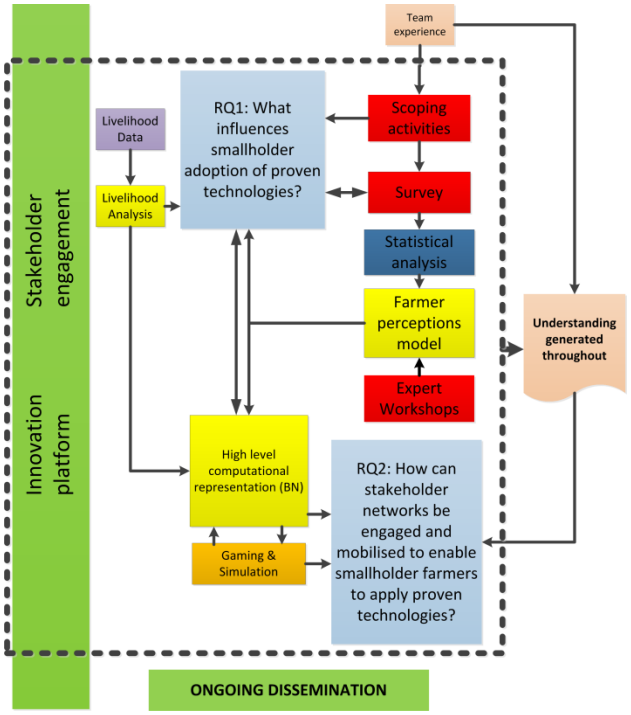

Figure 1: Research processes and activities

Project activities were conducted in Savannakhet and Champasak Provinces in major rainfed lowland rice ecosystems where the Lao government is targeting commercial agricultural production through a range of interrelated strategies (Ministry of Agriculture and Forestry 2015). In this region, international aid organisations are also assisting with agrarian production (Cramb et al. 2015, Cramb 2020, Stür and Gray 2014, Vote et al. 2015, WB (World Bank) and IRRI (International Rice Research Institute) 2012), to increase productivity and enhance rural development.

A Participatory Action Research (PAR) research strategy (Gonsalves et al. 2005) was employed to facilitate inclusive community-based, transdisciplinary research working in villages; with the involvement of Lao institutions and local organisations. Villages and farmers were purposively selected from locations frequented by ACIAR projects in the past and included villages in the four current ACIAR studies Figure 2 (Appendix 11.2). National Lao staff and local PAFO and DAFO assisted in the final selection of villages (Figure 2).

Ten villages in two districts (Champone and Outomphone) in Savannakhet Province and 10 villages in two districts (Photong and Soukhouma) in Champasak Province (Figure 2) were selected. Villages were located at varying elevation, with varying soil profiles, access to water supplies and presence/absence of irrigation channels supporting dry season crops. Accessibility to markets, access to banks or finance and areas where production of two crops per year is possible, were additional criteria. Note that the 'lowland' is made up of three topographies, available water usually from river/dams, irrigation production and dryland non-irrigation production at higher elevation. The purposive sample was finalised

through the input of senior Lao researchers and local government officials and ACIAR project details verified by ACIAR researchers.

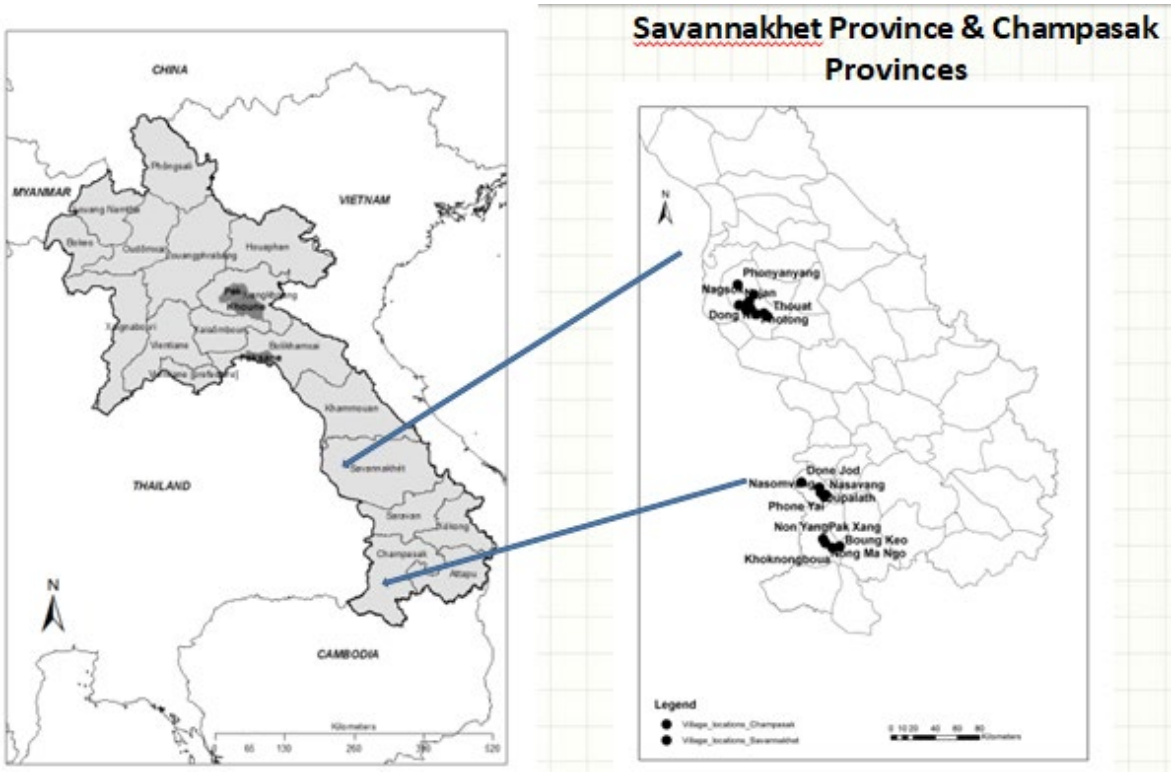

Figure 2: Selected villages in Savannakhet and Champasak Provinces

Villages in Savahnnakhet Province: Nanokkien, Sakheun Neau, Thouat, Photong, Alan Wattana, Nagasok, Najan, Dong Noi, Phonyanyang, Nakhilek

Villages in Champasak Province: Oupalath Done Jod, Nasomvang, Phone Yai, Nasavang, Boungkeo, Khoknongboua, None Yang, Pak Xang, Nong Ma Ngo

An exploration of farmer perceptions and agricultural decisions, community issues and economically viable agricultural activities was conducted. Perceptions of local agricultural institutions, private sector companies and government extension services were also conducted and used in the analysis to inform the development of 'solutions' to improve adoption.

The study included: a literature review (Larson and Alexander 2016), focus group discussions and interviews, (Alexander and Larson 2016, Alexander et al. 2016) farmer surveys (Alexander et al. 2019, Greenhalgh et al. 2017b), as well as the application of Q methodology (Alexander et al. 2018), serious gaming (Larson et al. 2020) and Bayesian Network analysis (Moglia et al. 2018). See Table 1 for a summary of research activities. An analysis of gendered roles in agrarian transition was also conducted on survey data by Moglia et al. (2020). The research team used a mixed-methods approach for synthesising qualitative and quantitative data. Reports and papers are publicly available on an online repository[1]. Qualitative and quantitative research was employed to establish a close understanding of farmer experiences and the criteria they use heuristically when faced with technology and management innovation adoption decisions. A transdisciplinary methodology (Greenhalgh et al. 2019) was used to improve the probability of identifying a comprehensive answer to the research questions and using an inclusive Agricultural Innovation System framework.

[1] https://sites.google.com/view/acrtechnologyadoption/project-reports

Table 1 Research activities in Savannakhet and Champasak Provinces

Research activity	***Respondents***	***Research aim***
Village Head interviews	40 interviews	Semi-structure interviews Provided qualitative data outlining key issues in each village.
Adoption factors ranking	83 rankings (45 male/38 female): including farmers, PAFO/DAFO, researchers, students & international scientists	33 questions ranked 0-10 in importance Quantitative data on stakeholders' perceptions of adoption issues. Informed BN & CBE activities
Farmer focus groups	20 male/20 female groups	~6 participants/group using a structured questionnaire Provided qualitative data for key gender issues, RDT & themes
Farmer survey and interviews	114 survey & interviews (66 male/48 female)	Open-ended questions 5-6 per village-Preferably participants involved in previous projects. Qualitative and quantitative data for key gender issues, RDT & themes. Provided explanatory qualitative material and village specific production details. Informed BN & CBE activities
Q methodology	~2 participants per village provided 35 farmers (19 male/16 female)	Used photographs in a ranking exercise to elicit qualitative data for RDT & themes and key gender issues. Informed BN & CBE activities
Farmer perception survey	745 e-voting (452 male/293 female)	Provided quantitative data Informed BN & CBE activities.
Stakeholder interviews:	19 interviews included: District Directors, District administrators, District extension staff, rice millers& a Lao research scientist	Semi-structured interviews of stakeholders to understand boundary issues and supply chain. Informed BN & CBE activities.
Bayesian Network (BN) model	The preliminary model was tested in a provincial workshop with local experts and stakeholders before finalising the BN model.	Synthesized village and local stakeholder information into one consistent framework of probabilistic logic. The BN model answered the initial research question. *"What influences smallholder adoption of proven technologies?"*
Collective Behaviour Elicitation (CBE) activities	4 villages in one district, groups of 10 participants: 40 men/ 39 women & players representing traders and extension workers	Uncovered tacit and explicit beliefs, decisions, and actions that lead to "*pinch points*" where farmers must make "*go/no-go*" decisions regarding uptake of new technologies.
Socio-economic literature review	Economic impacts and outcomes of agricultural projects operating in southern Lao PDR. Informed development of surveys, focus group questions, interview questions and used to develop Bayesian Network (BN) model and underpinned CBE activities	

Part 1: Factors influencing adoption

To complete the selection of stakeholders, informants, villages and farmers to be included in the project, a scoping exercise took place in southern Laos, before the main research activities. The first part of the research strategy was to interview and survey stakeholders and statistically quantify results, and analyse data using a range of techniques. Qualitative data collection activities included: individual interviews and focus groups with stakeholders (farmers, researchers, extension officers). Qualitative data were used to inform subsequent research activities. Several complementary approaches were used to investigate farmer decision-making (see Table1):

1. Farmer perception survey with statistical analysis - A comprehensive farmer perception survey was conducted covering as many pertinent issues as practical to supplement data from qualitative research and for further analysis and inclusion in participatory modelling exercises. The project survey was designed to identify the full range of factors involved in the propensity of a smallholder farmer to adopt new technologies. A novel electronic voting system was used to collect responses.

2. Livelihood analysis - Livelihoods are a function of multiple inputs including; human capital (labour, education), social and cultural capital, physical capital, natural capital (e.g., soil type, rain), infrastructure and institutions. Household data and project information collected by the previous ACIAR projects were reviewed. This activity was used to inform the development of participatory models (CBE and BN).

3. Collective Behavioural Elicitation (CBE) - Long-term adoption and large-scale diffusion depend upon a complex and context-dependent web of interactions: (a) technology with extension services, (b) technology with farmers and (c) extension services with farmers. Serious gaming (CBE) was used to examine farmers' beliefs, decisions and actions when participating is a realistic agricultural production game. The gaming process revealed both explicit and tacit factors were involved when farmers made production decisions. The game was also designed for use by another ACIAR research project: SMCN/2012/075 (Philp 2020) for use in Southern Laos and Cambodia.

4. Bayesian Network (BN) analysis –The Bayesian Network (BN) methodology synthesized findings from the concurrent multi-disciplinary research activities. BN causal diagrams depicted many factors that impacted on the chances of a smallholder farmer adopting a proposed change to farming practice and consolidated a greater understanding of farmer decision-making. The model synthesized information and judgments from interviews and workshops for more informed and comprehensive outputs as well as subsuming quantitative data from the survey.

Figure 2 depicts the research methods and processes for this project. Figure 2 indicates Research activities with partners throughout the project.

Part 2: Designing and trialling solution strategies

Findings from Part 1 were used to develop, monitor and evaluate 'solution' strategies to improve the likelihood of farmers adopting agricultural innovations. Solution strategies (principles, frameworks and tools) to enhance adoption involve engagement of many stakeholders (farmers, private sector, government agencies, and researchers) so that various supporting conditions are in place to maximize the likelihood and ability of farmers to adopt research results. In turn, this will improve livelihoods (income, food security, etc.) of farmers and their families. By assisting researchers and extension agents to develop more relevant technologies and extension strategies, this enhances the likelihood of smallholder farmers adopting proven technologies.

Figure 3 depicts project processes and qualitative and quantitative activities used as a multi-perspective mapping of the Agricultural Research Value Chain (Alexander et al. 2019) with outcomes, the Research Discussion Tool (Appendix 11.2) (Greenhalgh et al. 2018) and 9 Solution Space themes arising from the Solution Space Workshop (Greenhalgh et al. 2019).

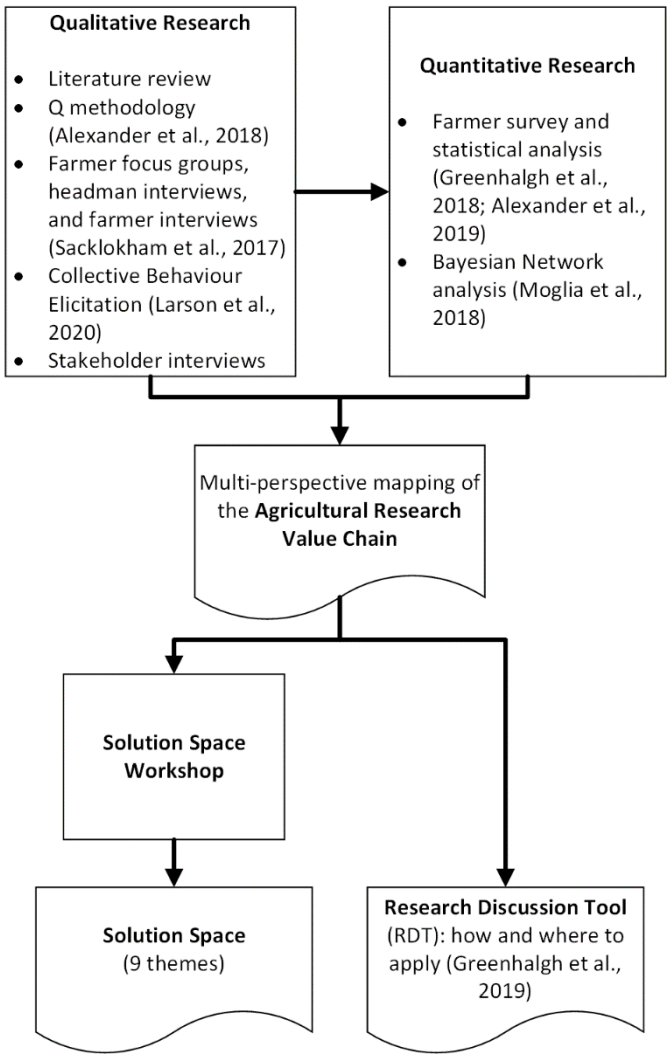

Figure 3: Activities from Part1 and Part 2 (Greenhalgh et al. 2019)

The Research Discussion Tool

The Research Discussion Tool (RDT) consists of 78 factors that came directly from the field research designed to answer RQ1 "What influences smallholder adoption of proven technologies?"(Appendix 11.2) (Greenhalgh et al. 2018). As a farmer's decision to adopt (or not adopt) is technology-dependent, the RDT presents a wide range of factors that may or may not be involved in a farmer's decision to adopt a technology. Hence the application of the RDT is at the village level, used as a guideline to prompt discussions between researchers, government officials, extension experts, farmers and other stakeholders if necessary. The tool was envisaged to be useful in selecting villages appropriate for technology introduction through quality discussions and incorporating local knowledge.

Solution Strategies

In the Solution Workshop in 2017 (Greenhalgh and Alexander 2017) 'solutions'[2] were synthesised from the research outputs (Part1) and strategies were co-developed with Lao

[2] *Note that in agricultural research literature, Reece, D. & J. Sumberg (2003) More clients, less resources: toward a new conceptual framework for agricultural research in marginal areas. Technovation, 23, 409-421. and Reece, J. D., J. Sumberg & L. Pommier (2004) Matching Technologies with Potential End Users: A Knowledge Engineering Approach for Agricultural Research Management. Journal of Agricultural Economics, 55, 557-573. have previously referred to the use of solution spaces.*

national staff and deployed in current ACIAR projects (ASEM/2012/081; SMCN/2012/071; SMCN/2012/075; SCMN/2014/088) and in sites associated with the project. Several solution strategies were operationalised in the form of a 'Project Charter'[3] by Australian and Lao teams (Appendix 11.3; Figure 4).

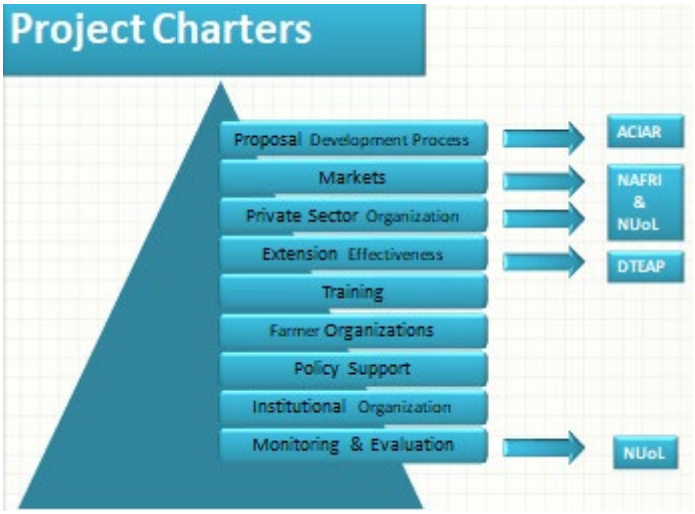

Figure 4: Use of the 9 themes to develop Project Charters by Lao institutions

Monitoring, Evaluation and Learning

Monitoring, Evaluation and Learning (MEL) activities were developed in a workshop in 2018 based on a 'Theory of Change' model deriving from the research aims, objectives and context (van Es, Guijt and Vogel 2015)(see Figure 5). Lao colleagues were trained and contributed collaboratively to the design of the MEL approaches using the emerging Theory of Change / Contribution Analysis (TOC/CA) methods and tools, in line with Owen's Five Forms of Evaluation (accent on understanding the 'what' and the 'why' of an evaluation). Activities encouraged capacity building, increased 'buy-in' and embedded M&E practices within our partner institutions. Comprehensive training was undertaken and Lao partners had hands-on practice in the use of TOC/CA methods and tools[4].

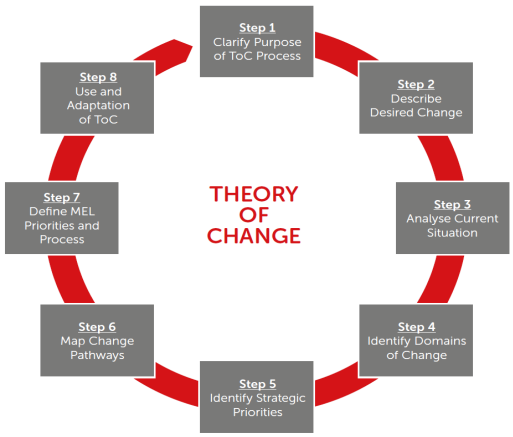

Figure 5: Monitoring, Evaluation and Learning based on the Theory of Change (van Es et al. 2015)

[3] https://sites.google.com/view/acrtechnologyadoption/project-reports

[4] https://sites.google.com/view/acrtechnologyadoption/project-reports

6 Achievements against activities and outputs/milestones

Objective 1: Identify the drivers and constraints affecting smallholder decision-making with respect to adoption of proven technologies

No.	Activity	Outputs/ milestones	Due date of output/ m'stone	Comments
	Scoping study: identification of sites, pilot questionnaires, advisory group contacted	Research activity planning – sites, staff, logistics etc. - Inform development of Farmer Perception Survey - Advisory group provisional list	Dec 2015 (Part H)	Milestones for this activity were adequately met and carried out in consultation and partnership with the Lao partners These outputs were used for: (a) Detailed planning for data collection in Feb 2016. (b) Provided background data (c) Advisory group to comment on work and also are potential end-users of improved practices
1.1	**Farmer Perception Survey** Clarify farmer perceptions at household level of a range of factors relevant to recent ACIAR projects including project buy-in factors; project implementation factors; individual farmer motivation factors; farmer lifestyle priority factors	Fieldwork data collection completed Validation of factors in the model of farmer perceptions. Construction of model	May 2016 Y1 June 2016	Informed subsequent methods including computer gaming (CBE, CSE and BN). Scientific impacts resulting from the answer to RQ1 & analysis informed Objective 2. Field data reports were used by the research team for analysis in Laos and Australia (Greenhalgh et al. 2017b)
1.2a	**Collective Behaviour elicitation (CBE)** Uncover tacit & explicit beliefs, decisions & actions that lead to "pinch points" where farmers must make "go/no go" decisions regarding uptake of proven innovations.	Five interactive tacit knowledge elicitation workshops completed	August 2016 Y1	Interactive workshops were used to elicit tacit drivers associated with farmers' adoption processes. Three to four hypotheses were tested in each workshop. Test results directly informed research activities in Objective 2.
1.2b	**Collective Behaviour Elicitation (CBE) Forages**	5 interactive workshops	Feb 2018 Y3	These workshops illustrated to partners the factors that influence adoption. Will be used during the capacity building stage.
1.3	**Bayesian Network Analysis (stage 1)** Identify causal networks & probabilities (BN) of social dynamics at village and district levels that affect farmer adoption decision-making.	Documentation of the BN model with assumptions & quantification.	August 2016 Y1	Use of model in engagement, strategies & activities.

No.	Activity	Outputs/ milestones	Due date of output/ m'stone	Comments
1.4	**Livelihood data** Secondary data (other projects) and primary data collection in selected villages	Secondary data from villages (other projects) exposed to proven intervention collated Primary data collection in the selected villages	Feb 2016 Y1 Feb 2016	Collected livelihood data provided contextual information for outputs of Objective 1 Provided inputs to Gaming (CBE) and BN modelling
1.5	**Stakeholders* perceptions** Clarify other stakeholders'* perceptions of agricultural change, & barriers & opportunities for adoption of innovations	Report of stakeholder perceptions collected, & interpreted highlighting issues affecting adoption and stakeholder roles	Aug 2016 Y1	This was a significant research undertaking providing rich qualitative information. Qualitative data used to inform the CBE and BN modelling for RQ1 and analysis informed Objective 2. The use of novel research methods, e-voting and Q-methods demonstrated a successful approach to capacity building. Lao researchers and young students as well as sub-national staff applied the newly gained methods in 10 villages with different socio-economic and environment and successfully conducted research activities in Champasak Province without the guidance of the international team.
1.6	**Synthesise results of all studies** into a coherent answer to RQ1 using appropriate systematic methodologies (BN) for solutions	Consolidated & integrated explanation of farmer decision-making & implications for adoption of innovations	Mar 2017 Y2	An important innovation in this project was the experience Dr Garry Greenhalgh brought from international business consulting. He conducted the workshop using change management and organisational management techniques and frameworks. Solution strategies for improved uptake by farmers of innovations involved in concurrent projects, CSE/2009/004 sites, & future projects. The Solution Space approach was an effective method to engage and enable diverse workgroups to collaborate, identify priorities, and take responsibility and ownership in a complex context.
1.7	**Schedule of integrative meetings**	Biannual and annual project meetings including current ACIAR project personnel and ASEM/052 researchers	June 2016 Y1 Jan 2017 June 2017 Y2 Jan 2018 June 2018 Y3 Jan 2019 June 2019 Y4 September 2019 March 2020	The meetings, workshops and collaborative activities enabled ongoing contact and information for current ACIAR projects and a point of communication for future projects when in the research design phase. Team integrative meetings and collaboration was a very positive aspect of this project

Objective 2: To develop solution strategies/methods to improve use of proven innovations by farmers

No.	Activity	Outputs/ Milestones	Due date of output/m'stone	Comments
2.1	**Solution spaces:** Develop solutions (principles, frameworks & tools) to assist smallholder farmers decide whether or not to adopt innovations	Workshops for farmers, DAFOS, PAFOS, DAEC & researchers generate 'draft solution spaces'.	December 2016 Y1	Solution spaces identified key factors affecting adoption outcomes and interest in proven technologies. With major barriers and constraints determined, solutions were used for further dialogues on ways to improve adoption rates. The solution space was the product of the workshop which identified key factors as well as barriers and constraints affecting adoption outcomes and interest in proven technologies. The research development tools were tested and used not only by the project partners but also by other concurrent ACIAR projects e.g. ASEM/2012/081. This was a very positive outcome of the project and contributed to sustainable improvements in the capacity of project participants. See Greenhalgh and Alexander (2017)
		Policy workshop to comment on draft solution spaces conducted	December 2016 Y1	Discussions were held with Lao partners. While the solutions comply with Lao government policy, it is still imperative that these results are appropriately shared.
		Refined solution spaces documented	Mar 2017 Y2	Refined solution spaces used to enable specific pathways for action to assist adoption in partner projects in Part 2 of the project. See Alexander, Greenhalgh and Larson (2017b)
		Workshop Pathways for enabling solutions for improved adoption established and agreed	Not undertaken	The workshop was envisaged to provide the basis for engagement and planning with partner projects in Part 2. Instead, Engagement and planning with partner projects in Part 2 were achieved within the country. (Greenhalgh 2017, Greenhalgh et al. 2017a)

No.	Activity	Outputs/ Milestones	Due date of output/m'stone	Comments
2.2	**Pilot solution strategies/methods** Pilot several solution strategies/methods to link research outcomes with the concurrent projects and monitor effects on farmer adoption and impact on productivity. (See suggested M&E activities below table)	Set of Project Charters and action plans with interested partner projects for the application of practices to improve adoption.	March 2017 Y2	The action plans formed the basis for development of support strategies to be provided by the project. A positive achievement of the project was testing and implementing research results in the field with project partners and concurrent ACIAR projects in the following areas: Projects included: • ASEM/2012/081 • SMCN/2012/071 • SMCN/2012/075 • SCMN/2014/088 (1) Field sites in Savannakhet were selected from AH/2012/068 & CSE/2014/086 (2) Field sites in Champasak selected from ((SMCN/2012/071 & SMCN/2012/075) (3) Field sites in Vientiane Province (ASEM/2012/081) chosen and Saravan (SMCN/2012/075). See Alexander et al. (2019) Alexander et al. (2017b); (Greenhalgh et al. 2019, Greenhalgh 2017, Greenhalgh and Alexander 2017)

No.	Activity	Outputs/ Milestones	Due date of output/m'stone	Comments
		Support interventions provided to (a) support current ACIAR projects in enhancing the uptake of innovations; (b) trial several strategies in CSE/2009/004 sites, and other projects as interested	Nov 2017 to March 2020 Y2-Y5	Improvement in the chances of farmers adopting innovations. Community impacts (as specified in 1.3 above). A report on the efficacy of the RDT tool has been prepared (Greenhalgh et al. 2019, Greenhalgh et al. 2018) This was a positive achievement of the project. The project partners used their acquired knowledge and skills to develop Project Charters based on the 9 thematic areas identified in the Solution Space e.g. • DTEAP: Project Charter "Extension Effectiveness" and Monitoring, Evaluation and Learning (MEL) NAFRI: Project Charter "Dry season cropping" and MEL • NUoL: Project Charter "Social Media"-Facebook page and (MEL) activities. • NUoL are now responsible for several "Dry season cropping exercises for completion in May 2020 While these Project charters are a positive step forward, there are further steps to take to ensure a complexity-sensitive approach.
2.3a	Identify the most effective solution pathways (e.g., mobilisation of relevant institutions, researchers and other resources including working in multi-disciplinary teams) that will enable out-scaling of strategies and methods deriving from 2.1 and 2.2.	Application of BN with stakeholders* Potential solution strategies & pathways & action plans for implementation	Nov 2017 Y2 March 2018-May 2018	Enhanced capacity to modify existing projects to improve chances of farmers adopting innovations Adoption pathways identified and action plans developed as 'Solutions' Capacity building impacts, further scientific & community impacts (Moglia, Alexander and Connell 2016, Moglia et al. 2018) Gaming exercises with SCMN/2012/075, conducted in March 2018 and a subsequent training session funded by Crawford Fund in May 2018. Conducted forage games in Cambodia in November 2019 (Philp 2020)

No.	Activity	Outputs/ Milestones	Due date of output/m'stone	Comments
2.3b	**Engage all relevant stakeholders** in a meaningful and productive way throughout the project.	Stakeholder engagement plan & communication strategy (SECS) developed. Ongoing reporting and evaluations Dissemination materials for the solution tools developed in a format suitable for the end users/ beneficiaries. Beneficiaries trained in the use of the solution tools.	May 2020 Ongoing	The project team have outlined an impressive array of publications, conference papers and reports. Increased awareness & the capacity of stakeholders & farmers engaged. Stakeholder engagement processes & methods template developed as one of the tools for increased project participation & adoption. Tools used by future projects & resulting in increased adoptions and benefits. Alexander et al. (2017c) Alexander et al. (2018) Alexander et al. (2019) (Greenhalgh et al. 2019) 34 reports have been prepared covering objectives, project activities and milestones 6 conference abstracts have been presented 7 journal papers published Solution tools manual has been completed Emails with project details regularly posted to stakeholders
2.3c	Social media strategy and web presence	Established web page and active social media on NUoL website	2018-20	Ongoing stakeholder engagement processes. (1) ASEM/2014/052 details available at https://sites.google.com/view/actechnologyadoption/home (2) The NUoL launched the Agricultural Extension Facebook Page at www.facebook.com/kasetnabong Celine Dillman attended the Scrollytelling workshop in Milan, Italy in June 2018. Using data from the Forages Gaming exercises, she constructed a visual story of Gaming exercises conducted with SCMN/2012/075. Options considered to explore sustainable upkeep of the website, and to connect the website to the ACIAR online document repository. Ensuring the longevity of this information is crucial for ongoing impact for projects and to ensure that subsequent projects build on this experience.

No.	Activity	Outputs/ Milestones	Due date of output/m'stone	Comments
2.4	**Evaluation of implementation solution strategies**	M&E process designed "Theories of Change"- the latest M&E used in the development setting	May 2017-May 2020	Comprehensive documentation of the Project Charters and MEL processes are available. The approach has been highly successful in engaging partners. Capacity building of agencies to use agreed indices and collect data for M&E. M&E processes provide partner agencies with a management tool to apply in an ongoing manner.
		Review of M&E process co-designed and implemented by NUoL	May 2020	M&E reports useful activities and ongoing uptake.
		Evaluation of stakeholder engagement and pathways of adoption by NUoL	Dec 2018-May 2020	Verification of adoption impact and support for further application of improved procedures. Theory of Change approach has underpinned the MEL and final project evaluation.
		Review of changes in farmer practices and productivity (adoption of research outputs) by NUOL	Dec 2018-May 2020	Verification of adoption impact and support for further application of improved procedures. Additional supply chain activities implemented
2.5	**Support for Project Charter Activities**	Workshops, facilitated discussions, supply chain observations. Co-planning for Project Charter activities Operational advice and assistance	Jan 2018-May 2020	Verification of approaches to dealing with barriers to the adoption of new technologies Workshops conducted in April 2018, December 2018 and May 2019 in Vientiane to review Project Charter activities and update MEL plans. Reports on activities received from Lao colleagues and recommendations made where necessary – up to June 2019. Project extension to June 2020 to continue supply chain activities and support the second year of peanut production
2.6	**Gender analysis of survey data**	Collected dataset re-analysed to explore gender differences in responses	March 2020-June 2020	Gender differences explored through publications Moglia et al. (2020) (Larson et al. 2020)

7 Key results and discussion

7.1 Key results

Objective 1: Identify the drivers and constraints affecting smallholder decision-making with respect to adoption of proven technologies

General findings

Lao PDR is following general agrarian trends in South East Asia towards intensified production, territorial expansion of large actors, market integration, including urbanization of the population, escalating industrialization, increased population mobility and facing regulatory and environmental changes (Larson and Alexander 2016). Lao farmers are caught up in, and contributing to, this much larger regional process of agrarian transition. Despite being a low-income, agriculturally-based country with a subsistence orientation, Laos is in the early stages of a major economic transformation. Rural households have been experiencing rapid change in their farming and livelihood systems. Importantly, as the agrarian transition proceeds and households are transformed from their initial subsistence orientation, they are not all transformed in the same way or at the same pace. Households have different capabilities and thus adopt different livelihood strategies, giving rise to a diversity of farm-household types. The Lao government has set ambitious agricultural policy targets for expanded production of various agriculture products: rice, other annual and perennial commodity crops, and livestock. While the Lao Government forecasts substantial increases in rice production in the southern plains, farmers will require specialised and tailored support, accounting for their envisaged livelihood and production goals, to allow the sector transformation that many stakeholders currently envisage (Larson and Alexander 2016).

In this research project we undertook a transdisciplinary approach to determine the key influences on technology adoption. Research activities (Table 1) generated sufficient data to identify the drivers, enablers, motivators and constraints that influence farmers' production decisions when contemplating adoption of new technologies. Our key findings are illustrated in Figure 6, depicting the introduction of new technology within the processes of a research project and agricultural research value chain (Alexander et al. 2019). The diagram indicates the factors that farmers contemplate during the decision to take up a new (unspecified in this case) technology introduced by a research project.

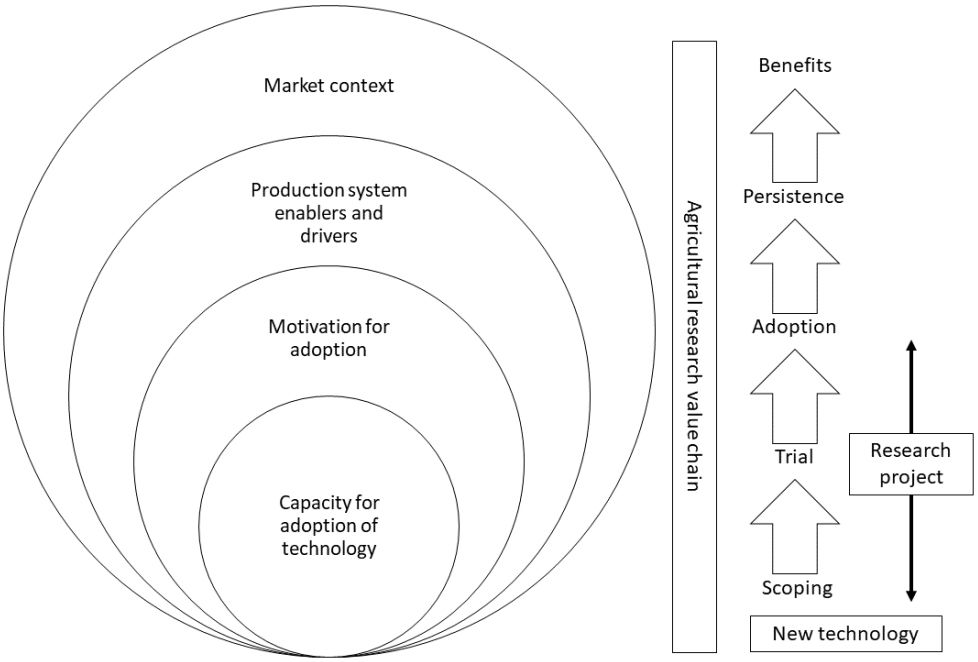

Figure 6: Conceptual diagram of influences on farmers' decisions

Note: Farmers continually evaluate the usefulness of technology and suitability for their production system and while they do adopt technologies, dis-adoption and/or partial adoption can occur over time.

When reflecting on new technologies, the farmer may contemplate his/her capacity and motivation, and assess their production system. Enablers and drivers that may facilitate adoption are also considered, as is the market context into which the product will be sold. Farmers' behaviours are more influenced by the 'agricultural research value chain' associated with the technology, rather than the technology itself. In more detail, Alexander et al. (2019) illustrate the key attributes of the farmer found to be important to production decisions and that their production goals are heavily dependent on the opportunities or constraints of the local 'agricultural research value chain'. For example, the factors found to influence farmers' propensity to adopt technologies included:(1) being proactive, (2) in need of support, (3) focus on production outcomes, (4) ease of selling produce, (5) trying to generate off-farm income, (6) competitive milling market (rice), (7) labour constraints, (8) risk avoidance and (9) access to storage and transport. The sustained use and value of the technology were also relevant. Alexander et al. (2019) concluded that research activities should be geared towards farmers who are proactive and responsive to incentives as these farmers are also more likely to persist with the technology and to report benefits.

Several different methodologies involving qualitative and quantitative research were used to triangulate findings and saturate our understanding of the factors influencing the adoption of new technologies. For example, Moglia et al. (2018) developed a Bayesian Network model describing factors impacting on the chances of Lao smallholder farmers adopting a proposed change to farming practice, providing important information on the factors acting as bottlenecks and thereby reducing the chances of adoption. We found that a farmer's ability to change production was highly dependent on the farmer's individual views and the technology in question (Moglia et al. 2016). The model provided an opportunity to engage experts and other stakeholders in discussions about their assessment of the technology adoption process, and the opportunities, bottlenecks, barriers and constraints faced by smallholder farmers when considering whether to adopt a technology (Moglia et al. 2018). This process provided a situation to co-construct knowledge amongst stakeholders and to tailor support as required by the farmers seeking to diversify production, often only about 25% of farmers (Alexander et al. 2019).

Alexander et al. (2017a) maintained that access to market opportunities continues to be a key motivation with farmers' showing a greater and more sustained interest in innovation when increased production assures financial returns for farmers. Consequently, farmers can be supported to achieve their production goals with agricultural systems support in place, based on their situational requirements and livelihood aspirations.

Q methodology allows for perspectives on a given issue to be grouped into typologies, representing different frameworks within which decisions and attitudes towards that subject are typically formulated (Browne et al. 2008, Stainton-Rogers 1995). Q captures 'the way a particular individual, in particular circumstances and at a particular time, relates to, and forms conceptions of, certain aspects of the world' (Barry and Proops 1999) (p338). Upon interpretation, these shared subjectivities have the structure and form of a discourse or shared narrative (Brown 1986). Q methodology techniques were used by Alexander et al. (2018) to explore 35 farmers' viewpoints when contemplating their production goals and potential to adopt technologies to improve productivity. Two farmer viewpoints 'labour saving productivity maximisation' and 'traditional labour productivity using improved techniques' describe the different issues guiding production decisions. The two narratives, constructs of different approaches to labour productivity, are akin to the 'mental models' discussed by Jones et al. (2011). Q methodology indicated that farmers assess their productivity and lifestyle goals and weigh up benefits and possible negative outcomes when assessing the potential of new technologies.

We also used a serious game approach to explore male and female farmers' decision-making processes when contemplating the adoption of new farming technologies and practices (Larson et al. 2020). The serious game was designed to explore adoption behaviours influencing decisions on transitioning from growing glutinous ('sticky') rice, a traditional variety of rice preferred for consumption by the Lao people, to growing 'white' rice (Hom Savanh variety) for commercial export to international markets. We found that women more readily adopted new varieties than did men in the game situation where their access to resources, both assets and information, was equal for all players. The approach allowed us to explore complex interplays and elicit specific behaviours. The game also resulted in a mind shift of local agricultural officers from an emphasis on 'technology' to a better understanding of potential users, their needs and motivations.

The Research Discussion Tool

While Figure 6 is an overall synthesis of research results, initial results from qualitative and quantitative research activities were synthesised into discussion guidelines for researchers/technical officers in the form of a Research Discussion Tool - incorporating 78 factors with a traffic light action system for use by project personnel and local government officials to elicit local knowledge Appendix 2. The co-constructed RDT (adoption drivers/motivators, enablers, opportunities, barriers etc.), was envisaged as a platform for discussions between stakeholders to gain a common understanding of the technology and then to select suitable villages to introduce a specific technology. Subsequently, the efficacy of the RDT was established through collaboration with several concurrent agricultural technology projects (Greenhalgh et al. 2018). Immediate uses of the RDT were deduced by team members for: (a) selection of villages; (b) review of previously selected villages; and (c) guidelines for monitoring and evaluation (MEL) activities. Also, it was envisaged that the tool would be useful in the project proposal stage to identify the significant factors for project-specific technology. The tool would also be suitable as an adapted planning and management tool. Finally, it was foreseen that the tool could identify lessons learnt at the close of the project.

Note that the RDT is designed to prompt discussions between researchers, government staff, men, women and young farmers and people involved in the supply chain. The tool is to be used when a new technology is introduced. The tool is constructed for a specific technology by the project teams through discussions of what is important from the list of 78 factors for that technology (Annex 2). While gender issues, the role and implications for

women when using an introduced technology are not explicit, the discussions prompted by the RDT guide (Annex 2) allows for voices, opinions and implications to be aired.

Figure 7 depicts the influencing factors within the RDT that farmers may consider, depending on the introduced technology (Alexander et al. 2019).

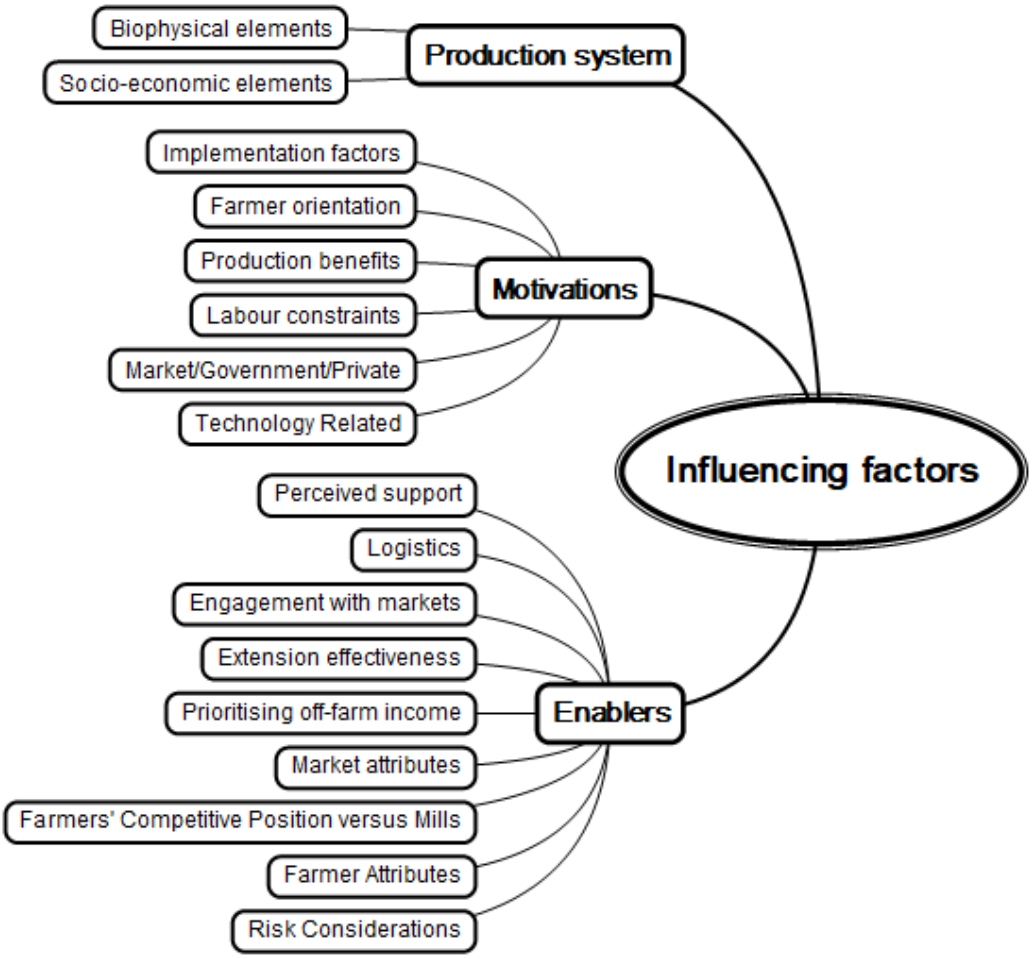

Figure 7: The initial set of factors within the farmers' production system, farmers' decision drivers/motivators and farmers' decision enablers that influence technology uptake

The following provides an example of 32 RDT factors for direct seeding technology. The subset could be further tested through facilitated workshop activities to determine the quintessential components important to the introduction and uptake of direct seeding technology:

- **Biophysical elements:** Suitable land, Soil, Water, Rice varieties/availability, Plant/livestock, disease, Pesticide, Vaccination, Fencing, Fertiliser, Weeds.
- **Socio-economic elements**: Farmer mindset, Production/social calendar, Cost of technology, Price of labour, Farmers' technical capacity, New technology – required training, inputs etc., Land ownership, PAFO/DAFO extension activities.
- **Research Project Implementation**: Solves the main problem; Guiding coalition ready (e.g. village support); Outcomes understood; Help available if needed (e.g. village/external); Trialable - the technology can be trialled before commitment.
- **Farmers' Orientations:** Size of benefit (profit); Quick wins (seasonal); Labour requirements; Time/labour availability; How different to what I do now?; Adoption

behaviour (when/what/how long); Trust (in the technology); Attitude to the risk of failure; Level of trust in perceived benefit.

- **Production Benefits**: Reduced input costs (e.g. reduced labour); Crop productivity; Ease/convenience.
- **Community Attributes:** Traditions; Social influence; What does my neighbour do?
- **Labour Constraints:** Perceived cost of change (e.g. additional labour).
- **Market/Government/Private:** Market access; Fit with government policy; Public/private support.
- **Technology Related:** Access to new technology, Affordability of new technology, Reputation of technology, Interest in new technology.
- **Perceived Support**: Technical support; First adopters; Clear expectations.
- **Engagement with Markets**: Improving livestock; Multiple rice buyers; Fair prices for rice.
- **Extension Effectiveness**: Interaction with DAFOs; Skills; Regular visits to the village by DAFOs.
- **Logistics**: On-farm/local storage, Multiple transport providers.
- **Market Attributes**: Easy to sell, Commodity prices (down or up), Global rice competition (access to markets), Traders (number and relationships), Farmer groups (effectiveness), Trader/farmer agreements.
- **Farmers' Competitive Position versus Mills**: Multiple mills, Local market prices for rice.
- **Farmer Attributes**: Trust, Labour, Fairness, Farmer co-operation, Skills/knowledge, Complex technology – training required, Impact on the seasonal calendar, Maintenance/repair of machinery.
- **Risk Considerations:** Size of risk-small?

It was noted that the relative importance of each factor in the above list is dependent on the specific technology being introduced and the local context for the farmer. The large number of interacting factors implicated in technology uptake explains in part why many technical projects do not achieve their expected rates of adoption. An important conclusion is that numerous factors need to be addressed for a given technology to be adopted on a broad scale. Researchers are not normally in a position to address all these factors and initially, projects may not be in a position to recognize more than a few important drivers/motivators and enablers. We argue it is effective to create a solution space that allows flexibility in determining the next set of actions for planned change.

Solution Space

A 'Solution Space' is a process based on change management models and tools shown to influence the practice of change leadership and assist in planned change for complex organisations (Beckhard and Harris 1987). These tools and methods allow multiple perspectives to be heard, enabling a diverse number of opinions to be aired and sensitive or mutually exclusive views to be discussed by group members. This serves to remove blind spots, and critically evaluate assumptions on which the success of technology relies. In the 'Solution Space', discussions were supported by our concurrent situational, contextual research findings, covering all the key factors that have been identified through our research. All workshop material and discussions were conducted primarily in Lao language and occasionally through interpreters; with all presentations in Lao script. Hence, a significant two-way transfer of knowledge was achieved. Importantly, this approach allowed junior through to senior staff to contribute in meaningful ways to discussions. This was important as many provincial and district staff attended the workshop and had an opportunity to share their local knowledge. Facilitation methods enabled a trusting environment to be established; one within which the voices of junior staff and the relatively powerless (lower ranked staff, female staff etc.) to be heard whilst also allowing authority figures to finalize decisions. A crucial consideration is the

hierarchical nature of the governance systems and leadership within Lao PDR (Case, Connell and Jones 2017, Case and Śliwa 2020). The outcome 'Solutions' are a combination of strategic/institutional, economic/social/political and operational/local actions to be formulated and implemented within various timeframes. Importantly, this approach generates a high level of ownership of 'solution/s' by those who will have to implement change.

Solution Space workshop

We held a workshop to collaboratively reflect on the key influences on technology adoption and to determine how to engage stakeholder networks to assist farmers to apply introduced technologies. The Solution Space workshop held in December 2016 was designed to review key research results and formulate a comprehensive solution to enhance technology adoption in rice-based agricultural systems in southern Lao PDR. The workshop was designed around the principles and practices of change management (Beckhard and Harris 1987, Greenhalgh and Alexander 2017). During the 3-day workshop, all possible 'solutions' or parts of 'solutions' that could be implemented to address the main areas of concern that arose from the factor synthesis were discussed. Initially, the conceptual diagrams were presented to Lao colleagues and provincial stakeholders and during the workshop, a comprehensive set of decision drivers/motivators and decision enablers for a 'generalised technology' were formulated and termed the Research Discussion Tool (RDT). Details are available in the report by Greenhalgh and Alexander (2017) and Greenhalgh et al. (2019). Also, a set of 9 areas representing a higher abstraction of the synthesis was achieved in break-out group activities, confirmed by consensus workshop activities. The workshop outcome designated the 'Solution Space' was formulated and is represented by the RDT and the 9 themed areas. The broad nature of the 9 solution areas and 78 factors within the RDT tool suggests that the 'Solution Space' is comprehensive and can be adapted for use with other technologies, regions and countries with relatively minor modification.

Objective 2: To develop solution strategies/methods to improve use of proven innovations by farmers

A second outcome of the Solution Space Workshop was the articulation of 9 thematic areas. These 9 'focus' areas all have the potential to influence the adoption of new technologies. These areas are abstracted factors arising from the RDT, the implications of these factors and additional areas that impact adoption. The 9 thematic areas were developed through extensive deliberation within the workshop process and were finalized to include: (1) Proposal process, (2) Markets, (3) Private sector, (4) Extension effectiveness, (5) Training, (6) Farmer organisations, (7) Policy support, (8) Institutional organisation and (9) Monitoring and evaluation.

Three areas that impact technology adoption and do not directly affect farmers were included in the thematic areas: (1) Proposal process, (7) Policy support (government) and (8) Institutional organisation (intercollegiate practices). To operationalise the 9 thematic areas, Lao partner organisations were asked to select an area of concern in which they would undertake research activities. Nominally, these **'Project Charters'** were established to outline research activities that our Lao partners from 3 national institutions would address for our overall project to have an impact at the high thematic level and to further assess adoption potentials.

Our partnership model required Lao colleagues to decide their priorities in addressing the 9 areas including:

1) **Proposal development process**: The research proposal is an essential starting point for improving farmer adoption rates of new technologies. Many of the issues that arise in the field could be eliminated or heavily mitigated through a gentle modification of the proposal development process. For example, a well-planned

and extended scoping exercise designed to answer all the relevant questions about the research project (using the RDT and 9 themes), would tend to eliminate most of the common issues arising in research for development projects. This could also be achieved by including an "adoption expert" in the research team who has considerable influence over the research design.

2) **Markets**: The relevant details concern the availability and accessibility of markets, as well as pricing of any additional output or products resulting from the adoption of new technologies.
3) **Private sector actors**: This area concerns the mobilization of private sector partners that can have a direct impact on farmer adoption issues. For practical purposes, this area may have to be combined with 'markets' above, for a more comprehensive solution. It was noted that in Lao PDR the term 'private sector organisation' refers to all actors in the end-to-end supply chain. The terms supply chain and value chains are often used interchangeably.
4) **Extension effectiveness**: The effectiveness of the extension role is a crucial determinant in lifting farmer adoption rates of new technology. Precisely how this role is carried out and how to overcome current constraints (e.g. skill/knowledge gaps) are issues to be addressed.
5) **Training**: Training is recognized as a key enabler to lift adoption rates. Specifically, Lao colleagues involved in extension activities require training across several areas including technical aspects of agriculture relevant to Lao conditions: technical aspects of specific technologies being introduced, management and organisation skills, and people-oriented skills to improve adoption rates such as presentation skills, technology demonstration skills and facilitation skills.
6) **Farmer organisations**: Farmer cooperation is seen as an effective vehicle to aid in boosting adoption rates of new technology. The exact nature, role and operating method of farmer organisations are current topics of discussion.
7) **Policy support**: Current Government of Lao policy is to raise farmer incomes. This area provides an opportunity to review current policy initiatives to identify further policy options that could facilitate farmer adoption rates.
8) **Institutional organisation**: There is a view that a permanent 'taskforce' consisting of key staff from local academic institutions and relevant government organisations (NAFRI, NUOL and DAEC) may improve the effectiveness of managing, in particular, large complex research projects.
9) **Monitoring and evaluation (M&E):** To enable ongoing learning and improvement, this area looks at the effectiveness of current M&E in ensuring that the potential benefits of new technology are actually realized, and also that management frameworks achieve expected results.

When deciding their priorities, choices in the deployment and activation of meaningful ground-level actions across the 9 areas were guided by the degree of difficulty and institutional capacity. For example, the area involving (5) **Training** - particularly of extension officers (i.e. PAFOS/DAFOS in the Lao context) appeared relatively straightforward, albeit expensive. Actions in the areas of **Markets** (2) and **Private Sector** (3) were inherently difficult due to local factors.

The final day of the 3-day Solution Space Workshop involved senior Lao officials who were presented with workshop developments explaining the key influences of smallholder technology adoption and the 'solutions' that would improve adoption rates formulated through the RDT and 9 thematic areas. A key item in the discussion was recognition of the need to connect with the farmer. The effective use of the Solution Space as represented by the RDT and the 9 themes has been designed to do exactly that (Greenhalgh and Alexander 2020). Senior Lao officials had an opportunity to discuss workshop outcomes with national, provincial and district staff within the Ministry of Agriculture and Forestry.

Project Charters

The Australian and Lao teams selected Project Charters based on the 9 thematic areas to continue to increase adoption of new technologies through solution strategies/methods to improve the use of proven innovations by farmers. A copy of the Project Charter Template is available in Appendix 3. All teams prepared a detailed Project Charter, an action plan and a budget for activities.

1. ***The Australian team Project Charter:*** (1) Proposal development process presented to ACIAR in 2017outlining suggested changes to the ACIAR research proposal process:

Changes for ACIAR

- Connect to the farmer
  - Greater emphasis on commercial benefits to the farmer - significantly improve farm income or reduce labour requirements
- Greater funding for, and emphasis on, the scoping exercise
  - Has implications for form, content and length of the concept note and preliminary proposal
  - Internal ACIAR assessment process may need to be modified
  - Encourage use of available tools e.g. Research Discussion Tool (to better target villages) and Nine Areas
- Possible targeting of Specialist Research Groups (SRG's)
  - Australian researchers with skills to respond to research priorities agreed with Lao Partners (research envelope approach)
- Greater transparency/access to related projects and reports

Changes for Australian researchers

- Larger projects probable – implications for project design
  - Expanded research teams versus lead researcher plus assistants
  - Social and economic researchers to properly cover human/social/economic elements
  - Agribusiness skills become important
- Scoping exercise becomes a vital go/no go (risk management) decision point
  - All commercial, technical and people-oriented questions need to be answered
- Greater emphasis on commercial benefits to the farmer
  - Significant impact on farm income is crucial
  - Engagement of private sector groups
- Dedicated project manager for large, complex and/or risky projects
  - Lao person if possible
- Greater focus on needs of PAFOs/DAFOs
  - Technical, managerial, organisational skills training
  - Visible funding in the budget to carry out their roles e.g. fuel to visit villages

Changes for Lao Partners

- Engage Lao Partners from concept note stage onwards
- Greater involvement from provinces and districts
- Joint proposal writing where practical to do so
- Greater transparency around previous research projects and associated reports

2. ***NAFRI and DTEAP Project Charters[5]: NAFRI and DTEAP*** worked collaboratively on developing their Project Charters and included (2) Markets, (3) Public-Private Partnerships and 4) Extension Effectiveness as thematic areas to explore.

   NAFRI: The project proposal was entitled "Improving Commercial Dry Season Crop Productivity and Income Generating through an Establishing Farmer Connection to

[5] https://sites.google.com/view/acrtechnologyadoption/home

Market with Value Addition and Public-Private Partnership Enhancement". Refer to the following reports for details.

Sinavong, P., Thephavanh, M., Phonhnachith, P. & Phimphachanvongsod, M. (2018) NAFRI's Project Charter: Target Village Identification by Applying Research Discussion Tool. Report for ACIAR ASEM/2014/052 project. NAFRI, Vientiane, Lao PDR.

Sinavong, P., Thephavanh, M., Phonhnachith, P. & Phimphachanvongsod, M. (2018). Field Work Report. Market survey for potential commercial dry season crops and its value chain study in Sukhuma district, Champasak province, Laos. Report for ACIAR ASEM/2014/052 project. NAFRI, Vientiane, Lao PDR.

Sinavong, P., Thephavanh, M., Phonhnachith, P. & Phimphachanvongsod, M. (2018). PowerPoint Presentation: Review progress and issues regarding Project Charters, Tues 3rd April 2018 prepared by the NAFRI Team, Vientiane, Lao PDR.

Sinavong, P. & Thephavanh, M. (2018). Field Report: Field Visit and Technical Exchanges Workshop on Commercial Dry Season Crops Production and Agri-business for Smallholder Farmers, 7-9 May 2018, Sukhuma district, Champasak Province, Lao PDR

NAFRI Team (2018) Field trip report: Farmer Field School Training on Growing Dry season Groundnut, 30 Oct to 5 Nov, 2018 at Houahee villages, Soukoumma district, Champasack province. ASEM/2014/052 Smallholder farmer decision- making and technology adoption in southern Laos: opportunities and constraints. Report 18th November 2018.

Larson, S., Alexander, K., & Sinavong, P. (2019). Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints. Development of the Theory of Change (ToC) based Monitoring, Evaluation and Learning (MEL) plan Progress report: Design of MEL plan for NAFRI Charter Project: Improving Commercial Dry Season Crop Productivity and Income Generating through an Establishing Farmer Connection to Market with Value.

Australian and Lao teams (2019) ASEM/2014/052 Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints. End of Project Review: Powerpoint presentation, September 2019, Vientiane, Lao PDR

DTEAP[6]***:*** Project Charter "Enhancing Extension Effectiveness in Champasack". Refer to the following reports for details.

Phouisombath, K. (2018). Report on Consultation workshop on Enhancement extension effectiveness in Champassack province prepared by the TDEAP Team, Vientiane, Lao PDR.

Phouisombath, K. (2018).Report on DAFO's existing capacity assessment in Champassack province prepared by the TDEAP Team, Vientiane, Lao PDR.

Phouisombath, K. (2018). Report on Training on Capacity Building for PAFO and DAFO extension staffs prepared by the DTEAP Team, Vientiane, Lao PDR.

Phouisombath, K. (2018). Report on Farmer group established to increase peanuts products at Houayhai village, Soukkhouma district, Champassack province, Department of Technical Extension and Agro-Processing (TDEAP) Team, Vientiane, Lao PDR.

Phouisombath, K. (2018). PowerPoint presentation DTEAP Project Charter Progress Report.

Phouisombath, K. (2018). Farmer group established to increase peanuts products at Houayhai village, Soukkhouma district, Champassack province.

Phouisombath, K. (2019). Training on Capacity Building for PAFO/DAFO extension staffs and farmers group in Soukkhouma district, Champassack province.

Phouisombath, K. (2019). Report on DAFO's improved capacity assessment, 01-05 April, 2019.

Phouisombath, K. (2019). Progress 1 Year of DTEAP Charter Project: "Enhancing Extension Effectiveness in Champassack" -presentation by Mr. Khamphouvieng Phouisombath.

Phouisombath, K. (2019). MEL plan for DTEAP Charter Project "Enhancing Extension Effectiveness in Champassack" presentation by Mr. Khamphouvieng Phouisombath.

Australian and Lao teams (2019). ASEM/2014/052 Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints. End of Project Review: Powerpoint presentation, September 2019, Vientiane, Lao PDR.

[6] https://sites.google.com/view/acrtechnologyadoption/home

Phouisombath, K. (2020). "Report on Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints :Project's results and review meeting" Department of Technical Extension and Agro-Processing Champasack provinces, Soukhoumma district, Lao PDR. 07-10 January, 2020.

NUoL[7]***:*** Project Charter "Social media strategy and web presence", supporting (4) Extension Effectiveness). Refer to the following reports for details:

Using the Research Discussion Tool: ASEM/2014/052: Report Activities January-June 2018.By Faculty of Agriculture, National University of Laos

Thammavong, P. (2019). "Agricultural Extension via Social Networks", March, 2018 to May, 2019. www.facebook.com/kasetnabong . PowerPoint presentation, March 28th 2019.

Facebook Team (2019). "MEL plan for Facebook page Project (NUoL Charter Project) Agricultural Extension via Social Networks". Faculty of Agriculture, National University of Laos.

Australian and Lao teams (2019). ASEM/2014/052 Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints. End of Project Review: Powerpoint presentation, September 2019, Vientiane, Lao PDR

Sacklokham, S., Larson, S., Alexander, K. and Khounsy, B. (2017). Can the Lao People's Democratic Republic improve food security through policies designed to improve farming production and improve smallholder farmers' livelihoods? Aspirations and reality. Ninth EuroSEAS Conference, University of Oxford, 16-18 August, 2017. Book of Abstracts. http://www.euroseas.org/

Monitoring Evaluation and Learning[8]

The Theory of Change was introduced to our Lao colleagues and each institution developed their Monitoring Evaluation and Learning (MEL) documents. Virtual 'Self – Evaluations' were undertaken at the end of the project (due to COVID-19 travel restrictions) by Lao colleagues (see11.4 Appendix 4). Refer to the following MEL reports.

MEL PLAN by NAFRI (2018-2020): Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints. Development of the Theory of Change (ToC) based Monitoring, Evaluation and Learning (MEL) plan. Final report: *Design of MEL plan for NAFRI Charter Project: Improving Commercial Dry Season Crop Productivity and Income Generating through an Establishing Farmer Connection to Market with Value Addition and Public Private Partnership Enhancement.*

MEL PLAN by DTEAP (2018-2020): Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints. Development of the Theory of Change (ToC) based Monitoring, Evaluation and Learning (MEL) plan. Final report: *Design of MEL plan for DTEAP Charter Project: Enhancing extension effectiveness in Champasack Province*.

MEL PLAN by NUoL (2018-202): Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints. Development of the Theory of Change (ToC) based Monitoring, Evaluation and Learning (MEL) plan. Final report: Design of MEL plan for NUoL Charter Project.

7.2 Discussion

Changes to skills and knowledge

The project has created new tools and approaches which have contributed to learning by all the participating researchers, and there are significant lessons to take from this project

[7] https://sites.google.com/view/acrtechnologyadoption/home

[8] https://sites.google.com/view/acrtechnologyadoption/home

for the future. Firstly, the project has contributed substantively to improving the participating researchers' and extension staff's knowledge and skills in research design as well as in using various new research tools that promote greater participation of stakeholders, and there is evidence of practice change as a result of this. For example, Lao researchers are using this acquired knowledge to access new funding sources. In addition, researchers have already successfully applied the research approach in farming villages in Champassack province. Ms Manythaythip Thaphavanh from NAFRI has had the opportunity to undertake a PhD through a John Allwright Fellowship, which has motivated many team members to explore opportunities to further upgrade their knowledge and skills in their respective fields. Two Lao researchers were included in the Meryl Williams Fellowship in Jan 2020 in Australia as a result of support and capacity resulting from participation in ASEM/2014/052.

Secondly, the project highlights the effectiveness of capacity building that focuses on complexity literature and transdisciplinary approaches. For example, researchers learned to use new tools such as the Research Discussion Tool, Theory of Change, Monitoring, Evaluation and Learning approaches, and the Solutions Space. The Solutions Space, in particular, has fostered a more participatory approach to co-design and decision making in research planning. These approaches address the challenges associated with problem identification and framing in complexity (such as the processes of innovation and adoption in farming systems).

Thirdly, a broad range of mixed methods was used, such as Q methodology, Bayesian networks, e-voting and serious gaming for data collection and analysis. Lao researchers were active in adapting these tools to the local cultural, physical and political context. While these provided interesting and highly useful results, the complexity and specialised nature of these tools meant that in-country researchers had limited ability to participate in design, analysis and interpretation of results as highly specialised researchers were brought in to carry out these tasks. However, they were able to participate in the implementation and data collection.

For example, the project used the Q methodology to understand the viewpoints or mental frameworks that farmers were using when making decisions on-farm productivity, which proved useful for both researchers and P/DAFO staff. They learnt how to define research questions, how to design the Q-set of statements, how to select participants, but they lacked the opportunity to participate in the remaining steps such as administering the Q-sort, using the software, interpretation and narrative reporting.

Fourthly, the project team demonstrated an understanding of the important role social science approaches play in the research as well as the need for networking and collaboration with other stakeholders. In particular, the project team incorporated frameworks and approaches from the organisation development and change management disciplines and literature. Lao researchers took advantage of a connection with the Charoen Pokphand (CP) agricultural company's research institute. The project allowed staff to work independently with less outside intervention, thus increasing motivation, interest, work ethic and project activity ownership by Lao researchers involved.

Finally, this project has demonstrated the value of a broader range of skill sets and approaches in agricultural research for development. Of particular importance for future capacity building is the opportunity for in-country researchers to operate more independently and to have a strong input to design and approaches, particularly in bringing in local knowledge perspectives.

Institutional and group practice change

The project has had a significant impact on group practice among the partners. Lao researchers said that they valued the teamwork and transdisciplinary approach, which offers an effective way to achieve research objectives and to share experiences. However, the project did not manage to influence institutional changes incorporating

approaches by involving stakeholders such as PAFO and DAFO staff who are the main information sources and in the front line of government support for farmers, in research activities.

The project has highlighted some key opportunities concerning change in extension systems and institutional settings and for training exercises to be context-specific and a combination of classroom training and field activity.

Technology adoption is still predicated on a top-down approach which is usually external donor-driven with PAFO and DAFO as implementing partners, rather than being demand-driven by farmers. Project Charter activities focused more on technical knowledge rather the capacity of transferring knowledge to farmers, which P/DAFO staff are substantially lacking. A significant practice change associated with this project is around some early steps towards a more demand-driven approach to extension, as explored on a pilot basis by an earlier ACIAR project, ASEM/2011/75. Identifying the need for a broader range of generic skills (such as group facilitation, presentation skills, knowledge of markets and value chains, partnership and network building skills) has been highlighted as critical, along with the shift to a demand-driven approach.

The Facebook site www.facebook.com/kasetnabong was developed as a “knowledge hub” for farmers to access expert advice. The site has held significant interest with 8,437 followers by May 2019, which exceeded expectations. The site continues to be hosted and managed at the NUoL by the Faculty of Agriculture. In total, 62 most popular posts and (animal husbandry and aquaculture the most popular) reached 993,238 people, resulting over 10,500 shares, 7,300 likes and 228 comments. However, encouraging farmers to access the FBP needs further encouragement for greater future benefits.

Despite encountering problems during the implementation of Project Charters, the team reported that the MEL process was instrumental in getting the project back on track, highlighting the importance of integrating MEL into research projects.

Effectiveness

The project has provided a positive contribution to the skills and knowledge of the Lao researchers who are now more confident to carry out similar research activities. In this regard, the project answers the first research question: “what influences smallholder adoption of proven technologies” by using a PAR strategy, which facilitates inclusive community-based, transdisciplinary research working in villages and engaging Lao national and sub-national institutions into all research processes.

In terms of “improving adoption by smallholder farmers of proven technology and management innovations”, this is a longer-term aim. What the project has done is to identify opportunities and barriers to this adoption and test some alternative approaches. Since improving adoption has been shown to require changes in both research approaches and practices, and both structural and practice changes for extension in Southern Laos, this is an ambitious goal, which will take programmatic shifts rather than a single project. However, this project has provided a sound basis for ongoing activities.

8 Impacts

Promoting a transdisciplinary approach has worked well in the Lao context and was enthusiastically received and accepted by the Lao researchers. Researchers noted that such approaches are more time-consuming and challenging in a "siloed" institutional system, but that they lead to better outcomes and potential impact. Lao researchers reported that they were able to look beyond their expertise domain, and were able to design and carry out research activities with less assistance from foreign researchers. Besides, they felt they could coordinate and manage budgets according to project guidelines and ensure timely, high-quality reporting.

This project has generated a range of important outputs with the potential to engage and influence government management agencies and policy-makers that have been well-targeted. There is potential to embed these learnings and outputs in government processes and policy at each level of government.

The project had relatively modest short-term socio-economic impacts (see subsections 8.3.1 and 8.3.2, below). Whilst it is too early to see wider socio-economic impacts from this project, further impact pathways and strategies are underway with policy briefs and policy papers to be co-developed with Lao colleagues and published, in order for the project to reap broader benefits. Encouraging policy dialogue at both provincial and national levels is critical to address the lack of resourcing for extension processes and to develop alternative partnerships and resourcing strategies. It is reasonable to envision, therefore, that socio-economic impacts will continue to accrue as a direct result of project interventions and activities in the coming 5 years.

8.1 Scientific impacts – now and in 5 years

Publications, scientific outputs

To date, the project has published 7 journal papers. Six conference presentations have been well received by international audiences, a field manual and 34 project reports have been produced.[9] This demonstrates that the project has worked hard to disseminate results widely to research and development communities. All documents are a useful and important resource for future research.

Research Discussion Tool

The RDT has been successfully trialled in concurrent research projects for specific technologies such as dry season cropping, forage production, use of greenhouses and a 'best practice' project (Greenhalgh et al., 2018, National University of Laos (NUoL), 2018). The use of the RDT in projects at various stages of project progression has enabled discussions between diverse stakeholders. Discussions highlighted the barriers and constraints to adoption when introducing technologies, which tended to vary according to the technology, project and/or region. The RDT created a platform for important discussions for stakeholders to gain a common understanding of the technology and the requirements for productive adaption. Use of this process should theoretically increase adoption rates through better village selection processes and allow for stakeholders to more fully understand the technology and requirements for productive technology adoption.

Recommendations from the initial trialling of the RDT indicated that the tool was useful and ensured collaborative activities were purposeful and successful. The selection of participants was critical to the success of establishing the most important factors for a

[9] https://sites.google.com/view/acrtechnologyadoption/home

given technology. Involving farmers in these discussions verified the accuracy and efficacy of the tool (National University of Laos (NUoL), 2018).

Several project teams have been surprised that their project trials have not been fully understood by government staff and farmers and that future significant efforts are required to ameliorate these difficulties the project successfully progressing. For example, the cost of a recommended greenhouse was six times greater than available Chinese greenhouses and hence unlikely to be adopted as ripened fruit do not gain a higher price at market. A best-practice project was unable to articulate best practices and hence there was an inability to communicate project details to Lao researchers and farmers. If these details continue to be overlooked, adoption uptake will continue to be less than anticipated. Lao researchers have been empowered to question the veracity of the introduced techniques and the complex nature of adoption- thereby deflecting blame for failed adoption outcomes.

Benefits perceived by researchers in Lao partner institutions

The main benefit to science has been to employ transdisciplinary research and mixed methods to more fully understand the complexity around factors influencing adoption of new technologies in southern Laos. An interdisciplinary collaboration of the 3 Lao institutions was also important to scientific leaders and mid-career scientists involved. As Lao colleagues from different institutions had the same goal within the project, they were able to share resources, knowledge and experiences. Scientific impacts include learning: (1) new research methods such as Q methodology, Bayesian Belief Network, Companion Modelling-gaming; (2) evaluation approaches- through training on the application of the Theory of Change approach for project design and evaluation, (3) experiences of sharing knowledge and (4) experiences between researchers and extension officers to further agricultural development. As noted by one Lao colleague, “We realised that translation from sciences to practice and policy is possible.”

Ownership of the project design and implementation experiences were both noted as scientific benefits. The capacity of project implementers was strengthened as the project progressed. To provide the information required by extension officers and farmers, Lao researchers developed new networks. In turn, these new capacities and networks allowed some researchers to successfully gain work and research opportunities.

In summary, benefits to science reported by Lao researchers include:

1) Researchers capacity building, both technical and management skills;
2) Built new researchers’ networks (national and international);
3) The research team working together and sharing lessons and experiences;
4) Discovered new research tools and know how to use them effectively;
5) Attained authorship on internationally published scientific papers.

In terms of specific and additional benefits of Charter projects; the Facebook Project team reported benefits in the opportunity to learn and improve themselves in terms of teaching and transfer of knowledge by social networks. They found benefits for lecturers who could showcase their research by posting to the Facebook site and the FB page was seen as promoting both NUOL as an institution as well as its researchers. Also, researchers had an opportunity to understand more about extension methods as FB page provided an extension approach for the use of scientific knowledge. Another contribution was that FB page provided an avenue to promote and distribute knowledge and materials available at the Faculty of Agriculture, helping Lao society to have access to technology at low investment cost and information presented in Lao language and videos.

8.2 Capacity impacts – now and in 5 years

Research activities were co-constructed and administered by international researchers and Lao agricultural researchers from the National Agricultural and Forestry Institute (NAFRI), the National University of Laos (NUoL) and the Department of Technical Extension and Agro-Processing (DTEAP). In the provinces, Provincial Agriculture and Forestry Officers (PAFO), District Agriculture and Forestry Officers (DAFO) and students from NUoL collaborated in data gathering exercises. Lao colleagues contributed to the development of several research methods, such as: Q methods, Bayesian modelling and gaming theory. Lao colleagues also contributed to scientific instrument design, clarifying the appropriateness of concepts for Lao culture and language. Joint research efforts determined village selection, data collection and discussion on the application of the Research Discussion Tool. Design and implementation of the Solution Space Workshop jointly convened. Research activities involved interacting with farmers, heads of villages, government officers, district governors and rice millers, and workshops with Thai experts-representing key stakeholders of the agricultural research value chain for local rice production.

This project has demonstrated the efficacy of "learning by doing" and transdisciplinary approaches to capacity building in ACIAR projects. The project also has tested approaches to a more demand-driven approach to extension and agricultural development as well as engagement with a wider group of partners.

Monitoring, evaluation and learning approaches and training had a very positive impact in terms of empowering Lao researchers to design, monitor and evaluate their research.

Female researchers are benefitting from the project and have contributed positively to the project achievements, which is in line with the government and MAF strategy on promoting women's leadership and advancement for women.

Capacity impacts reflected in self-evaluations

Self-evaluation of the project and the Charter by key Lao research partners were conducted in May 2020 and the summary is presented in Annex 11.4.

Perceived improvements in technical and academic capacity

Capacity improvements at the personal level, as reported by Lao researchers, included:

- New knowledge on farmer learning, farmer groups and market access;
- New research methods, Q method, Bayesian Belief Networks, Gaming;
- Experience with the development of a new tool: Research Discussion Tool;
- Understanding the Theory of Change (ToC) approach;
- Project design skills;
- Improved capacity to work with other researchers as a team;
- Collaborating on research outputs, publications and promotion;
- Learning to work with other stakeholders.

Many comments received were linked to the ToC approach. Lao researchers found it a very useful tool for planning and design stage; for team building, and continuous self- and project evaluations.

In terms of learning at the level of the Team, the following capacity changes were reported, many of them similar to the individual level but in relations to the team as a whole:

- Learning a new technique of ICT (via a social network)
- Improving skills related to planning, implementation and evaluation
- Learning how to work together, especially via ToC approach

- In term of webpage Facebook team, the team got more contracts from followers; the team worked together and provided technical manuals.
- Use of new research methods Q method, Bayesian Belief Networks, Gaming.
- Use of Research Discussion Tools and the Theory of change
- The research team had the opportunity to share lessons, knowledge and experiences
- Expertise of the research team is improved
- A better understanding of how to work with the community

Capacity building and learning beyond technical and academic capacity

Several learnings, beyond the technical and academic capacity, were also reported by Lao team members. On a personal level, they included:

- Understanding other people's perspectives
- Understanding the way of thinking when designing and implementing research using Theory of Change
- Timing and time management
- Learning how to manage/implement the research project from Australian project leader and researchers
- Understanding clearly the objective of each project and solidarity between team members created synergy and success
- Learning about the needs of district officers as well as farmers

On the team level,

- Learning the importance of timing and time management
- Accepting the perspectives of others
- Learn how to work with other researchers (Lao and Australian), DAFO and farmers
- Benefits of joint planning
- Sharing lessons
- Practicing in the field

Sharing

Every Lao team member has reported that sharing of capacities and learnings generated in this project has already taken place, with the students, other academics, extension services, development projects and/or farmers.

Specifically, researchers reported already applying the strategy of working together with several partners, particularly different researchers (Social Science Faculty of NUOL) and extension, on other projects. New skills gained in the monitoring and evaluation using the ToC approach was also reportedly used on other projects. Organisational meetings and research education opportunities within institutions were used to share new knowledge and skills.

Also, some researchers had the opportunity to share their capacity on the FB page; while the FB page administrator is now also administering Lao One Health University Network (LAOHUN) FB webpage. Other researchers reported new opportunities to work on ACIAR and other donor projects, as a result of experiences gained in ASEM/2014/052.

Researchers also plan to continue knowledge exchanges in the future, applying it to other projects/activities and sharing with the students and colleagues. Topics with the potential for future sharing include research technical and methodological topics; but also

experience with the management of research/development project, ToC approach to project design, time management, and language skills and confidence building.

8.3 Community impacts – now and in 5 years

This project has no specific 'technological innovations' that it provided to communities; rather, it addressed the issue of relatively low farmers' adoption of introduced technologies. As such, its key social, economic and environmental contributions are related to the increased capacity of Lao partners in terms of increased knowledge and the capacity to share that knowledge (via social networks and training) and, most importantly, in terms of improving understanding of how 'adoption' works, and understanding the key drivers of change and the key obstacles to farmers. In addition, the project has created several tools, such as the Research Discussion Tool (RDT) whose application early in the project and, with Lao colleagues support, can greatly improve project design. It is expected that improved understanding of the dynamics of change and adoption and the application of project learnings and recommendations in future projects, will precipitate into social, economic and environmental benefits in the future.

8.3.1 Economic impacts

Farmers have benefited from support in growing peanuts in the dry season Project Charter. Peanuts in Houayhai village were harvested and sold by February 2019. General details about peanut production in Houayhai village were most of the farmers in the farmer group grew peanuts every year: 112 households grew peanuts, the total production area was 50 Ha, produced 60 tonne (60,000 kg), yielded 1.2 tonne/Ha, sold for 4,000 Kip/Kg. Total =240,000,000kip ~USD$27,660. In the farmers' group the area for peanut production was 12 ha, total produced was 12,570 Kg and sold to local district buyer for 4,000 Kip/Kg. Total =50,280,000kip ~USD $7,200. Farmers were happy with their yield, as the investment cost was low and buyers were satisfied with peanut quality. Farmers were satisfied with their farmer group experience and they will plant again next season. No new farmers have joined the farmer group, they prefer to observe first. NAFRI has completed a public-private partnership (PPP) with Vapi World Heritage site to sell peanut products. It should be noted that farmers opportunistically grow dry season peanuts on the riverbank; hence it is not possible to make direct comparisons with other years. Four farmers were trained and used fields to grow peanuts with irrigation equipment and one farmer dedicated a field to peanut production.

NUOL has undertaken supporting activities that involve peanut processing (not grading) and marketing on behalf of NAFRI. The Project Charter is now a joint exercise and the MEL document will be updated to reflect these changes. Issues encountered so far by NUoL in their exploratory activities include: aflatoxins, issues about drying peanuts, possible alternative drying processes, closure of export market to Thailand, and the need for the continued support from DTAEP and DAFO in training farmers and coaching farmers.

Market studies are underway and training on peanut processing, combined with value chain studies and study group trips to see successful farmer groups with established processing markets.

Economic impacts may arise from Lao researchers and the ongoing FB site as NAFRI, NUoL and DTEAP continue to apply knowledge and skills derived from the project and extend knowledge out to rural communities. Community outcomes and impacts are expected later in the project lifecycle and in a post-project phase through: (a) the use of the Research Discussion Tool by other projects; (b) policy dialogues and presentations; and, (c) implementation of the Project Charters in areas that drive adoption of new technologies.

This project operated at national, provincial and district levels to more effectively present ACIAR project information and liaise with projects on the ground and with farmers. Through capacity building exercises at these levels, the intention is that farmers will be in a better position to make informed decisions about production and will be supported by knowledgeable, especially trained, dedicated local staff.

8.3.2 Social impacts

Contributions to society and societal change

Main benefits to the society, farmers and other stakeholders, as perceived by Lao partners

The project linked 3 partner institutions (NUOL, NAFRI and DTEAP), with a combination of research and extension activities. It showed that knowledge and skills provided by various researchers and experts from partners are useful for farmers and society. Farmers had access to this expertise and also to many project activities that were useful and improved their capacity and production capacity. Joint planning for development and correct analysis of the problems and resulting problem-solving were also beneficial to both stakeholders, who learnt to work together, and farmers, who benefited from problem-solving.

In terms of specific benefits of the Project Charter projects, the FB webpage proved very useful for students, farmers and the society, providing agricultural extension techniques via social network. Also, it provides important relevant knowledge and skills to extension officers at local/districts and provinces level. As extension officers gain greater knowledge and experiences they can become more confident in helping farmers, and assisting farmers with problem-solving. Over 10,000 people are following the webpage (Communications: June 2020).

Key perceived benefits of two other Charters are related to training activities that farmers and D/PAFOs received, specifically:

- Peanut processing methods for value-adding, to produce peanut bars and snacks
- Hygiene and food safety
- Improved peanut planting techniques
- Management of the group
- Increased knowledge and understanding of the market
- Benefits of farmers' collaboration and mutual support

Gender

Women have played a significant role in the success of this project. We have two young women who are striving to gain recognition as emerging scientists and move into their mid-career academic positions. They have been instrumental in linking to Thai researchers and agribusiness experts and organising workshops where their Thai counterparts have led discussions and shared their expertise. We have a senior female educator who is actively mentoring young female students using our methods. We also have new and emerging young female researchers taking over the project duties in 2019 and who have benefited from recent training exercises in Monitoring, Evaluation and Learning (MEL), a cutting-edge approach to M&E in development methods. We have female researchers using our research methods and leading activities. Several female researchers took part in the Gaming training exercises and have had opportunities to work in the districts and provinces of southern Laos.

In addition, several research activities have generated data from gender-specific groups, adding to the knowledge on gender issues, opinions and ways of thinking at the village

level. Publications are being drafted and a conference paper presented at the Seeds of Change conference (Larson et al. 2019).

8.3.3 Environmental impacts

Environmental impacts may arise from Lao researchers and the ongoing FB site as NAFRI, NUoL and DTEAP continue to apply knowledge and skills derived from the project and extend knowledge out to rural communities

8.4 Communication and dissemination activities

Communication strategies and activities in the project included a project website (which included all project documents) and the project team members indicated that they felt that communication was clear and frequent within the project. The project team clearly enjoyed working together and interacted and communicated positively amongst themselves and with the review team. Networks have been built and emails and information were exchanged with other ACIAR projects, for example, SMCN/2012/075, SMCN/2012/071, CSE/2009/004, and ASEM/2012/081. Regular project updates have been delivered to key stakeholders informing of project progress. The level of reporting to ACIAR was comprehensive and appropriate. Both the country manager and the RPM reported exceptional communication processes and approaches by the project leader.

8.4.1 Achievements

Refer to Section 6: 'Achievements against activities and outputs/milestones' for details of activities. Key personnel are listed in Appendix 11.5. Listed below are project achievements not documented elsewhere in the report.

Interactions with Australian scientists

- Dr Tony Pattison, Principal Nematologist, Soil Health Team Leader, Department of Agriculture and Fisheries, Queensland contacted Dr Kim Alexander to discuss the emerging Panama disease in Laos. In addressing, ACIAR in-house review questions concerning the proposal on "banana growers decision making toward management of the disease" in Lao, he sought advice. This action was recommended by the review committee.
- Dr Olena Kravchuk, Adelaide University: AC21 application Academic Consortium for the 21st Century (AC21) Special Project Fund (Japan) for $10,000USD for collaborative research projects and activities, entitled "Promoting the uptake of the modern sampling theory in agriculture research and extension applications". Through collaboration, Dr Olena Kravchuk at Adelaide University, has successfully applied for Crawford funds for Lao researchers to attend a Symposium "Promoting the uptake of the modern sampling theory in agriculture research and extension applications" at Adelaide University in September 2018. https://rankedsetsymposium2018.website/. She ran a workshop at NUoL in 2018 with Prof Silinthone as the main contact. ASEM/052 collaborated throughout, largely through contacts with Dr Kim Alexander and Dr Garry Greenhalgh.
- Statistics in Research and Teaching in Agriculture and Environmental Sciences https://www.crawfordfund.org/news/news-statistics-in-research-and-teaching-in-agriculture-and-environmental-sciences-november-2018/
- In October 2018: Results from game data for forages Laos game was received. Report from ETH Switzerland also received and sent to Matthew Denton's group to collaboratively write a paper
- In October 2018, a short movie clip and testimonial were incorporated in the mid-term review for SMCN/2012/075 November 2018 in Cambodia. Appendix 5
- Research experience with Prof Silinthone has enabled her to take over the NAFRI Project Charter in February 2019. She has the staff and ability to engage other

researchers to be involved in our project activities and to design and budget for the agreed activities- this is an outcome of our projects change management technique.
- The journal paper Greenhalgh et al. (2019) been forwarded to CSIRO Urban Living Laboratories as a potential application to develop a similar tool to the RDT, before testing new technologies in urban living labs (see https://research.csiro.au/darwinlivinglab/ and https://www.csiro.au/en/Research/LWF/Areas/Resilient-cities-21C/Urban-challenges/Urban-Living-Lab).
- ACIAR Goat Production Systems and Marketing in Lao PDR and Vietnam Project (LS/2017/034) led by Professor Stephen Walkden-Brown, UNE. Dr Lanoy has been able to introduce the RDT for use in this project to select suitable villages for goat production.
- A positive achievement of the project was testing and implementing research results in the field with project partners and concurrent ACIAR projects in the following areas: Projects included: ASEM/2012/081, SMCN/2012/071, SMCN/2012/075, SCMN/2014/088.
  Field sites in Savannakhet were selected from AH/2012/068 & CSE/2014/086
  Field sites in Champasak selected from ((SMCN/2012/071 & SMCN/2012/075)
  Field sites in Vientiane Province (ASEM/2012/081) chosen and Saravan (SMCN/2012/075). See Alexander et al. (2019) Alexander et al. (2017b); (Greenhalgh et al. 2019, Greenhalgh 2017, Greenhalgh and Alexander 2017)

Training

General training and capacity building exercises have been instituted through workshops designed to support research activities. Other capacity-building exercises are available in previous reports. For example,

- Training exercises, development of instruments, pilot study etc. - in preparation for qualitative and quantitative Fieldwork exercises February- May 2016, Southern Laos.
- Gaming and Bayesian Network Analysis training and fieldwork, August 2016, Southern Laos.
- Australian team meeting, 15-16th September, Sydney. Synthesis of results
- Solution Space Workshop, December 2016, Vientiane,
- Stakeholder meetings with concurrent ACIAR projects, Australia (meetings, skype, telephone). January 2017-March 2017.
- Team Meeting June 2017, Vientiane, To trial “solutions” from the Solution Space Workshop and agree on future activities for 2017- development of Project Charters
- Mid-term review ASEM/2014/052, June 2017, Vientiane
- Forages Games with Matthew Denton’s group, January 2018, Champasak Province (Philp 2020)
- Team meeting and workshop, Vientiane April 2018 to finalise data on RDT exercises and Gaming activities, review Project Charters, MEL theoretical training and workshop
- ‘Gaming as a socioeconomic tool’, NAFRI, Vientiane from the 22-24 May, 2018. Attendees Lao and Cambodian researchers. Presented by Dr Josh Philp.
- Vientiane Times-News article, May 15th 2018 entitled: “A solution to the question of farmer adopting new technologies”
- Celine Dillmann from ETH in Switzerland involved in a 3 day “Story” workshop in Milan, -used the latest visualization techniques for the Forages project.
- MEL Self-Evaluation Meeting, Vientiane, October 2018
- Team meeting November 2018, Vientiane, update on Project Charter progress.

- February 2019- virtual meetings/updates with Lao institutions
- March 2019- virtual meetings/updates with Lao institutions
- Team workshop, June 2019, Vientiane, progress update
- Several Lao colleagues were funded to attend the Symposium "Promoting the uptake of the modern sampling theory in agriculture research and extension applications" at Adelaide University in September 2018 (contact through SMCN/2012/075).
- JAF Scholarship: Ms Manithaythip Thephavanh, awarded an ACIAR John Allwright Fellowship, is progressing her PhD studies at the Adelaide University, South Australia, commencing in July 2018. She is under the supervision of Dr Matthew Denton, Dr Joshua Philips and Dr Ian Nuberg. Her PhD proposal is entitled "Engaging youth in agricultural entrepreneurship in Laos". Her study objectives align well with our project and further our social research activities, looking more specifically at young farmers and their aspirations. Ms Manithaythip Thephavanh has been awarded a Crawford fund scholarship to further support her PhD studies (collaboration with SMCN/2012/075).
- Statistics in Research and Teaching in Agriculture and Environmental Sciences https://www.crawfordfund.org/news/news-statistics-in-research-and-teaching-in-agriculture-and-environmental-sciences-november-2018/
- Crawford Fund training workshop 'Gaming as a socioeconomic tool', held at NAFRI, Vientiane from the 22nd to the 24th of May, 2018 by Josh Philp (collaboration with SMCN/2012/075).
- Selection of 2 female Lao colleagues for the ACIAR 2019/2020 Meryl Williams Fellowship: Dr Phonevilay Sinavong (NAFRI) and Dr Daovy Kongmanila (NUoL)
- End of Project Review Vientiane, September 2019.

Journal publications (in reverse chronological order)

Larson, S., Dray, A., Cornioley, T., Thephavanh, M., Thammavong, P., Vorlasan, S., Connell, J.G., Moglia, M., Case, P., **Alexander, K.S.** and Perez, P. (2020). A game-based approach to exploring gender differences in smallholder decisions to change farming practices: white rice production in Laos. *Sustainability*, 12, p6594. https://www.mdpi.com/2071-1050/12/16/6594

Moglia, M., **Alexander**, K.S., Larson, S., (Giger)-Dray, A., Greenhalgh, G., Thammavong, P., Thepavanh, M. and Case, P. (2020). Gendered roles in agrarian transition: a study of lowland rice farming in Lao PDR. *Sustainability,* 12, p5403.

Greenhalgh, G., Alexander, K. S., Larson, S., Thammavong, P. S., Sacklohkham, S., Thephavanh, M., Sinavong, P., Magnus Moglia, M. Perez. P. and Case, P. (2019). Transdisciplinary agricultural research in Lao PDR. Journal of Rural Studies, responding to review July 2019.

Alexander, K., Greenhalgh, G., Moglia, M., Thephavanh, M., Sinavong, P. Larson, S., Jovanovic, T. and Case, P. (2019). What is technology adoption? Exploring the agricultural research value chain for smallholder farmers in Lao PDR. Agriculture and Human Values, accepted June 2019. DOI: 10.1007/s10460-019-09957-8

Moglia, M., Alexander, K.S., Thephavanh, M., Thammavong, P. Sodahak, V., Khounsy, B., Vorlasan, S. Larson, S., Connell, J., and Case, P. (2018). A Bayesian network model to explore practice change by smallholder rice farmers in Lao PDR. Agricultural Systems, 164:84-94.

Alexander, K., Parry, L., Thammavong, P., Sacklokham, S., Pasouvang, S., Connell, J., Jovanovic, T., Moglia, M., Larson, S., and Case, P. (2017). Rice farming systems in Southern Lao PDR: Interpreting farmers' agricultural production decisions using Q methodology. Agricultural Systems, 160 (2018) 1-10.

Alexander, K., Case, P., Jones, M. and Connell, J. (2017). Commercialising smallholder agricultural production in Lao People's Democratic Republic. Development in Practice 27(7), 965-980, DOI: 10.1080/09614524.2017.1353064

Field manual

Greenhalgh, G. and Alexander, K. (2020) Agricultural Research for Development (AR4D): A Field Guide for Experienced Practitioners. Partnerships for Positive Social Transformation.

Conference Papers (reverse chronological order)

Development (R4D) projects. Poster presentation at TropAg conference, Brisbane, 11-13th November, 2019

Larson, S, Perez, P, Giger-Dray, A, Moglia, M, Thammavong, P, Thephavanh, M, Sodahak, V, Khounsy, B, Philp, J, Boyd, D, and Alexander, K. (2019). What influences smallholder adoption of proven agricultural technologies? Identifying differences in men and women's' agricultural production decision making in southern Laos using Collective Behaviour Elicitation (CBE) Gaming activities. Seeds of Change Conference, Canberra University, 2nd-4th April 2019

Greenhalgh, G.R. and Alexander, K. (2019). Enhancing agricultural aid effectiveness for smallholder farmers in Lao PDR. Australasian Aid Conference (AAC), 19th - 20th February 2019.

Alexander, K. (2018) Visualizing Lao farmers' agricultural production decisions using Q methodology. Third Agripace Conference, Bangkok, Thailand, 26th-28th November, 2018.

Greenhalgh, G.R. (2018). Novel approaches to inter-disciplinary research generate practical solutions for smallholder farmers in Lao PDR. Third Agripace Conference, Bangkok, Thailand, 26th-28th November, 2018.

Sacklokham, S., Larson, S., Alexander, K. and Khounsy, B. (2017) Can the Lao People's Democratic Republic improve food security through policies designed to improve farming production and improve smallholder farmers' livelihoods? Aspirations and reality. Ninth EuroSEAS Conference, University of Oxford, 16-18 August, 2017. Book of Abstracts. http://www.euroseas.org/

8.4.2 Limitations of the research approach

Some important limitations of our research are listed here:

- The results from the survey should perhaps be interpreted with some caution because of the difficulty for farmers to accurately respond to the survey questions. To mitigate the possible effects of misunderstanding, the survey was subject to extensive testing and was administered by local collaborators as facilitators who were trained to provide appropriate and consistent priming when necessary.
- In hindsight, we realise that the survey that was undertaken, for good reasons, in a way that was not technology-specific. Accordingly, our analysis identifies several factors that can influence technology adoption. However, we believe that a more targeted and innovation-specific survey would pinpoint more precisely the factors that are most germane for any given technology. Further research is required to

develop a refined survey to explore technology- and product-specific issues in light of the encompassing agricultural research value chain.

9 Conclusions and recommendations

9.1 Conclusions

Primary beneficiaries of the project have been Lao researchers at the national level and, to some extent, PAFO and DAFO extension staff. There has been to date modest socio-economic benefits directly to farmers, but this is to be expected as the project was designed to provide a better social scientific understanding of the challenges and opportunities to the adoption of proven technologies in farming systems. The project has clearly demonstrated the complexity of this issue and that there is no one single cause or solution. The outputs have been useful in engaging government agencies with the challenges associated with farmer innovation and adoption, particularly at the district level. Further engagement is needed at both provincial and national level to share these learnings.

This project has revealed some very positive and innovative outcomes and has the potential to generate significant impact. One of the challenges of such a project is clearly and concisely capturing the learnings and outcomes. Monitoring evaluation and learning (MEL) was introduced and yielded productive results. This process was extremely helpful when one of the sub-projects went off-track and out of scope.

The project particularly highlights the need for demand-driven or bottom-up approaches to extension (rather than top-down) and constraints in terms of capacity and resourcing at the provincial and district level. Moving away from a top-down approach to extension, towards a more demand-driven approach starting with farmers and to the intersection of farmer practice and innovation, extension and research and policy is a very positive step forward but difficult to achieve at scale in the Lao context. Significant changes to the management of smallholder support services, taking into account the complexities of inter-institutional relationships and political priorities in the agricultural sector, would be needed for the system to become truly responsive to smallholder farmer needs.

Investments to increase the capacity of researchers and research institutions requires a long-term commitment. A four-year project can realistically only contribute to incremental change as part of a larger or longer-term strategy. Researchers need to continuously adapt to constantly fast-changing socio-economic, political and environmental conditions. All changes require new research capacity and skills of researchers and the change agents, who will bridge the research results to the reality for positive impact on farmers' livelihoods.

There are some very useful learnings from this project that may benefit future ACIAR investments. Firstly, the value of adopting a more transdisciplinary approach to AR4D, and the need to engage more effectively with complexity and the wider range of factors affecting farmer innovation. In particular, this project has demonstrated the usefulness of methodologies and methods associated with organisational development and change management approaches and practice.

While the Lao Government forecasts substantial increases in rice production in the southern plains, farmers will require specialized and tailored support, accounting for their envisaged livelihood and production goals, to allow the sector transformation that many stakeholders currently envisage.

Key messages

1. **Mixed methods** are a powerful way to combine the richness and depth of qualitative techniques with the breadth and statistical analysis of quantitative approaches.

2. **Novelty** in tools used (electronic voting) and other methods (Bayesian networks; Q-method; Gaming activities) can generate insights not obtainable by other means.

3. **The fundamental base** for achieving lasting results includes:
   - ***Strategic leadership*** of the research project
   - ***Local ownership*** of research objectives, outputs and results
   - ***Local leadership and management*** of activities and finances

4. **Tools** that help local staff interact with farmers, researchers and each other strengthen the fundamental base of communication and understanding

5. **Transdisciplinary research** is more likely to be sustainable
   - Research that is co-designed, conducted and evaluated by experts from different sectors of society such as governments, industry, communities, NGO's and universities.

6. **Transdisciplinary research included**
   - Seven different research methods
   - Three Lao institutions
   - Lao management of activities and finances
   - Joint development of new knowledge
   - Process consulting approaches
   - Private sector involvement
7. **Human and relational factors**
   - Important though a source technology might be, to influence adoption the focus should be on human and organisational factors.

9.2 Recommendations

***Recommendation 1*: Managing multi-disciplinary, multi-national teams**
We recommend that all projects select an in-country indigenous Project Manager that is not an employee of the partner organisations and can operate independently.

***Recommendation 2:* Arising from the Solution Space: ACIAR Proposal Development**
We recommend a more thorough scoping of major projects prior to contracting.

Possible modifications to the proposal process stemming from the Solution Space Workshop included:

Connect to the Farmer: this would require proposals to generate a significant increase in farmer income, which is consistent with current Lao PDR policy. This would probably result in larger projects.

Expanded Scoping Exercises: which would answer all the questions that farmers would naturally ask, followed by training of PAFOs/DAFOs to enable them to present the research project and expected income benefits in a way that enhances the probability of adoption. Note: the expanded scoping exercise is also about connecting to the farmer.

Better Targeting of Villages: Use of the Discussion Tool to better target villages suitable for a specific technology.

Ongoing Allocation of Funds for PAFO/DAFO Training: We believe that PAFO/DAFO training needs to be ongoing. One training session on, for example, presentation skills, is

not enough. It has to be continuous. The idea here is to ensure that every project allocates funding for technical and skills training.

Ongoing Funding to Allow PAFOs/DAFOs to Do Their Job: We are aware of instances in multi-year projects where DAFOs have not been able to do their job because, for example, there was not enough money at District level to pay the necessary petrol money that would allow the DAFOs to visit villages. This may appear to be a small thing but specific budget lines would ensure funds are available for this.

Research Proposal 'Envelopes': This is similar to 'investment envelopes' for foreign direct investment. As an example, it may be possible for our Lao Partners and ACIAR to develop a proposal 'envelope' that details preferred areas of research and outcomes sought. Researchers would be free to respond to this, or ACIAR might target senior Australian researchers who have the skill and contacts to put together an effective research team to carry out one or more of the preferred areas of research. There would be resulting benefits to all relevant stakeholders, i.e., ACIAR, Lao Partners, Lao farmers and Australian researchers.

***Recommendation 3*: Arising from the Solution Space: Re-evaluating previous technology-based projects that had unrealized potential to generate greater impact**. In the last five or so years there have been some well-designed technology-based research projects that for one reason or another did not result in the impacts and uptake that might have been expected. We recommend the following actions:

Identify projects from the last (say) five years that had the potential to significantly lift farmer incomes

Develop an integrated approach for re-introducing the outcomes from these research projects to targeted villages using the Research Discussion Tool etc.

Review of past ACIAR projects to select technologies, tested using the Research Discussion Tool. The groundwork could be carried out by an in-country appointment

***Recommendation 4:* Arising from the Solution Space: Strengthened capacity of project teams**
Qualitative and quantitative research methods were employed to collect a wide range of data on farmer decision-making and relevant stakeholder perspectives. These activities included deployment of two innovative quantitative methods: Lumi voting and Q-sort. The data collection exercise demonstrated that a wide range of data could be collected very efficiently by multi-disciplinary teams from JCU and Lao national institutions. The project has also increased capacity in the provinces and strengthened networking opportunities between institutions.

We recommend that in the future projects consist of multi-disciplinary, multi-institutional teams that work together for transdisciplinary research outcomes.

***Recommendation 5*: Arising from the Solution Space: Collaboration with other ACIAR Projects**
Correspondence with ACIAR project leaders has yielded collaborative strength to the project and an interest in project findings when they are broadcast. We have co-designed activities of mutual interest and provided additional support to projects in terms of activities, tools, and research design (see tabulated activity and milestone/output report in Section 3, below, for details).

We recommend that projects incorporate brief project updates to be set regularly to update key stakeholders on project progress (Lao partners, ACIAR project researchers and administrators, Australian project team, workshop attendees, DFAT/ACIAR in-country personnel, etc.).

We recommend that projects strengthen relationships with other projects and organisations working on similar technologies or geographical areas to increase project returns and facilitate lessons learnt and possible approaches where there are gaps due to research disciplines.

We recommend that the regional ACIAR country program manager is regularly updated and discussions are held to understand how the project findings can be used in-country as a tactical activity.

Recommendation 6: **Arising from the Solution Space: Increased capacity building**
With sufficient training and support NAFRI, NUoL, and DAEC staff have worked collaboratively with the JCU team in successful data collection exercises and applied these research methods by working independently in a second province. Giving responsibility for project management and design/ funding of future research activities by these government staff has been well received.

We recommend that projects allow for Lao partners involvement in the design of research activities and actively engage with their partners to ensure a greater buy-in in terms of responsibility and interest through greater ownership.

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11 Appendixes

11.1 Appendix 1: Research Partnerships

The project incorporated learning from past research and sought collaborative opportunities with continuing rice-based systems projects in southern Laos in pursuit of project objectives. Experiences and lessons learned from CSE/2009/004 will be of primary interest. Insights from a collaborative review of that project will provide the foundation for co-learning opportunities with four current projects: SMCN/2012/071, SMCN/2012/075, SMCN/2014/088 and ASEM/2012/081. Projects that inform the extent and location of agricultural technologies and suggested management systems established by ACIAR in southern Laos are summarised in Table 1.

Table 2- Summary of relevant ACIAR projects in Laos

Project code	Project details
AH/2012/068 Active	**Development of a market-driven biosecure beef production system in Lao PDR.** The project aims to support the supply of beef animals into the developing market in Savannakhet Province. As an ongoing livestock production project based on CSE/2009/004), this project leader is a major stakeholder in our project and close liaison will be encouraged, based on issues around adoption of forage, animal health and animal production research.
SMCN/2012/071 Active	**Improving water and nutrient management to enable double cropping in the rice growing lowlands of Lao PDR and Cambodia.** These projects aim to improve the profitability of lowland farming systems by increasing dry season crop production through the improved management and use of water, improved crop nutrition and the alleviation of key soil constraints. The major obstacles to adoption of non-rice dry season crops will be investigated, including effective water management, soil physical and chemical constraints, and appropriate alternative crop selection. As an ongoing water/nutrient management project in Champasak (based on CSE/2009/004), this project leader is a major stakeholder in our project and close liaison will be encouraged.
SMCN/2012/075 Active	Sustainable Management Practices for Profitable Crop-Livestock Systems in Cambodia Lao PDR and Thailand
LWR/2012/110 Active	**Regional co-learning in simple mechanised tools for rice planting.** This project aims to refine alternative methods of rice establishment with strategic and targeted development of key on-farm demonstrations using direct seeding methods established in LWR/2008/019, in Savannakhet Province. Success of extension materials, farmer field days and stakeholder engagement will be reviewed with team members and lessons learnt be made available and/or modified to suit other projects.
CSE/2012/077 Active	**Mechanization and value adding for diversification of lowland cropping systems in Lao PDR and Cambodia.** This project is developing cropping and postharvest systems using emerging labour saving technologies, synergistically with project SMCN/2012/071. The use of direct sowing, mechanising harvest and post-harvest drying will be reviewed with team members. Articulation with other projects is expected to foster exchange of information on value chains, agribusiness and market linkages which influence agricultural production decisions. The project leader will be included as a stakeholder.
AH/2012/067 Active	**Enhancing trans-boundary livestock disease risk management for poverty reduction in Lao PDR.** This project is operating in Northern Laos and is linked to AH/2012/068. The project aims to address disease constraints affecting livestock marketing. This project leader is a major stakeholder in our project and close liaison will be encouraged.
ASEM/2014/007 Active	**Lao Agricultural Research Fund (LARF3)** is a key stakeholder in the Australian–Laos engagement platform. The project develops Lao researchers' independent research capabilities and national research institutions according to their development priorities, with funding of US$12,000 for prospective researchers in a range of areas of agricultural research. Opportunities to support relevant LARF studies will be monitored in key project villages and a close liaison has already been established.

Project code	Project details
ASEM/2012/081 Active	**Improving market engagement, postharvest management and productivity of the Cambodian and Lao PDR vegetable industries.** Working in Vientiane and Champasak Provinces: Mr Jeremy Badgery-Parker and Mr Thongkhoun Sisphaythong
SMCN/2014/088 Active	Integrating soil and water management in vegetable production in Lao PDR and Cambodia 1.Input supply chain functioning and performance 2. The influence of livelihood, socio-cultural and socio-economic factors in Lao PDR and Cambodia on adoption of improved technologies and practice change 3.Improvement of management of structurally unstable and nutrient deficient Acrisols and Ferrosols 4. Improvement of irrigation management in relation to soil water status and crop requirements.
Findings from completed projects (see below) and discussions with former team members will inform the current project in the following ways: choice of specific research sites; choices of new technologies/innovations to review; identification of key lessons learnt; identification of specific stakeholders; and incorporation of AIS outcomes.	
CSE/2014/086 Completed	**Crop-livestock systems platform for capacity building, testing practices, commercialisation and community learning.** Located in previous research sites in southern Laos used by CSE/2009/004, this project is facilitating adoption of integrated crop-livestock technologies including post rice crop diversification and forages. Stakeholder engagement is a key feature building institutional capacity with NAFRI, PAFO and DAFO for establishing local platforms for commercialisation and co-learning. This project leader is a major stakeholder in our project and close liaison will be encouraged.
CSE/2009/004 Southern Laos Project Completed	**Developing improved farming and marketing systems in rain-fed regions of southern Lao PDR. Project aim**: Improved farming and marketing systems in rain-fed regions of southern Lao based in Savannakhet and Champasak Provinces. This project is of direct relevance to ASEM/2014/052 in terms of project activities on post-rice crops, forages, market chains and household typologies. We will revisit selected community hubs and villages in which they worked. CSE/2009/004 mid-term review indicated the constraint for uptake of new technologies from the project was the capacity and capability of PAFO/DAFO, especially from a governance perspective. Outputs from the proposed project may help to resolve this problem.
LWR/2008/019 (ACCA) Completed	**Developing multi-scale climate change adaptation strategies for farming communities in Cambodia, Lao PDR, Bangladesh and India.** Managing drought risks through dry direct seeding, improved rice varieties and nitrogen management. The project is relevant as it sought to adapt and apply tools/methods to select and assess adaptation strategies for rice based cropping systems, especially for water management in two Savannakhet districts. Results from evaluating management strategies, developing capacity and disseminating knowledge to farmers and policy makers are relevant background for the proposed project. Interviews with farmers in Champhone district may highlight issues around the adoption of direct seeding technology.
CSE/2006/041 Completed	**Increased productivity and profitability of rice based lowland cropping systems in Lao PDR. Project aim:** to improve the productivity and profitability of the dominant lowland rice-based systems and to diversify (some of them) by adding non-rice crops under irrigation in the dry season. The results of intensification and diversification projects in Savannakhet and Champasak on irrigated rice-based cropping systems are relevant to determine farmers' views on of post crops, direct seeding and drought risk assessments.
ASEM/2009/023 Completed	**Developing agricultural policies for rice-based farming systems in Lao PDR and Cambodia. Project aim:** to contribute to improved agricultural policies for rice-based farming systems in Laos and Cambodia, taking account of trends in Thailand and Vietnam, in line with ACIAR's food security initiative for the Mekong region. The longer-term benefits of the project will be to strengthen the capacity of government policy agencies, universities, research institutes, non-government organisations and technical researchers in the region to apply evidence from field studies to policy

Project code	Project details
	development and evaluation. Linkage with stakeholders is important to ASEM/2014/052.
ASEM/2009/039 Completed	**Agricultural policies affecting rice-based farming systems in Cambodia, Lao PDR and Bangladesh. Project aim:** to contribute to improved agricultural policies for rice-based farming systems in Laos and Cambodia, taking into account trends in Thailand and Vietnam, in line with ACIAR's food security initiative for the Mekong region.
ASEM/2011/075 Completed	**Enhancing delivery and management of agricultural extension in Lao PDR.** This project will directly inform ASEM/2014/052 as Australian personnel (Case and Connell) are members of both project teams. The project aims to enable DAEC to support Provinces and Districts to provide effective extension delivery to smallholder farmers. Action Research findings will be used to develop extension strategies and management innovation platforms.

11.2 Appendix 2: Research Discussion Tool

11.2.1 Research Discussion Tool

Research Discussion Tool					
Date:					
Project Name and Number:					
Project Funding Institution and Research Program Manager					
Project Description:					
Main Project Objectives:					
Key Stakeholders					
Discussion Group Details					
Name	Institution				
Which of the following items are important (**H**igh, **M**edium, **L**ow) for this particular project? What is the status of the important items now?					
Elements of the Farmer Production System					
Importance H M L	Item	Status now ✗	Status now ?	Status now ✔	Comment/Action
	1. Biophysical				
	Soil				
	Water				
	Pesticide				

Research Discussion Tool					
	Suitable land				
	Rice variety availability				
	Plant disease				
	Livestock disease				
	Vaccination				
	Fencing				
	Fertilizer				
	2. Socio-Economic				
	Social calendar				
	Farmer mind-set / strategy				
	Cost of technology				
	Price of labour				
	Farmer technical capacity				
	New technology: level of training required				
	Land ownership				
Decision Drivers/Motivators					
Importance H M L	Item	Status now ✗	?	✔	Comment/Action
	1. Research Project Implementation				
	Solves main problem				
	Guiding coalition ready				
	Outcomes understood				
	Help available if needed				
	Trialable				
	2. Production Benefits				
	Reduced input costs				
	Crop productivity				
	Ease/convenience				
	3. Labour Constraints				
	Perceived cost of change – additional labour				
	4. Technology Related				

Research Discussion Tool					
	Access to the new technology				
	Affordability of the new technology				
	Reputation of the technology				
	Interest in the new technology				
	5. Individual Farmer Aspects				
	Size of benefit				
	Quick wins				
	Labour requirements				
	Time / labour				
	How different to what I do now				
	Adoption behaviour				
	Trust				
	Attitude to risk of failure				
	Level of trust in perceived benefits				
	6. Community Aspects				
	Traditions				
	Social influence				
	What my neighbour does				
	7. Market and Government				
	Market access				
	Fit with Government policy				
	Public or private support				
Decision Enablers					
Importance H M L	Item	Status now ✗	?	✔	Comment/Action
	1. Perceived Support				
	Technical support				
	First adopters				
	Clear expectations				
	2. Engagement with Markets				
	Improving livestock				

Research Discussion Tool					
	Multiple rice buyers				
	Fair prices for rice				
	3. Prioritizing Off-Farm Income				
	Prioritizing off-farm income				
	4. Competitive Position versus Mills				
	Multiple mills				
	Local market prices for rice				
	5. Risk Considerations				
	Small risk				
	6. Logistics				
	On farm / local storage				
	Multiple transport providers				
	7. Extension Effectiveness				
	Interaction with DAFOS				
	Skills				
	Regular visits to village by DAFOS				
	8. Market Aspects				
	Easy to sell				
	Commodity prices				
	Global rice competition				
	Traders				
	Farmer groups				
	Trader/farmer agreements				
	9. Farmer Aspects				
	Trust				
	Labour				
	Fairness				
	Farmer co-operation				
	Skills/knowledge				
	Complex technology – training required				
	Disruption to seasonal calendar				

Research Discussion Tool					
	Maintenance/repair of machinery				
	10. Commercial Aspects				
	Contract farming opportunities				
	Cost of inputs				
	Access to cheap finance/funding				
	Land use competition				
	11. Rice				
	Variety preference				

Are there any additional items specific for this particular research project?

Example	'production calendar' for main crops				

11.2.2 RESEARCH DISCUSSION TOOL EXPLANATION

RESEARCH DISCUSSION TOOL EXPLANATION			
#	**Factors to consider**	**Explanation of factors**	**Lao Language**
A	**Biophysical factors**	**For this technology**…	
	Soil	..soil is crucial for success	
	Water	..water is crucial for success	
	Pesticide	..pesticide is crucial for success	
	Suitable land	..land suitable for intended use is crucial for success	
	Rice variety availability	..rice variety is crucial for success and is readily accessible (obtainable)	
	Plant disease	..we need to consider plant disease	
	Livestock disease	..we need to consider livestock disease	
	Vaccination	..vaccination is important for success	
	Fencing	..fencing is important for success	
	Fertiliser	..fertilizer is important for success	
	Socio-Economic factors	**For this technology**…	
	Social calendar	..will the technology significantly disrupt social events that the villages usually celebrate or participate in? Will this technology disrupt the current village livestock crop interactions? Will these disruptions prevent/limit adoption of the technology?	
	Farmer mind-set/strategy	..the farmer mind-set is important for success. How do the farmers think about their farm productivity? e.g., Are farmers happy to grow food to eat or are they really interested in making extra income from production as well?	
	Cost of technology	..the direct cost of purchasing the technology is important for success.	
	Price of labour	.. how much do farmers have to pay for labour e.g. labour costs are important for success(kip/hour or kip/day).	
	Farmer technical capacity	.. farmers' technical capacity is important for success. E.g. How much knowledge and skill do farmers have? Greater technical capability increases the	

RESEARCH DISCUSSION TOOL EXPLANATION			
		likelihood the farmer will use the technology more effectively.	
	New technology: level of training required	.. the amount of training is important for success. E.g. How long does it take to train a farmer in the proper use of the technology (hours/days/seasons)? If extensive training is required does this mean fewer farmers will adopt?	
	Land ownership	..land ownership is important for success. E.g. Do the farmers have land titles owning their land? Does this affect decisions to adopt? Are farmers using other farmers' fields?	
	Decision Drivers		
	Research Project Implementation	**For this technology**…	
	Solves main problem	..solving the farmer's main problem is important for success. E.g., naturally a farmer might ask, "Does this technology solve a major problem for me - such as labour saving, increasing income, and production diversity?"	
	Guiding coalition ready	..a guiding coalition is important for success. E.g., naturally a farmer might ask, "Is there a group of people ready to manage the implementation of this technology?"	
	Outcomes understood	..understanding the outcomes is important for success. E.g., Do farmers clearly understand the outcome of using the technology?	
	Help available if needed	..the availability of help if needed is important for success. E.g., naturally a farmer might ask, "If I adopt this technology and have a problem, can I get help quickly?"	
	Trialable	..the ability to trial it is important for success. E.g., naturally a farmer might ask, "Can I test this technology before I decide to adopt it?"	
	Production Benefits	**For this technology**…	
	Reduced input costs	..a reduction in input costs is important for success. E.g., farmers can purchase inputs such as: rice (or other crop), fertiliser, pesticide, fuel for tractor etc., at reduced costs	
	Crop productivity	..crop productivity (tonnes/hectare) is important for success.	
	Ease/convenience	..it is easier or more convenient to use than current methods which is important for success.	
	Labour Constraints	**For this technology**…	
	Perceived cost of change – additional labour	..the farmer's judgement as to whether the technology will require more labour than the current method is important for success.	
	Technology Related	**For this technology**…	
	Access to the new technology	..the availability of the technology is important for success.	
	Affordability of the new technology	..whether the farmer can comfortably pay for it is important for success.	
	Reputation of the technology	..it is important for success that the technology is known to farmers and has a good reputation.	
	Interest in the new technology	..it is important for success that the farmer has an interest in the new technology.	
	Individual Farmer Aspects	**For this technology**…	
	Size of benefit	..the size of the benefit is important for success.	
	Quick wins	..quick wins for the farmer is important for success.	

RESEARCH DISCUSSION TOOL EXPLANATION			
	Labour requirements	..the amount of labour required is important for success. If more labour is required compared to current methods then farmers are unlikely to adopt the technology.	
	Time/Labour	..the time/labour (hours) required from each person is important for success. If the time required can be reduced (even if the number of people required stays the same) then the farmer is more likely to adopt the technology.	
	How different to what I do now	..the farmer's judgement as to how different this technology is from current methods is important for success. If the technology is very different from what the farmer currently does/uses then the farmer may not adopt the technology.	
	Adoption behaviour	..farmer adoption behaviour is important for success. E.g., Is the technology very different from current methods (or requires a high level of technical knowledge) that only the 'modern' farmers should be targeted?	
	Trust	..the level of trust between the farmers, PAFOS/DAFOS and researchers is important for success.	
	Attitude to risk of failure	.. the risk of failure is higher than normal and farmers' attitude towards the risk of failure is important for success.	
	Level of trust in perceived benefits	..it is important for success that farmers actually believe they can really achieve the stated benefits of the technology.	
	Community Aspects	**For this technology**…	
	Traditions	..farmers may see this particular technology as going against many farmer traditions. It is important for success that the reasons for this be explained properly.	
	Social influence	..the views of people in the local area are important for success.	
	What my neighbour does	..decisions made by each farmer's neighbours is important for success.	
	Market and Government	**For this technology**…	
	Market access	..easy access to markets is important for success.	
	Fit with Government policy	..it is important for success that farmers believe production fits government policy.	
	Public or private support	..support and involvement of public institutions or private sectors are important for success.	
	Decision Enablers		
	Perceived Support	**For this technology**…	
	Technical support	..technical support for farmers is important for success.	
	First adopters	..it is important for success that other farmers see the first adopters as better off because of the technology.	
	Clear explanations	..clear explanations are important for success.	
	Engagement with Markets	**For this technology**…	
	Improving livestock	..an improvement in livestock raising is important for success.	
	Multiple rice/crops/livestock buyers/traders	..having multiple buyers/traders for rice/crops/livestock are important for success.	
	Fair prices for rice	..it is important for success that farmers know they will get a fair price for their rice/crops/livestock.	
	Prioritising Off-Farm Income	**For this technology**…	
	Prioritising off-farm income	..the ability of the farmer to maintain a preference for off-farm income is important for success.	

RESEARCH DISCUSSION TOOL EXPLANATION			
	Competitive Position versus Mills	**For this technology**…	
	Multiple mills for rice	..the availability of multiple mills to sell rice is important for success.	
	Local market prices for rice/crops/livestock	..knowledge of local market prices for rice/crops/livestock is important for success.	
	Risk Considerations	**For this technology**…	
	Small risk	..it is important for success that the farmer sees any risks as small and manageable.	
	Logistics	**For this technology**…	
	On farm / local storage	..having adequate on farm or local storage is important for success.	
	Multiple transport providers	..having multiple transport options is important for success.	
	Extension Effectiveness	**For this technology**…	
	Interaction with DAFOS	..interactions between DAFOS and farmers is important for success.	
	Skills	..skills of DAFOS is important for success.	
	Regular visits to village by DAFOS	..it is important for success that DAFOS regularly visit the villages.	
	Markets	**For this technology**…	
	Easy to sell	..it is important for success that any additional or new product is easy to sell.	
	Commodity prices	..knowledge of commodity prices is important for success.	
	Global rice competition	..it is important for success that additional or new rice can compete with global competition.(Crops/livestock?)	
	Traders	..the availability of fair traders/fair prices is important for success.	
	Farmer groups	..activities of farmer organisations are important for success.	
	Trader/farmer agreements	. trader/farmer agreements are important for success.	
	Farmers	**For this technology**…	
	Trust	..the level of trust between farmers, village headman, DAFOS and researchers, is important for success because of the need of farmers to feel they are fully supported in adopting this technology.	
	Labour	..decisions by farmers as to how labour will be used is important for success.	
	Fairness	..it is important for success that farmers believe they are being treated fairly.	
	Farmer co-operation	..co-operation among the farmers is important for success.	
	Skills/knowledge	..farmers' skills and knowledge are important for success.	
	Complex technology – training required	..it is complex and for success additional and specialised training for farmers is required.	
	Disruption to seasonal calendar	..it is important for success not to disrupt the seasonal calendar of events.	
	Maintenance/repair of machinery	..farmer's ability to maintain or repair equipment or machinery is important for success.	
	Commercial Aspects	**For this technology**…	
	Contract farming opportunities	..the opportunity for contract farming is important for success.	
	Cost of inputs	..the actual cost of inputs (crop, fertilizer, pesticide, fuel etc.) is important for success.	
	Access to cheap finance/funding	..access to cheap/affordable finance is important for success.	
	Land use competition	..how the farmer views alternative uses for his land is important for success.	
	Rice	**For this technology**…	
	Variety preference	..the ability of the farmer to decide on rice variety is important for success.	

11.3 Appendix 3: Project Charter Template

PROJECT CHARTER			
Project name:			**Date:**
Estimated start date:	**Estimated finish date:**		
Project Justification **(**Why is it important?)			
Project outcomes (What are we trying to achieve? How will we know we are successful?) *(SMART: specific, measurable, agreed, realistic, time bounded)*			
Deliverables/Outputs (What do we have to produce?)			
Milestones	**Milestone**	**Who?**	**When?**
(What are the major achievement points? What will help us decide whether the project is on schedule or not?			
Key team members (Who are they?)			
Resource needed (How many people? How much money? How much time)			
Skills/knowledge (What new skills, knowledge will the team need?)			
Risks (What could go wrong? How will you minimise or manage the risks? What if we don't do the project?)			

11.4 Appendix 4: Self-Evaluations May 2020

ASEM/2014/052: Smallholder farmer decision-making and technology adoption in southern Lao PDR: opportunities and constraints

Self-Evaluations at End of the Project: Lao Team

A self-assessment of the project benefits and suggestions for improvements, and capacity building achievements resulting from this project was planned as a face-to-face meeting of key Lao project participants. However, due to Covid-19 pandemic situation, this activity was finalised via email. Five key Lao partners that were engaged with the project in

general, and with one or more Chapter activities[10], participated in the exercise. Participants were asked about perceived project (1) benefits, (2) suggestions for change/improvements, and (3) key capacity building aspects.

11.4.1 Benefits

Perceived benefits were discussed at the level of the project overall and for each Project Charter. Two levels of benefits were perceived, those to society (farmers and other stakeholders); and those to science, research team and researcher's institution.

Project overall

Main perceived benefits to the society (farmers and others stakeholders)

The project linked 3 partner institutions (NUOL, NAFRI and DTEAP), with combination of research and extension activities. It showed that knowledge and skills provided by various researchers and experts from partners are useful for farmers and society. Farmers had access to this expertise and also access to many project activities that were useful and improved their capacity and productions.

Joint planning for development and correct analysis of the problems and resulting problem-solving were also beneficial to both stakeholders, who learnt to work together, and farmers, who benefited from problem-solving.

Benefits to science and your research team/institution

Different partners had the same goal within the project so they shared the resources and helped each other's development. There was a very good collaboration between 3 institutions, sharing knowledge and experiences. We were learning together, e.g. techniques on research, extension and evaluation approaches. The exchange of knowledge and experiences between researchers and extension workers for agricultural development increased.

We also realised that translation from sciences to practice and policy is possible.

Capacity of project implementers was strengthening as project progressed. The researchers developed new networks to be able to provide the information. New capacity and networks allowed them to get more work and research.

The main benefit to science was increased understanding of factors influencing adoption of new technologies in southern Laos.

Main benefit to researchers included:

1) Researchers capacity building, both technical and management skills;
2) Built new researchers' networks (national and international);
3) Research team working together and sharing lessons and experiences;
4) Discovered new research tools and know how to use it;
5) Published scientific papers.

[10] *The 9 Project Charter areas were finalised to include: (1) Proposal process, (2) Markets, (3) Private sector, (4) Extension effectiveness, (5) Training, (6) Farmer organisations, (7) Policy support, (8) Institutional organisation and (9) Monitoring and evaluation. Project Charters were designed based on these underlying themes.*

NUoL Project Charter (4): Extension Effectiveness: Social Media Facebook Page

Main perceived benefits to the society (farmers and others stakeholders)

Facebook webpage proved very useful for students, farmers and society, providing the agricultural extension techniques via social network. In addition, it also provides important relevant knowledge and skills to extension officers at local/districts and provinces level. If they gain higher knowledge and experiences they will be more confident to help farmers, and will be able to assist farmers with problem-solving.

More than 10,000 people are following the webpage. So the useful information is being easily transferred to them. Farmers, Agribusiness and the people who are interested in agricultural techniques and technologies have better access to new techniques and technologies in agricultural production via social networks for solve their daily problems resulting in improvement of the agricultural production.

Benefits to science and your research team/institution

This FB page promoted both NUOL as an institution as well as its researchers.

Team of researchers involved had an opportunity to learn and improve themselves in terms of teaching and transfer of knowledge by social networks. Benefit to lecturer's who can showcase their research by posting to the Facebook site.

Researchers also had an opportunity to understand how it is to do extension work as FB pages very much an extension approach. Faculty of Agriculture has source to disseminate their new agricultural technics and technology to society and faculty can help society to have access to technology with low investment cost.

NAFRI and DTEAP Project Charters- (2): Public Private Partner Partnership, (5) Market Engagement: Peanut processing and marketing; and Charter (4) Enhancing extension effectiveness

Main perceived benefits to the society (farmers and others stakeholders)

A number of benefits from the range of trainings that farmers and D/PAFOs received, specifically:

- Peanut processing methods for value adding, to produce peanut bars and snacks
- Hygiene and food safety
- Improved peanut planting techniques
- Management of the group
- Increased knowledge and understanding of the market
- Benefits of farmers' collaboration and mutual support

Benefits to science and your research team/institution

Research and extension teams worked together to enhance their knowledge and experience, especially in field work. The way Charters were designed design and implementation experiences increased the ownership of the project, which in turn increased knowledge and resulted in broader findings of the research.

11.4.2 Suggestions for change and improvements

At the project level

- Process of selection of the Lao team members needs improvement. Selection should be based on qualifications relevant to job description.

- Lao team needs to try and cooperate with other experts to obtain relevant expertise and information on new agricultural techniques but also other project relevant aspects (i.e. capacity in specific research methods; or training area such as value chain analysis)
- If all the Lao partners, NAFRI, DTEAP and NUOL share the same goal, work together as one with mutual respect and good leadership, we will achieve our project goals
- The implementation plan needs to be clear, simple, and multi-functional.
- ACIAR should provide stricter monitoring of its projects in Laos (who spends money and what on; who makes decisions and based on what etc.)

At the Project Charter level

- For FB page: Timing and topics of posts should be considered based on 'hot issues' that society needs and also seasonal needs; Invite expert from more varied fields of expertise to share their new techniques and technologies in agricultural production via social networks.
- For DTEAP chapter: Period of training should be expanded, as well as the training materials; training evaluation approach should be improved; and planning should be done jointly at the central, provincial and district levels.
- For Peanut chapter: It was not a good idea to go ahead with NAFRI suggestion and choose peanut as a product to promote in Sukuma - not many farmers grow this crop and the market is only local; and the benefits were to a few households only. Research should be done on what people can use and what benefits most. Also, responsibility for this Charter was not clear to parties involved.

At the team level

- Team should have developed training plan on topics more relevant to participants, based on the need in a specific region.
- Indicators of success with the long-term effect should be considered.
- Project design and planning should be participatory with all the team members from the beginning.
- Communication skills are very important for team work, should work on it
- Team realised during the project that they need to adapt and accept sometimes.
- More understanding of agricultural value chain and development is needed, plus knowledge about marketing

Self

- I will use more of mix techniques and methods in other project, as I learnt benefits of this in this project.
- I will better plan tasks to fit the budget and make it more efficient.
- I will promote participatory project design and planning with villagers/ local communities from the beginning.
- I will keep on improving my English as language skills are very important
- If everyone shares the same goal, it creates energy and success.

11.4.3 Capacity building

Improvements in technical and academic capacity

Improvements reported at the personal level included:

- New knowledge on farmer learning, farmer groups and market access.
- New research methods, Q method, Bayesian Belief Networks, Gaming.

- Experience with the development of a new tool: Research Discussion Tool;
- Understanding Theory of change (ToC) approach
- Project design skills
- Improved capacity to work with other researchers as a team.
- Collaborating on research outputs, publications and promotion
- Learning to work with others stakeholders

A number of comments were received linked to the ToC approach. Researchers found it very useful tool for planning and design stage; for teambuilding; and for continuous self- and project evaluations.

In terms of team-learning the following capacity changes were reported, many of them similar to the individual level but in relations to the team as a whole:

- Learning new technique of ICT (via social network)
- Improving skills related to planning, implementation and evaluation
- Learning how to work together, especially via ToC approach
- In term of webpage Facebook team, the team got more contracts from followers; the team worked together and provided technical manuals.
- Use of new research methods Q method, Bayesian Belief Networks, Gaming.
- Use of Research Discussion Tools and the Theory of change
- The research team had the opportunity to share lessons, knowledge and experiences together
- Expertise of research team is improved
- Better understanding of how to work with the community

Learnings beyond technical and academic capacity

Several learnings, beyond the technical and academic capacity, were also reported. On the persona level they included:

- Understanding other peoples' perspectives
- Understanding the way of thinking when designing and implementing research using Theory of Change
- Learning about implementation planning through the use of ToC
- Timing and time management
- Learning how to manage/implement the research project from Australian project leader and researchers.
- Understanding clearly the objective of each project and solidarity between team members created synergy and success.
- Learning about the needs of district officers as well as farmers

On a team level,

- Learning the importance of timing and time management
- Accepting perspectives of others
- Learn how to work with other researchers (Lao and Australian), DAFO and farmers.
- Benefits of joint planning
- Sharing lessons
- Practicing in the field

Sharing

Every team member reported sharing capacity/learnings, with the students, other academics, extension services, development projects and/or farmers.

Specifically, project participants reported already applying the strategy of working together with several partners, particularly different researchers (Social Science Faculty of NUOL) and extension, on other projects. New skills gained in the monitoring and evaluation, using the ToC approach was used on other projects. Organisational meetings and research education opportunities within institutions were also used to share new knowledge and skills.

In addition, some researcher had the opportunity to share their capacity on the FB page; while the FB page administrator is now also administering Lao One Health University Network (LAOHUN) FB webpage.

Other project participants reported new opportunities to work on ACIAR and other donor projects, as a result of experiences gain here.

Project participants also plan to continue knowledge exchange in the future, applying it to other projects/activities and sharing with the students and colleagues. Topics with the potential for future sharing include research technical and methodological topics; but also experience with the management of research/development project, ToC approach to project design, time management, and language skills and confidence building.

11.4.4 Drivers of change:

Participants were asked to rank from 1-10 the drivers of change listed below, where **1 is least important to the farmer** (not important at all) and **10 is the most important to the farmer** considering to adopt a new technology or not:)

Driver of change	R 1*	R 2	R 3	R 4	R 5
Availability of the water	10	10	2	9	4
Secure land ownership	8	8	6	8	2
New varieties / seeds easily available	5	8	3	10	7
Labour required is available	10	8	9	9	6
This change is in line with government policy	8	7	7	8	1
How big is going to be increase in income	6	9	8	5	10
Do I have a right soil quality	5	8	1	7	5
Can I find a fair trader	5	10	5	8	8
Can I get technical support/ answers	7	6	4	9	3
How easy it will be to sell this new product	7	10	10	8	9

*R is the researcher

- **Outliers in red;**
- Drivers of change **with good agreement in blue** – corresponding to main findings of this research.

11.5 Appendix 5: Key Personnel

Countries involved	Institution	Personnel
Laos	National Agriculture and Forestry Research Institute (NAFRI)	Dr Thavone Inthavong Dr Phonevilay Sinavong Ms Dalivanh Samontry Ms Manivanh Phimphachanvongsod Dr Bountom Khounsy
	National University of Laos (NUoL)	Prof Silinthone Sacklokham Prof Somphanh Dr Daovy Kongmanila Mr Phomma Thammavong
	Department of Technical Extension and Agro-Processing (DTEAP)	Mr Khamphouvieng Phouisombath Ms Keooudone Philangam Mr Viengkham Sodahak
Australia	James Cook University	Dr Kim Alexander Prof Peter Case Dr Garry Greenhalgh Dr Silva Larson Dr Magnus Moglia Mr Tom Jovanovic Mr John Connell
Australia	Consultant	Senior Professor Pascal Perez
ETH Switzerland		Dr Anne (Giger) Dray Dr Tina Cornioley Ms Celine Dillmann
	ACIAR RPMs	Dr Carolyn Lemerle Dr Jayne Curnow