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Adoption of ACIAR project outputs

2020

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Editors

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2021

The Australian Centre for International Agricultural Research (ACIAR) was established in June 1982 by an Act of the Australian Parliament. ACIAR operates as part of Australia's international development cooperation program, with a mission to achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia. It commissions collaborative research between Australian and developing-country researchers in areas where Australia has special research competence. It also administers Australia's contribution to the International Agricultural Research Centres.

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ACIAR Adoption Studies

ACIAR seeks to ensure that the outputs of the research it funds are adopted by farmers, policymakers, quarantine officers and other beneficiaries. As part of its efforts to monitor the outputs and outcomes of its projects, ACIAR commissions project leaders and participants to revisit projects 3–4 years after completion, and report back to ACIAR on the medium-term outcomes of the work. The Adoption Studies series of publications reports the results of these studies. The series is distributed internationally to selected individuals and scientific institutions, and is also available from the ACIAR website at aciar.gov.au.

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Foreword

Since 2000, the Australian Centre for International Agricultural Research (ACIAR) has periodically revisited a sample of past projects. A few years after completion, a project team leads an assessment of the adoption of project technologies, knowledge and frameworks. The ACIAR Adoption Study series has been an invaluable record of the types of sustained changes that can result from ACIAR research project investments.

This study looks at a diverse set of projects, from small-scale furniture value-chain optimisation to supporting multi-region climate change adaptation strategies. Consistent with past Adoption Study synthesis, the appraisers studied project outputs under 3 broad categories:

- the emergence of new technologies or practical approaches to tackling problems
- the gaining of new knowledge that would lead to better understanding of scientific and socioeconomic aspects of agriculture
- the introduction of new models and frameworks to assist policymakers in reaching decisions that influence the environment of farmers and others along the market chain.

This set of projects reflects the diversity of ways in which ACIAR is supporting positive changes at different scales across the agri-innovation systems of the Indo-Pacific region. ACIAR wishes to thank all research teams who have contributed to the production of Adoption Studies in the last 20 years and looks forward to continued collaboration through our new Outcome Evaluation series.

This compilation of reports will be the final publication of Adoption Study series. As ACIAR reaches the mid-point of the ACIAR 10-Year Strategy 2018–2027, we are adopting new approaches to monitoring, evaluation and reporting that more closely align to a set of portfolio-wide strategic objectives. To reflect this evolution of our operations, we will launch a new Outcome Evaluation series in 2022. This series will seek to systematically investigate how and in what ways research contributed to intended outcomes, aligned with ACIAR strategic objectives. The series will provide a stronger foundation for cross-case analysis and aggregate reporting, seeking to contribute more systematic, analytical insights on effective agricultural research-for-development.

Daniel Walker
Chief Executive Officer (Acting)
ACIAR

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Abbreviations

ACCA	Adapting to Climate Change in Asia (LWR/2008/019)
ACIAR	Australian Centre for International Agricultural Research
APDMP	Andhra Pradesh Drought Mitigation Project
APKJ	Jepara Small-scale Furniture Producers Association (Indonesia)
ASPIRE	Agriculture Services Programme for Innovation, Resilience and Extension
AWP	Australian Water Partnership
BCS	body condition score
BPTP	Balai Pengkajian Teknologi Pertanian (Indonesia)
CLIC	Climate Information Centre (India)
DAFO	District Agriculture and Forestry Offices (Laos)
DFAT	Department of Foreign Affairs and Trade (Australia)
ELISA	enzyme-linked immunosorbent assay
ICARD	Indonesian Center for Animal Research and Development
IFAD	International Fund for Agricultural Development
MAFF	Ministry of Agriculture, Forestry and Fisheries (Cambodia)
NAFRI	National Agriculture and Forestry Institute (Laos)
PADEE	Project for Agricultural Development and Economic Empowerment (IFAD)
PAFO	Provincial Agriculture and Forestry Office (Laos)
PJSTAU	Professor Jayashankar Telangana State Agricultural University
RKVY	Rashtriya Krishi Vikas Yojana
SIWAB	Sapi Indukan Wajib Bunting (Indonesia)
SNV	Stichting Nederlandse Vrijwilligers (Laos)
SVLK	Sistem Verifikasi Legalitas Kayu (Indonesia)
WASSAN	Watershed Support Services and Activities Network (India)

Overview

David Pearce and Bethany Davies

Introduction

This report summarises the adoption results for 4 Australian Centre for International Agricultural Research (ACIAR) projects completed in 2014–15. The projects involved:

- 4 partner countries – Indonesia, Cambodia, Laos and India
- 1 wood processing related project in Indonesia
- 1 multicommodity project (rice, wheat, cotton and vegetables) concerned with climate adaptation strategies
- 2 animal production projects (pigs and cattle).

All of the projects involved the development of new technologies or practical approaches to a variety of issues ranging from animal production to adaptation to changed climatic conditions.

Most of the projects also involved capacity building in partner countries and institutions, ranging from formal university-based training to a variety of on-the-job training activities for technical staff and research scientists.

Three of the adoption studies indicate relatively low levels of adoption of the project outcomes, while one study indicated very high levels of adoption.

Project outputs – what was discovered

ACIAR's adoption studies classify outputs into 3 broad categories:

- **new technologies or practical approaches** for dealing with particular problems or issues, which are designed to be applied ultimately at the farm, processing or marketing level, or in some cases at the breeder level
- **new scientific knowledge or basic understanding** (pure or basic science) of the phenomena or social institutions that affect agriculture, which are designed as inputs into further research processes, ultimately to help in the future development of practical approaches for smallholders, processors, wholesalers and retailers
- **knowledge, models and frameworks for policymakers** or broad-level decision-makers, which are not necessarily for use at the farm level but will influence the contextual environment in which farmers, processors, wholesalers and retailers must operate.

Given the diversity of ACIAR-funded research, there is considerable overlap between these categories, and many projects contribute to more than one of them. Table 1 summarises the outputs for the 4 projects covered in this report.

New technologies or practical approaches were the major outputs for all of the projects covered here. This ranged from the very practical establishment of a furniture association to a range of very targeted farming responses to climate variation.

New scientific knowledge – in the form of detailed data collection for future use – was a feature of 2 of the projects.

Three projects also developed **knowledge or models relevant to policymakers**. This ranged from the development of an industry strategy (subsequently embedded in regulation) to the provision of technical reports to policy makers to assist in climate adaptation.

Table 1: Summary of project outputs

Project	New technologies or practical approaches	New scientific knowledge	Knowledge or models for policy and policymakers
Mahogany and teak furniture: action research to improve value chain efficiency and enhance livelihoods (Jepara, Indonesia) (FST/2007/119)	• producer participation in trade exhibitions and online marketing • establishment of a furniture association: Jepara Small-scale Furniture Producers Association		• establishment of furniture industry strategy (roadmap) along with a district regulation
Improving reproductive performance of cows and performance of fattening cattle in low input systems of Indonesia and northern Australia (LPS/2008/038)	• development of a better cow management system based on rice straw • better fattening rations		• better understanding of household livelihood, supply and value chains
Developing multi-scale adaption strategies for farming communities in Cambodia, Lao PDR, Bangladesh and India (LWR/2008/119)	• Cambodia: 'response farming' approach to seasonal variability around the monsoon • Laos: mechanised direct seeding to deal with wet season variability and labour constraints • India: improved agro-met advisories including a rainfall visualiser, sowing rules and a strategic irrigation guide	• 36 peer-reviewed publications in high-ranking scientific journals (e.g. *Field Crops Research*, *Agricultural Systems*, *Land Use Policy*)	• Cambodia: 'response farming' technical report for use by General Directorate of Agriculture to inform extension and training • Laos: mechanised direct seeding information package for use by national and provincial government agencies • India: Climate Information Centres established to guide industry and government
Increased productivity and reduced risk in pig production and market chains (Laos) (AH/2010/019)	• development of a value-chain analysis methodology that included serological studies to understand risk factors for pig-related diseases • proof of concept for pork tapeworm (*Taenia solium*) control. • establishment of a value chain for pork sales into Vietnam	• dataset based on a seroprevalence survey of northern pigs and villagers to provide a foundation for future work • 13 peer-reviewed publications in high-ranking scientific journals (e.g. *Acta Tropica*, *PLoS Neglected Tropical Diseases*)	

Capacity development

Most of the projects reported here had explicit or secondary objectives to improve the capacity for research and development in partner countries. Table 2 summarises the capacity built and used in the projects.

Capacity development included both formal training (university-level degrees) and on-the-job and informal training. Training ranged from advanced topics in serology to the dissemination of practical veterinary skills to farmers.

In most cases, the research capacity and research infrastructure continued to be used after project completion. The collaboration developed between organisations often remains in place, and staff skills and expertise developed through training continue to be used.

Table 2: Research capacity built by the projects and its continued use

Project	Research capacity built in partner country(ies)	Research infrastructure	Capacity used
Mahogany and teak furniture: action research to improve value chain efficiency and enhance livelihoods (Jepara, Indonesia) (FST/2007/119)	• developed capacity in value-chain analysis and participatory action research		• capacity continues to be used through ongoing development of the Jepara Small-scale Furniture Producers Association
Improving reproductive performance of cows and performance of fattening cattle in low input systems of Indonesia and northern Australia (LPS/2008/038)	• completion of 9 Masters' or PhD degrees • increased capacity of junior scientists employed in the project		• most scientists in the project continue to work on cattle-related industries through a number of programs
Developing multi-scale adaption strategies for farming communities in Cambodia, Lao PDR, Bangladesh and India (LWR/2008/119)	• general skills development through participation within the project team		
Increased productivity and reduced risk in pig production and market chains (Laos) (AH/2010/019)	• specific training in polymerase chain reaction, serology and parasitology at the Lao National Animal Health Laboratory • capacity for ELISA tests for pig-related zoonotic diseases at the National Animal Health Laboratory and the National Centre for Laboratory and Epidemiology • farmers trained in basic veterinary approaches		• laboratory techniques continue to be used in relevant organisations • a number of farmers have continued to use the veterinary techniques learned

Uptake of outputs – progress along adoption pathways

Most of the projects had several different objectives and outputs. Summarising the often complex adoption outcomes for a range of projects is difficult and involves an element of judgement. For the summary in Table 3, a 4-level classification scheme has been used (as in previous adoption reports) to indicate no, low, medium or high uptake.

In this classification scheme, the lowest level of adoption is ***O* or no uptake** of the results by either initial or final users of the outputs of the project. One project had no adoption of some of the project outputs (although there was low adoption of other project outputs).

The next level of adoption is ***N* or low uptake**, in which there has been some uptake by initial users but not by final or ultimate users of the research. Three projects had some outputs in this category (although other components had higher levels of adoption).

The next level of adoption is ***Nf* or medium uptake**, in which there has been uptake by initial users and some uptake by final users. One project had outputs in this category.

The highest level of adoption, ***NF* or high uptake** (use by initial and final users), was achieved in one of the projects.

Table 3: Current levels of adoption of key project outputs

Project	New technology/ practical approach	Scientific knowledge	Knowledge, models for policy
Mahogany and teak furniture: action research to improve value chain efficiency and enhance livelihoods (Jepara, Indonesia) (FST/2007/119)	***NF*** – Jepara Small-scale Furniture Producers Association		***NF*** – District Regulation and Strategic Plan
Improving reproductive performance of cows and performance of fattening cattle in low input systems of Indonesia and northern Australia (LPS/2008/038)	***N*** – rice straw management system ***O*** – better fattening rations		
Developing multi-scale adaption strategies for farming communities in Cambodia, Lao PDR, Bangladesh and India (LWR/2008/119)	***Nf*** – Cambodia ***N*** – Laos ***Nf*** – India		***N*** – Cambodia ***N*** – Laos ***Nf*** – India
Increased productivity and reduced risk in pig production and market chains (Laos) (AH/2010/019)	***N*** – some, but limited, adoption of key project outputs		

Note: Level of uptake is summarised as high, medium, low or none using the following abbreviations:
NF demonstrated and considerable use of results by the initial and final users
Nf demonstrated and considerable use of results by the initial users but only minimal uptake by the final users
N some use of results by the initial users but no uptake by the final users
O no uptake by either initial or final users.

Factors influencing adoption and impact

Many factors underlie adoption outcomes. They can be summarised as follows:

- **Knowledge**
  - Do the final or ultimate users *know* about the project outputs?
  - Is there *continuity* of staff in organisations associated with adoption, leading to the ongoing transfer of knowledge?
  - Are the outputs *complex* compared with the capacity of users to absorb them? (Do users have a sufficient knowledge base to support adoption?)
- **Incentives**
  - Do users have sufficient *incentives* to adopt the outputs?
  - Does adoption of the outputs increase *risk or uncertainty* for the users, thus reducing incentives to adopt?
  - Is adoption either *compulsory* or indirectly *prohibited*? (Are there extreme forms of incentives or barriers?)
- **Barriers**
  - Do potential users face *capital or infrastructure constraints*, limiting their ability to fund the adoption of the outputs?
  - Do potential users face *cultural or social barriers* to adoption?

Table 4 summarises some of the major factors affecting adoption for the projects in this report.

Table 4: Factors influencing adoption and impact – summary of key findings

Factor		Key findings
Knowledge	Do potential users know about the outputs?	This does not appear to be a constraint or issue for the studies covered in this report.
	Is there continuity of staff in organisations associated with adoption?	This does not appear to be a constraint or issue for the studies covered in this report.
	Are outputs complex in comparison with the capability of users?	In the Indonesia cow performance project, the adoption study indicated that most participants did not fully understand the systems approach proposed.
Incentives	Are there sufficient incentives to adopt the outputs?	The lack of a national program on cattle fattening has limited adoption in the Indonesian cattle project. In the case of the pig project in Laos, recent rapid economic development has reduced incentives for pig production in favour of other economic activities, leading to a lack of incentives to adopt pig-related practices.
	Does adoption increase risk or uncertainty?	This does not appear to be a constraint or issue for the studies covered in this report.
	Is adoption compulsory or effectively prohibited?	This does not appear to be a constraint or issue for the studies covered in this report.
Barriers	Do potential users face capital or infrastructure constraints?	Household adoption of the rice straw and fattening projects in Indonesia has been limited by difficulty in accessing credit for supplements or to purchase a bull. At the same time, decreasing availability of key inputs (rice straw and cassava) appears to have placed a constraint on adoption. The ability to raise funds may prove to be a constraint on the operations of the Jepara Small-scale Furniture Producers Association in Indonesian furniture.
	Are there cultural or social barriers to adoption?	This does not appear to be a constraint or issue for the studies covered in this report.

Lessons

The results from the adoption studies reported here provide a number of lessons for ACIAR-funded projects.

External effects on adoption

The development of a particular industry and the adoption of technologies for that industry is often affected or constrained by developments outside the industry, either in input markets or in competing product markets. A good example of this is the cattle feed project in Indonesia, where rice straw and cassava are key inputs to the new feed systems developed. However, the availability of rice straw and cassava are both declining for a number of reasons. For rice straw, this is related to the effects of mechanical harvesting, and for cassava, it relates to competition for export sales.

Rapid economic development

The same theme of the impact of outside factors is even more strongly evident in the pig-production project in Laos. Rapid economic development in the project regions (even over the course of the project) led to a range of new and more profitable options for smallholders so that the importance of pig production was substantively reduced. There is very little incentive now to undertake pig production as a core activity.

Multiple research agencies

ACIAR is often one of several organisations supporting research within a country on a particular industry or issue. Sometimes this can result in a perceived or actual duplication of effort, or limited ability to make use of complementary research. In these circumstances, the importance of a coordination role for research becomes evident. ACIAR may be able to play a role in assisting local research agencies to develop capacity for this form of coordination.

Mahogany and teak furniture: action research to improve value-chain efficiency and enhance livelihoods

Ahmad Dermawan, Center for International Forestry Research

Project number	FST/2007/119
Project title	Mahogany and teak furniture: action research to improve value chain efficiency and enhance livelihoods
Collaborating institutions	Indonesia: Center for International Forestry Research; Forest Research and Development Agency; Forum Rembug Klaster; Bogor Agricultural University Australia: University of Melbourne
Project leader	Herry Purnomo
Project duration	2008 to 2013
Funding	ACIAR A$1,012,090
Countries involved	Indonesia, Australia
Related projects	Improving added value and small medium enterprises capacity in the utilisation of plantation timber for furniture production in Jepara region (FST/2006/117) Improving economic outcomes for smallholders growing teak in agroforestry systems in Indonesia (FST/2005/177)

1. Motivation – what the project aimed to achieve

This project was implemented between 2008 and 2013 in Jepara district in Central Java, Indonesia. The aim of the project was to improve the performance of teak and mahogany small-scale furniture enterprises in Jepara. This in turn required overcoming constraints related to inefficiencies in supply and value chains, low levels of organisation a mong furniture producers and limited producer access to finance.

The specific objectives and activities of the project were:

1. to enhance the structure and function of the furniture industry for the benefit of small-scale furniture producers
2. to improve marketing by small-scale furniture producers and their industry associations
3. to monitor changes on the effects and early acceptance of innovations from objectives 1 and 2 and revise and reinforce project strategies.

The project approach was mostly based on value-chain analysis, participatory action research, and institutional and governance analysis. Project partners applied value-chain analysis to identify the actors and their roles in adding value along the value chain and identified inefficiencies along the value chain. The use of participatory action research ensured community participation in the identification, analysis and solution of problems. In addition, project partners applied institutional and governance analysis to identify actors and their power structure and identify ways to improve the conditions of the small-scale furniture producers in Jepara.

2. Outputs – what the project produced

Technical and policy outputs

Key technical and policy outputs included:

1. The Jepara Small-scale Furniture Producers Association (APKJ) was legally established and has emerged as an important avenue for improving its members' capacity to manufacture better-quality furniture and deal with management issues.
2. A comprehensive strategy for the development of the furniture industry (the Roadmap) was created for the period 2013 to 2023 and a Jepara District Regulation based on the Roadmap was issued in 2014.
3. A group of 9 small-scale furniture producers and 1 individual obtained certification under Indonesia's national timber legality assurance system (Sistem Verifikasi Legalitas Kayu [SVLK]).
4. Small-scale furniture producers have increased their income thanks to a better understanding of the market, training provided under the project, participation in trade exhibitions and use of online marketing to reach a wider market.

Capacity development by the project

The Center for International Forestry Research and its partners conducted several capacity-building activities during the course of the project. Capacity developed includes the areas of participatory action research. Much of the capacity developed in this project is closely related to the technical and policy outputs set out above. In particular, the APKJ is a forum designed in part to increase the capacity of furniture producers in all aspects of their industry.

The project has improved networking between small-scale furniture producers and the Ministry of Trade and Industry, the Ministry of Forestry and other agencies at various levels. These networks have begun to include APKJ and its members on their list of invitees for any capacity-building, policy and business events. APKJ is becoming an example of how small-scale producers can organise themselves. However, this does not overcome the challenges for APKJ in strengthening its organisation and attracting new members.

Through the formulation of the Roadmap, the project contributed to the improvement of the capacity of Bappeda and Disperindag in developing a strategic plan for the district's furniture industry. Jepara government agencies, such as Bappeda, will have more data on the Jepara furniture industry and are better equipped to develop plans in a more participatory manner. The Industry and Trade District Office will be allocated more funds to support small-scale furniture producers.

3. Adoption – how the project outputs are being used

Adoption of technical and policy outputs

APKJ has been running for 10 years. It has gone through 3 administration periods. The current administration started in 2017 and will finish in 2022. APKJ has become known both within Jepara and outside Jepara, partly due to APKJ's participation in the national exhibition or trade shows and through APKJ's extended network. APKJ has been engaging with the district government of Jepara for the allocation of district budget to cover the participation of APKJ members in the exhibition and trade show. The scale of business of several APKJ members has become bigger, which led to the change in the meaning of the initial 'K' in the APKJ from 'Kecil' (small) to 'Kayu' (timber). The change of the name also aimed to clarify the scope of APKJ to include only timber-based furniture and handicraft producers.

District Regulation 2 of 2014 was the first district-level regulation that aims to protect the furniture industry in Indonesia.

District Regulation 2 has mandated obligations for the district government in several areas. To protect the furniture industry (Chapter III), the regulation mandates the district government to protect the furniture industry in the following areas (Article 5): infrastructure, business certainty, furniture price

and insurance coverage. The government needs to empower the furniture industry (Chapter IV) in the following areas (Article 17): education and training, extension and facilitation, quality standard, marketing system and infrastructure, partnership scheme, financing, access to knowledge and technology, and institutional strengthening.

Meanwhile, the district government needs to foster the furniture industry (Chapter V) by conducting 4 actions:

- fostering furniture producers in areas that are relevant to the interest of the producers
- developing and facilitating education, training, extension services and research on furniture
- facilitating the development of business networks and cooperation that is mutually beneficial for furniture producers
- providing consultancy services to help solve the problems faced by the furniture producers (Article 41).

Adoption in the future

Adoption in the future depends both on ongoing development of APKJ as well as the ongoing implementation of District Regulation 2, particularly through a range of technical guidelines.

APKJ

Participants in this adoption study articulated a general expectation that APKJ will be able to help improve the prosperity of its members and bring them more benefits. Some participants had more specific aspirations, for example, that APKJ can conduct more frequent meetings for the members and provide more training on better production techniques, marketing, access to finance and SVLK certification. Others expect APKJ to become a venue to help each other through members' visits and through provision of up-to-date market information. Another also hoped that APKJ's office can serve as a place to learn from each other. External participants hoped that APKJ will have a stronger voice in setting the agenda in the furniture sector in Jepara and that it can voice the concerns of its members to the district government. They also hope APKJ will have more collaboration with both national and international partners.

District Regulation 2

District Regulation 2 mentions 6 areas that require the technical guidelines (formally called the Regulation of the Head of the District – *Peraturan Bupati*):

- administrative requirements and quality standard of furniture products for the export market (Article 12)
- provision of an insurance scheme for furniture producers (Article 14)
- procedure of data collection of furniture producers (Article 19)
- procedure of the provision of assistance or grants for furniture producers (Article 20)
- creation of the Jepara Furniture Council
- creation of a special unit of furniture financing (Article 44).

Factors affecting adoption

APKJ

One challenge related to how APKJ moves forward is related to its ability to raise funds. APKJ currently does not apply membership or regular fees to its members. Some of the members are financing APKJ's operations. In the future, APKJ needs to think strategically about fundraising. APKJ could consider applying membership or regular fees, which would give some flexibility to conduct their activities and attract new members.

At the same time, the formulation of fundraising policies and plans needs to be balanced with attention to improving APKJ's internal conditions. Several key personnel have been working tirelessly to run the APKJ since its establishment. Active members get a better chance of receiving more benefits. One participant said, '...only certain people get the benefit of participating in the exhibitions.' APKJ should develop policies and mechanisms that enable collaborative efforts among its members.

Externally, APKJ has not been able to attract new members as rapidly as it did during the early period. As one APKJ member said, '…it is difficult to attract new members because they will ask about the benefits of being a member as opposed to doing business by themselves.' Some non-members are interested to know more about the APKJ after being given explanations on its activities. However, APKJ does not have marketing materials ready for dissemination. Producing leaflets and a website for APKJ would require funding.

District Regulation 2

One critical factor that will affect the implementation (and ongoing adoption) of District Regulation 2 is the availability of the technical guidelines (*Peraturan Bupati*), which will help government agencies develop plans and programs.

Another factor that will affect the adoption is whether the formulation of the technical guidelines forms part of the current government's priorities. The industry and trade office is formulating the District Industrial Development Plan (*Rencana Pembangunan Industri Kabupaten*). The government will be able to propose the allocation of funding for the formulation of the technical guidelines when the plan is available. Funding is required to cover the cost of meetings and consultation in the formulation of the technical guidelines. As the local government will issue the technical guidelines, the formulation of the technical guidelines could be shorter than if the process involves the legislative branch.

Changes in government personnel can also affect the adoption of District Regulation 2. There is some evidence that not all levels of government are currently aware of the regulation.

4. Impact – the difference the project will or may make

Community impacts

Participants contacted as part of this adoption study indicated that they have received a range of benefits from the establishment of APKJ. Essentially, these benefits involved increased income or increased opportunities, including:

- better market access (including through trade shows and other marketing)
- better access to innovations
- better networking among furniture producers
- a strengthened furniture producer voice in political arenas in Jepara
- training on quality improvement.

Benefits from District Regulation 2 are less evident at the moment because of the lack of technical guidelines and changes in government personnel. Participants agree, however, on the importance of District Regulation 2 to protect, empower and foster the furniture producers in Jepara.

Factors affecting the magnitude of the impact

The factor that affects the magnitude of the impact of the APKJ is the resources that APKJ can secure to conduct internal coordination and external engagement and outreach. This issue is particularly important given that APKJ does not collect membership or regular fees. In the longer term, strengthening the cooperative that was set up in 2012 could be an option to secure the budget to conduct its mission. APKJ could also consider developing a fundraising strategy and communicate with the members about its annual budget, to raise awareness about the need for resources to conduct its activities.

The magnitude of the impact of District Regulation 2 will depend on the completion of the technical guidelines. Subsequently, the government will need to change the priorities, allocate a budget and reach an agreement with the local parliament. Once these are in place, the implementation and its outcomes will become the basis for the impact assessment. As such, the factors that affect the magnitude of the impact are whether there are sufficient resources to formulate, finance and implement the technical guidelines.

Improving reproductive performance of cows and performance of fattening cattle in low input systems of Indonesia and northern Australia

Dennis Poppi, University of Queensland
Atien Priyanti, Indonesian Agency for Agricultural Research and Development
Di Mayberry, CSIRO

Project number	LPS/2008/038
Project title	Improving reproductive performance of cows and performance of fattening cattle in low input systems of Indonesia and northern Australia
Collaborating institutions	Australia: University of Queensland; Northern Territory Department of Regional Development, Primary Industry, Fisheries & Resources Indonesia: Indonesian Center for Animal Research and Development, Bogor; Beef Cattle Research Institute, Grati; Balai Pengkajian Teknologi Pertanian (BPTP) – Nusa Tenggara Barat; Faculty of Animal Science, University of Mataram; BPTP – Sulawesi Tenggara; Department of Animal Production, University of Haluoleo
Project leaders	Dennis Poppi, Atien Priyanti and Di Mayberry
Project duration	2009 to 2013
Funding	ACIAR: A$1,538,040 In-kind from participating organisations: A$608,322
Countries involved	Indonesia, Australia
Related projects	Developing an integrated production system for Bali cattle in the eastern islands of Indonesia (AS2/2000/103) Strategies to increase growth of weaned Bali calves (LPS/2004/023) Scaling-up herd management strategies in crop-livestock systems in Lombok (SMAR/2006/096) Opportunities to use cocoa pods and forages to address feed gaps in the dry season in South East Sulawesi (SMAR/2007/013) Improving reproductive performance of cows and performance of fattening cattle in low input systems of Indonesia and northern Australia (LPS/2008/038) Profitable feeding strategies for smallholder cattle in Indonesia (LPS/2013/021)

1. Motivation – what the project aimed to achieve

Indonesia had a long-running program to develop its domestic beef industry, as the demand for beef in Indonesia was increasing and current domestic supply was unable to meet local demand. Simply increasing cattle numbers was not an option without some increase in the feed supply or better use of crop residues. The large rural population and intensity of land use for food crops mean there are limited opportunities to increase the feed available for livestock. Increasing cattle numbers and improving the productivity and profitability of smallholder cattle enterprises will therefore require greater and more efficient use of feed resources such as rice straw and crop by-products.

Rice straw is currently underused in Indonesia. It is traded as an important feed resource, especially in East Java, where there is shortage of land. Rice straw is a low-quality feed, but if directed towards cows with low maintenance requirements, it would be adequate. This would free higher-quality feed resources to be directed towards growth of weaned animals, resulting in faster turnover and output from the system.

This project used a systems approach by applying an improved cattle management system (Integrated Village Management System) that had been developed and tested with Bali cattle in Lombok in previous ACIAR projects. This was combined with feeding of untreated rice straw to cattle, and the strategic supplementation of animals with high nutritional demands. Developing better growing and fattening systems by using other crop by-products could then be developed. Together, the total feed resources in a region could be better used for both cow–calf systems and fattening systems within a household and the region to increase beef output. There are many similarities between the cattle production systems in Australia and Indonesia, and lessons learned in both countries can be mutually beneficial.

The focus of this project was Bali (*Bos javanicus*) and Ongole (*Bos indicus*) cattle. These are the 2 most common cattle breeds in Indonesia, and they comprise 32% and 29% of the national beef herd respectively. Villages with Ongole cattle were selected in East Java and villages with Bali cattle were selected in Lombok and Southeast Sulawesi.

The project aimed to develop and test a cow–calf system based on rice straw using the Integrated Village Management System, and to formulate better fattening rations for bulls. A socioeconomic evaluation of the system, the importance of cattle to the household and the supply and value chain of rice straw and cattle in East Java provided guidance for the extension and scale out of results.

2. Outputs – what the project produced

Technical outputs

Development of a better cow management system based on rice straw

A technical package based on the Integrated Village Management System was applied to both Bali and Ongole cows fed on rice straw with a small level of tree legume or concentrate supplement. This was successfully implemented within a village system and was further demonstrated to work in on-station controlled experiments.

Features of the package included:

- a focus on body condition score (BCS) at calving (>3 out of scale 5)
- early weaning (6 months or less)
- a mating procedure (bulls or artificial insemination starting at 40 days post-calving with enhanced farmer capacity in oestrous detection).

A major finding was that cows fed untreated rice straw can maintain a BCS at a level required for successful reproduction when this feed is supplemented with a small amount of readily available tree legume, for example, gliricidia or leucaena.

Better fattening rations

Better fattening rations were tested within villages and on-station based on *onggok* (cassava bagasse). The income over feed cost was increased by 55% using these improved rations within a village system. High inclusion of onggok led to very low liveweight gain. There is currently no nutritional explanation for this finding.

Household livelihood, supply and value chains

There was a better understanding of the role of cattle in household livelihoods in both upland and lowland areas of East Java. It was found that small-scale backyard cattle enterprises can help poor households get ahead and assist in poverty reduction. There was already a large trade in all feedstuffs in addition to cattle trading within cow–calf and fattening systems.

Policy outputs

There were no direct policy outputs from the project and policymakers were not directly engaged. However, there are policy implications from the results. Smallholder fattening systems need access to a high-energy feed source. Cassava and its by-products provide one of the few opportunities for this within Indonesia. However, cassava chips are exported and cassava production is declining. There is a policy consideration about the national value of an export industry versus value adding in the cattle industry.

Capacity outputs

There was strong development of capacity in farmers involved in the project, especially with respect to understanding the importance of BCS, weaning and mating procedures and the role of tree legumes as a supplement. Farmers made these statements:

- 'I know about BCS and how to feed the cow.'
- 'I know untreated rice straw needs some tree legume to maintain BCS.'
- 'I know to wean the calf.'
- 'I know I can use gliricidia.'

There was capacity development in both Indonesian and Australian researchers. Nine people completed master's or doctorate degrees during or soon after the project. Five of these were in Australia (on John Allwright Fellowships) or New Zealand.

The junior scientists employed by the project followed a model of full-time employment and training set up in the ACIAR projects 'Strategies to increase growth of weaned Bali calves' (LPS/2004/023) and 'Scaling-up herd management strategies in crop-livestock systems in Lombok' (SMAR/2006/096). Government and university scientists who managed activities recorded statements such as 'first international paper, skills in data acquisition, quality control and manipulation, promotion (at various levels up to professor), enhanced national network'. All of the scientists have roles in implementing SIWAB (Sapi Indukan Wajib Bunting), a national program to increase cow reproduction across all provinces in Indonesia, and all use their capacity developed in this project. Australian scientists recorded similar statements. For most of them, it was their first ACIAR project. All have gone on to be project leaders in their own projects with ACIAR and Meat and Livestock Australia.

3. Adoption – how the project inputs are being used

Capacity

All the Indonesian scientists (university and BPTP) involved in the project are involved in the national program SIWAB, and some are also involved in the Department of Foreign Affairs and Trade (DFAT)/ ACIAR program Indobeef. The experience they gained in this project has enabled them to contribute technically to the SIWAB program. A local champion (farmer and scientist/extensionist) of the research results was essential for there to be outreach of the outputs. These local champions had to be confident and knowledgeable. The opportunity to link to a national program with government support was also important.

The junior Indonesian scientists, most of whom were in their first job, have not had a clear path for further progression. They were contracted employees for the project, even though they were placed within a university, BPTP or the Indonesian Center for Animal Research and Development (ICARD). Of the 13 junior scientists, 8 are currently employed by government agencies, universities or the commercial livestock sector, or are undertaking further postgraduate training within the livestock sector. The other 5 are in non-livestock activities.

All the junior Australian scientists have continued to work in the livestock sector and have taken on more senior roles within CSIRO, the Northern Territory Department of Primary Industry and Fisheries or a university. They are all project leaders of ACIAR and/or Meat and Livestock Australia projects. One has used his experience to contribute to the operation of the Indonesia Australia Red Meat and Cattle Partnership in East Kalimantan Breeders Support project.

Technical and policy outputs

The primary purpose of this research project was to test interventions and develop robust technical packages. It was not intended to scale out beyond engaging the villagers directly involved in the monitoring exercise, nor did it seek to influence policy directly.

BCS, weaning and a mating procedure are all results from this project that are being used in SIWAB, the national program to improve reproduction in cows in Indonesia. They contribute to general principles used by agencies within Indonesia to advise on cow reproduction. This program started in 2016 and currently has 3 million cows (cattle and buffaloes). The Indobeef program uses some of the same principles in their approach. The principles developed in this project are not original but the demonstration that they work and the longitudinal data that supports them provides confidence in their uptake.

There has been no adoption of better fattening rations. The results were very significant and showed that income over food costs were 55% greater if a strategy of better formulation for least-cost and high-feed conversion were employed. This has led to the development of an ACIAR project 'Profitable feeding strategies for smallholder cattle in Indonesia' (LPS/2013/021), which is developing least-cost rations for high-feed conversion using a least-cost ration formulator. The lack of any national program on cattle fattening to facilitate adoption has hampered the uptake of the results. The new project targets commercial feed companies and cooperatives as next users who could facilitate this.

There are policy implications for the use of cassava and its by-products. Smallholders could benefit enormously if cassava and its by-products were value added within Indonesia through cattle fattening.

The supply chain and value-chain analysis has informed decision-makers but the extent to which it has influenced programs and their evaluation is not known.

Adoption in the future

Adoption in the future depends on the Indonesian Government's willingness to support the livestock sector through programs such as SIWAB. SIWAB offers the best opportunity for key outputs to be adopted widely, in particular BCS of the cow and early weaning and the different means to achieve that. The focus on BCS to achieve high reproduction rates is a significant change in the approach and the team members have contributed greatly to the technical information to achieve that.

Adoption by farmers depends on a local champion researcher/extension specialist and the opportunity for farmers to see and have confidence in the technology being proposed. Various scale-out models have been proposed and investigated in other projects, but the adoption of the system used in this project in part or in full depends on a local champion strongly encouraging and supporting the technology.

4. Impact – the difference the project will or may make

Community impacts

Smallholder farmers were the key target beneficiaries of the system used in this project. Participating villages have adopted parts of the system, especially BCS and weaning, which are the key drivers to increasing reproduction. These villages have limited impact locally, except for Karang Kendal and Papak in North Lombok, which have used their skills to advise other farmers. SIWAB has provided an opportunity to have a larger impact on smallholders.

There was no community impact of the fattening system and no immediate uptake of the outputs. This appears to be due to the cost structure and investment required to implement the new diets, despite significantly enhanced returns. There is also no national program that focuses on fattening, despite the large potential impact to both households and national meat production.

There was a large impact on the scientific capacity of participants and their networking, and their involvement in national programs has increased that.

Factors affecting the magnitude of the impact

The development of a national program on cow reproduction (SIWAB) separate to this project provided a vehicle for extending the results more widely. This was not planned but it was a fortuitous outcome that hastened the uptake of results. The contrast to the poor uptake of the results from better fattening rations was very apparent. The socioeconomic study provided important information on household livelihood, the role of cattle, the players in the supply and value chains and the response to suggested interventions. While some individuals from the project are senior enough to influence policymakers there was no pathway to identify policymakers as next users who could influence decisions.

SIWAB was developed to run from 2016 to 2019 with a possible 5-year extension. Indobeef, another large project on cow–calf systems, started in 2018 and will use some of the principles from this project.

Photo: Massimo Munnichi

Developing multi-scale adaptation strategies for farming communities in Cambodia, Laos, Bangladesh and India

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Project number	LWR/2008/019
Project title	Developing multi-scale adaptation strategies for farming communities in Cambodia, Lao PDR, Bangladesh and India
Collaborating institutions	Australia: CSIRO Cambodia: Department of Agricultural Extension; Cambodian Agricultural Research & Development Institute; International Development Enterprises Laos: National Agricultural & Forestry Research Institute; Department of Agricultural Extension and Cooperatives; Department of Meteorology and Hydrology; Provincial Agriculture and Forestry Office, Savannakhet Bangladesh: International Rice Research Institute; Bangladesh Agricultural Research Institute; Social Economic Research & Development Institute; Bangladesh Agricultural Research Council India: Professor Jayashankar Telangana State Agricultural University; Livelihoods & Natural Resource Management Institute; Watershed Support Services & Activities Network; Indian Meteorology Department; National Centre for Medium Range Weather Forecasting
Project leader	Christian Roth (CSIRO)
Project duration	2010 to 2015
Funding	ACIAR A$5,516,026 In-kind from participating organisations: A$3,300,000
Countries involved	Australia, India, Cambodia, Laos and Bangladesh
Commodities involved	Rice, wheat, cotton and vegetables
Key related ACIAR projects	Developing research options to mainstream climate adaptation into farming systems in Cambodia, Laos, Bangladesh and India (SRA) (LWR/2008/015) Developing capacity in cropping systems modelling to promote food security and the sustainable use of water resources in South Asia (LWR/2010/033) Regional co-learning in simple mechanised tools for rice planting (SRA) (LWR/2012/110) Increased productivity of rice-based cropping systems in Laos (CSE/2006/041)

1. Motivation – what the project aimed to achieve

Farming communities in Asian countries such as Cambodia, Laos, Bangladesh and India are highly vulnerable to the effects of a changing climate. Climate risks are high and include shifts in rainfall patterns, changing temperature regimes, increased frequency of extreme weather events, salinity intrusion and increased seasonal variability.

Typically, resource-poor smallholder farmers in these countries are highly vulnerable as they have limited opportunities to change their enterprises and practices. This is compounded by a lack of infrastructure and underdeveloped institutional capacity to support effective adaptation.

In 2008, ACIAR established a dedicated Climate Change Initiative to build on our diverse portfolio of climate-related projects managed across sectors. The first phase of the new initiative was focused on farm-level adaptation to climate change and more efficient use of water resources, particularly in the lower Mekong Basin and South Asia.

ACIAR commissioned CSIRO's Climate Adaptation Flagship to undertake the scoping and design study 'Developing research options to mainstream climate adaptation into farming systems in Cambodia, Laos, Bangladesh and India' (LWR/2008/015). This scoping study comprised extensive consultations with national and international research institutions and key government and non-government stakeholders, identification of partner agencies and groups, co-development of project design and initial in-country testing of a number of analytical tools.

The study noted that adaptation interventions generally fall into 2 broad groups. Top-down approaches designed in response to national scale climate change vulnerability and impact assessments provide strategic guidance for sectors or regions but offer little insights or support for household or community scale adaptation and resilience. Bottom-up approaches provide practical interventions at these scales but are constrained by the challenge of scaling success for broader impact.

The intent of 'Developing multi-scale adaptation strategies for farming communities in Cambodia, Lao PDR, Bangladesh and India' (referred to as Adapting to Climate Change in Asia, or ACCA) was to bring these 2 approaches together by:

- working with farmers in selected regions in these 4 countries to identify, select and test locally feasible adaptation options that are viable, suitable for local communities and that better position them to respond to climate variability and change
- supporting people in charge of policy and programs to design and deliver more effective adaptation initiatives that are relevant to smallholder livelihoods and food security.

2. Outputs – what the project produced

ACCA's approach was consistent across Cambodia, Laos, India and Bangladesh: build an understanding of locally feasible management options to increase smallholder capacity to adapt to climate and explore promising mechanisms for broad application. However, the pathways, outputs and influence were different across the 4 countries, and are considered separately as part of the adoption study.

Outputs, adoption and impact of the Bangladesh component of ACCA forms part of a submitted adoption study report for *Adoption of ACIAR project outputs 2019*. Because of its comprehensive coverage of crop systems modelling and application that was the primary emphasis for ACCA, this adoption study focuses on adoption of research in the other 3 countries.

Capacity developed

Capacity from the project was defined as skills developed by the in-country project team to:

- achieve specific project milestones
- understand/ implement the ACCA research approach to climate adaptation, using systems understanding and stakeholder engagement to address climate risk in a dynamic environment.

Technical outputs

The adoption study focuses on synthesised research outputs most applicable to the country context that were developed from social, biophysical and farming systems research; modelling; and farmer engagement.

Synthesised technical outputs for each country:

- **Cambodia**: The 'response farming' approach to addressing seasonal variability assumes that there are a number of ways in which the monsoon period can be used to produce wet-season rice. Options better suited to particular climatic conditions and response farming provide farmers with flexibility to address their climate risk as a season unfolds.
- **Laos**: Mechanised direct seeding[1] was used to manage risks associated with variable wet season starting dates and labour shortages due to migration and off-farm work opportunities. ACCA was not the first, or only, project to test or promote the use of direct seeding methods in Laos. Disentangling the contribution of ACCA in this broad body of work is difficult, as projects shared institutional partners, individual team members and, in some cases, project sites. ACCA's distinct contribution was the exploration of the potential of mechanised dry seeding as an adaptive response to seasonal variability, with a focus on rainfed production systems.
- **India**: Outputs were improved agro-met advisories[2] (incorporating farmer feedback, diversity in dissemination channels and a shift to more accessible presentation), a rainfall visualiser to support local understanding of rainfall patterns, sowing rules to help reduce the risk of seedling loss due to dry spells after sowing and a set of locally customised rules to guide farmers on strategic irrigation to reduce the risk of crop failure during drought periods.

Policy outputs

Influencing the policy and programs of donors and governments was a deliberate impact pathway pursued by the project. Key outputs supporting this included:

- **Cambodia**: A technical report produced by a technical reference panel summarised principles and guidance for response farming for monsoon rice and was endorsed by the General Directorate of Agriculture. This was used to inform extension and training in climate variability and change for initial users (project partners: Department of Agricultural Extension and International Development Enterprises) and next users (International Fund for Agricultural Development [IFAD]).
- **Laos**: A summary of technical knowledge and insights on use of direct seeders, including the benefits, challenges and areas that needed to be addressed to support inclusion of direct seeding into farmer practices was produced. This was a resource for stakeholders as part of ongoing engagements, rather than being a discrete package for adoption. Initial users included the project partners, particularly the National Agriculture and Forestry Institute (NAFRI) and Provincial Agriculture and Forestry Office (PAFO). Intended next users included District Agriculture and Forestry Offices (DAFO), and other development actors such as Stichting Nederlandse Vrijwilligers (SNV) and IFAD.
- **India**: Climate Information Centres (CLICs), as a consolidation of the technical outputs from ACCA (advisories, sowing and irrigation rules) are a 'one-stop-shop' for farmers seeking information and advice on agricultural activities. The CLICs were designed to provide timely and locally relevant information to farmers to guide decision-making. Initial users included project partners. Intended next users included local government (Village Gram Panchayats), state government (Department of Rural Development, Department of Panchayati Raj) and research and development partners. Policy and stakeholder workshops were the primary mechanism to engage with key stakeholders and promote the potential benefits of the work.

1 This report follows the language used in the ACCA project, which used 'direct seeding' as shorthand for mechanised drill seeding in dry soil. This is slightly different from the broader use of direct seeding, which can be used to include broadcast, dry or wet direct seeding using a drum seeder.

2 Agriculture is weather-dependent at the local level. However, farmers often do not have access to reliable locally relevant meteorological and agricultural information to help them plan and manage their farming operations. Agro-met advisories are weather-based, crop-specific advisories to farmers to help with crop planning.

3. Adoption – how the project outputs are being used

The level of adoption across 3 countries is summarised in Table 5. More detailed aspects of adoption in the 3 countries follows.

Table 5: Summary of adoption across countries and outputs

Country	Technical outputs	Policy/institutional outputs
Cambodia	*Nf*	*N*
Laos	*N*	*N*
India	*Nf*	*Nf*

Based on ACIAR categories *0* or no uptake by initial or final users; *N* or low uptake, where there was some uptake by initial users but not by final users; *Nf* or medium uptake, where there was some uptake by initial users and final users; and *NF* or high uptake by initial and final users.

Cambodia

Capacity use

The adoption study found that partner agencies continue to use technical methods and integrated learning in subsequent programs on adaptation and resilience, and contribute to the clarification of climate change issues in Cambodia by providing a pathway for action on climate adaptation.

The Cambodian Ministry of Agriculture, Forestry and Fisheries (MAFF) and provincial partners who were part of the development of ACCA's technical knowledge around adaptation options were critical in the design and subsequent implementation of larger adaptation and extension programs, such as IFAD's Project for Agricultural Development and Economic Empowerment (PADEE) and Agriculture Services Programme for Innovation, Resilience and Extension (ASPIRE) programs.

There are certainly larger and more influential partners who have supported Cambodia's climate policy and, subsequently, its alignment with global frameworks such as the United Nations Sustainable Development Goals. However, ACCA coincided with the creation of MAFF's first sectoral climate change action plan to support the broader Cambodia Climate Change Action Plan (2016–18) and Strategic Plan (2014–23), which align with the Agriculture Sector Strategic Development Plan (2014–18) and National Strategic Development Plan (2014–18).

At the end of ACCA, Dr Mak Souen, then the Deputy Director General of the General Directorate of Agriculture, reflected that 'until ACCA involvement in Cambodian climate change research, it had been difficult to develop a clear understanding of the topic. The combination of ACCA training and communication, biophysical research, systems analysis and potential systems solutions had provided a way forward, allowing the government to develop appropriate responses.'

Adoption to date

At the end of the project, the ACCA team estimated that over 20,000 farmers had been exposed to some aspects of ACCA's response farming package through the International Development Enterprises' farm business advisors, Department of Agricultural extension training and extension and PADEE's community extension workers. Five per cent adoption would mean around 1,100 households might benefit by US$328–390/ha over traditional practices.

At the time of the adoption study, aspects of the response farming package had been incorporated into training and extension material PADEE used with 492 community extension workers and around 1,200 local extension agents, who directly serviced around 89,000 households in 246 communities across the 5 provinces of Svay Rieng, Prey Veng, Kandal, Takeo and Kampot.

Members of the ACCA team were involved in the design and initial implementation of ASPIRE and used ACCA resources and knowledge to train and guide ASPIRE staff. For example, aspects of the response farming package were implemented into 24 provincial Departments of Agriculture as part of the ASPIRE program.

Adoption in the future

Agency interviews suggested that technical aspects of ACCA had a strong influence in PADEE, particularly through provision of information and changes to the approach of extensionists towards addressing climate risk. ACCA had some influence in the design of ASPIRE, but less in its operations and this is likely to be further diluted with shifts in the program strategy towards its anticipated 2021 finish.

With respect to specific adaptation options promoted as part of the response farming package, at a minimum, the continued use of modern rice varieties, double cropping where feasible, drum and broadcast seeding and water storage in Svay Rieng province would be expected.

Factors affecting adoption

For ACCA in Cambodia, factors affecting adoption include:

- a focus on guiding farmers and policy makers to better understand seasonal variability and how to adapt to it (compared with the productivity focus of many other programs)
- ongoing variability in climate in the study region
- the provision of a range of tools and advice to explicitly help farmers manage climate risk
- variable access to inputs and infrastructure, particularly access to irrigation
- fostering co-ownership
- supporting institutionalisation of response farming into other programs.

Laos

Capacity use

Capacity built during ACCA has supported the establishment of the Research Centre for Climate Change Resilience in Agriculture within NAFRI and skills and knowledge relating to direct seeding continue to be used at provincial and district levels.

ACCA (along with other internationally funded projects like the Climate Resilience Project with the United Nations Development Programme) promoted understanding and awareness about climate change in NAFRI and contributed to the establishment of NAFRI's Research Centre for Climate Change Resilience in Agriculture. According to one interviewee, NAFRI was able to establish the centre because of capacity in climate analysis and research that was built in ACCA. This also enabled key staff from ACCA to lead the centre.

A former team member reflected that during ACCA, the PAFO team had built strong skills and an understanding of the information farmers needed to effectively use the direct seeder. They had been able to support farmers to think about the influence and impact of climate change on their farming. Despite their new positions, former team members from PAFO continue to discuss and share their experiences in their new roles, and continue to promote the direct seeder, providing advice to farmers, DAFO and extension stations.

Given the number of ongoing projects that are testing and/or promoting the direct seeder, it was noted that much provincial knowledge is held by those who were involved in the project. The extent to which learning is shared across projects is mostly dependant on key staff being allocated across multiple projects to bring these lessons and insights with them.

Adoption to date

By 2014, ACCA had supported the following outcomes:

- NAFRI had incorporated monitoring and understanding changes in climate, and results from the direct-seeded rice research into their good agricultural practice training. This training had been delivered to 240 farmers in Outhomphone and Champhone.
- PAFO had established demonstration plots, farmer field schools, on-farm testing, a range of communication materials and a number of direct seeders for farmer use (with a goal to support seeder access in all districts and a plan to purchase an additional 1,000 seeders by 2019–20).

- As part of its Sustainable Natural Resource Management Productivity Enhancement Project,[3] IFAD sought direct input and information on use of the direct seeder from members of the ACCA team to help prepare their training manual (distributed to 1,000 research and extension offices across 5 target provinces) and extension pamphlets (distribution of 2,000 was anticipated by 2016). No information on the outcomes of the distribution was available as part of the adoption study.
- SNV had incorporated direct seeding of rice into its Climate Smart Agriculture initiative in Khammouane province, including field testing and development of training packages in collaboration with NAFRI and the Khammouane PAFO office. By the initiative's close in 2015, it was expected about 500 farmer champions in SNV's focus districts would have been trained. No information on the outcomes of the distribution was found as part of the adoption study.

To the extent that additional policy and program influence was uncovered by the adoption interviews, much of this was due to the efforts of former team members in NAFRI and PAFO continuing to champion direct seeding and climate information, and as such is closely linked to capacity developed as part of the project. These efforts are often dependent on the presence of international development projects that provide the resources to support further work. Examples of ACCA influence include:

- NAFRI continues to use materials developed with ACCA as part of their good agricultural practice training. This has been further developed with a Lao-language DVD that was produced based on ACCA findings with additional funding support from ACIAR in 2015.
- In 2014–15, NAFRI integrated methods for climate information and understanding tested in ACCA into the IFAD-funded 'Climate Risk Management in Agriculture' project. The project worked in at least one ACCA village and incorporated village-level climate monitoring, rainfall visualisers and seasonal advisories into a climate farmer field school format promoted by IFAD. Unpublished reports suggest the climate farmer field schools had contributed to increased farmer knowledge, and many farmers had used, or were interested in using, the seeders.
- Two interviewees indicated that as a result of the support fostered for direct seeding by ACCA and other projects, the Savannakhet provincial government had introduced a policy to promote the direct seeder and had removed import taxes to make machines cheaper for farmers to purchase.

Table 6 provides an estimate of the area sown by farmers using mechanised direct seeding between 2013 and 2018, showing a peak in 2016, followed by a decline in 2017. The area of land planted can change from year to year based on seasonal conditions; however, this indicates that at its peak in 2016, 8–9% of lowland rice in Savannakhet was sown using direct seeders.

Variation in the use of the seeder from season to season is to be expected, as its suitability depends on the seasonal conditions (for example, if rains come early, farmers are likely to transplant because of water availability and difficulty manoeuvring the seeder through the heavier soil). Farmers also are not necessarily using the seeder to plant all their fields. However, the decline in seeder use is also related to the increasing weed problem.

Table 6: Estimated area of Savannakhet planted using mechanised direct seeder (ha)

2013†	2014‡	2015	2016	2017	2018
100	80	836	16,000–17,000	7,000	10,000

† In 2013, 51 farmers were involved in ACCA-related farm demonstrations and trials. Farmers were encouraged to use the seeders in additional (non-trial) fields once the trial fields were sown. Other projects were also actively trialling and promoting direct seeders at this time. Farmers described the season as having prolonged dry spells.

‡ In 2014, ACCA reduced the number of farmers it was conducting trials with to 9 to enable greater support and higher-quality data collection. According to one interviewee, 2017 and 2018 were both characterised by early rains, which reduced the suitability of and need for the direct seeder.

3 The Sustainable Natural Resource Management Productivity Enhancement Project aimed to improve the use of natural resources and productivity through institutional capacity building in Laos. Component 2 oversaw 71 subprojects aimed and improving productivity, one of which supported introduction and use of direct seeders.

It is reasonable to suggest that the trials and demonstrations conducted by NAFRI, PAFO, DAFO and farmers as part of ACCA, built confidence and capacity in the method, provided access to some machines and contributed to the initial increase in use of the seeder. Ongoing use of the seeder has been encouraged by a number of subsequent and ongoing projects. Separating ACCA's contribution from other research and international development projects is difficult, but it is likely to be modest relative to larger projects.

Adoption in the future

The biggest constraint in the continued use of mechanised direct seeding is weeds. Unless appropriate strategies and methods for controlling weeds in direct-seeded rice are developed, it is likely that farmers will stop using the seeder and revert to transplanting – something which many interviewees had already observed – or increase the use of herbicides.

If suitable strategies for the weed problem are developed, and appropriate information and support becomes available to help farmers learn how to use direct seeders for their conditions, it is reasonable to expect ongoing use of direct seeders and expanded use over time.

As direct seeders are not appropriate in all fields due to topography and soil type, or in all seasons depending when the rains start, 100% use would be unlikely. One interviewee estimated that if the weed problem could be addressed, 40–50% of farmers in Savannakhet could be expected to use direct seeders by 2025.

Factors affecting adoption

One of the advantages of the direct seeder is that it addresses multiple constraints for farming households. The primary motivation for the ACCA team in trialling the direct seeder was the advantage of getting the crop sown without having to wait for sufficient rain for seedling nurseries and transplanting. Although this was valuable for farmers, their main interest in using the seeder was primarily the labour savings. The fact that the direct seeder method enables labour (and associated cost) savings, in addition to its advantages in a particular season, supports ongoing interest and use by farmers.

During ACCA, a key constraint to farmers using direct seeding was access to machinery. Since the project finished, machines have become more widely available for sale locally, and some farmers who bought machines have started to provide contracting services, which makes the technology more accessible. However, while the machine has become more accessible, some interviewees were concerned that there was a lack of information available to farmers to support decision-making about its use.

Farmer field trials during ACCA confirmed weeds were a greater problem in direct-seeded fields compared to transplanted fields, largely due to the lack of standing water to suppress weeds in direct-seeded rice. Since ACCA finished, and with farmers now having several seasons of experience in direct-seeded rice, it is clear that control strategies are not sufficient over successive seasons.

The Eighth National Social and Economic Development Plan highlights the importance of climate adaptation, with targets to strengthen adaptive capacity to climate change and integrating climate adaptation into the agriculture sector. This is reflected in MAFF's strategic plan, which outlines a focus on supporting farmers to adapt to climate change and an agenda for small, and large-scale mechanisation of rice production. There is significant potential for the use of the direct seeder to conflict with the current government emphasis on Lao agriculture as 'clean and green', and a risk that farmers struggling to contain weeds in their direct-seeded fields will turn to chemical control measures.

India

Capacity use

The desktop approach taken for the India study limited our ability to identify specific examples of how capacity built in ACCA is being used by partners, although the few interviewees that participated did indicate an ongoing impact in how they approach their work:

- 'The ACCA project introduced climate change analysis and related knowledge to [our] core work on natural resource management. It is immensely enriching as this important dimension is integrated into all our projects now. Understanding climate and its variability to build adaptation strategies has become an important aspect of our work.'
- 'The stakeholder communication skills have helped me a lot. [I have] insight into how to structure communications, how to identify stakeholders. That has added one more competency to our institution. We have used it effectively in all projects we are involved in … when we talk about any policy issue, we put stakeholder framework first. That's one of the major things we picked up from ACCA – the need to understand different needs of different stakeholders.'

Adoption to date

At the end of the project, there was strong evidence of partners using outputs from ACCA as part of their programs and leveraging additional support and funding for CLICs expansion (Table 7).

Table 7: Use of ACCA outputs by project partners and stakeholders, Telangana, 2015

Organisation	Uptake and use outputs, 2015
Professor Jayashankar Telangana State Agricultural University (PJSTAU)	• agro-advisories broadcast 2 times/week via television and radio networks, SMS and email. (potential radio/tv audience 5.5 million; 2,500 farmers receiving email/SMS) • incorporated CLICs and practices into training programs: – district agricultural officers – State Farmers Federation, Rashtriya Krishi Vikas Yojana (RKVY) the National Agriculture Development Scheme RKVY projects – Young Progressive Farmers program (1,930 participants across all programs) • incorporated into training for agricultural staff at the university (300 staff), with further plans to embed the approaches into agriculture diploma courses (potentially 1,200 students per year) • established 12 additional CLICs through RKVY; CLICs were funded until 2016, with PJSTAU to provide technical support
Watershed Support Services and Activities Network (WASSAN)	• distributed Telegu language posters on ACCA recommendations (received by 8,700 villages through WASSAN network) • pilot schools program to engage farming families through students • video screenings on agro-advisories in 12 villages • street theatre play performed across 63 villages in project districts • established 18 additional CLICs by integrating into their work under the Watershed Development Program, funded by the Department of Rural Development

Table 8 summarises the ongoing use of CLICs since ACCA finished.[4] Most notably, CLICs have been integrated into the IFAD-funded Andhra Pradesh Drought Mitigation Project (APDMP) that commenced in late 2017, with design documents for APDMP explicitly articulating ACCA's role in developing CLICs.

The APDMP aims to increase household incomes by improving household resilience to drought through improved crop management, diversification into livestock and improved management of water resources. CLICs have been embedded into component 1 of APDMP: climate resilient production systems. The APDMP use of CLICs will retain the original content and expands it to include livestock information and equipment-hire services. CLICs established under APDMP will be transferred to farmer organisations for ongoing operation by a trained operator.

4 Given the largely desktop nature of this country study, the following section focuses on ongoing uptake of the CLICs as a model that encompasses the ACCA practices.

Table 8: Summary of known use of Climate Information Centres by next users

Next user	End of project (2014)	Current operations (2019)	Expected future operation
Project activity	• 3 pilot Climate Information Centres (CLICs) established	–	–
The Department of Rural Development supported CLICs through their Watershed Development Program	• 18 CLICs established, supported by WASSAN	• 5 CLICs still operational – integrated into farmer cooperatives with primary role as outlet/ custom hire centre • estimated 300 farmers using services	Not available
RKVY – the National Agriculture Development Scheme	• 12 CLICS funded to 2016, supported by Professor Jayashankar Telangana State Agricultural University	No information	Not available
IFAD incorporates CLICs model into Andhra Pradesh Drought Mitigation Project	–	• 105 CLICs established across 5 districts in Andhra Pradesh • CLIC managers have been hired, but still in early stages of implementation	• 132,000 farmers accessing CLICs, more than 25% female

There are also examples of more modest/informal influence of ACCA outputs, including:

- adoption and promotion of the sowing rule by a neighbouring state government
- a university in Maharashtra overseeing the translation of posters from ACCA promoting project practices.

An evaluation of CLICs was conducted in 2015 to examine household access to CLICs and the utility of information. The evaluation compared the performance of 3 ACCA CLICs to 5 additional CLICs established through other mechanisms. The evaluation found most farmers had visited the service more than once. Women and scheduled caste farmers had also accessed CLICs for information. However, farmer satisfaction with the information varied greatly, depending on the facilitator.

The evaluation did not quantify the translation of knowledge gained from the CLICs into changes in farmer practice. Quantification of how farmers are using information from CLICs to change their practices is challenging, but it is reasonable to assume that multiple visits by farmers within a season suggests utility of information and may be indicative of changing practices.

Adoption in the future

It is expected that the use of the CLICs, agro-advisories and other climate information to guide farmer decisions will continue and expand into the future. The APDMP has established 105 CLICs across Andhra Pradesh with a target of 132,000 farmers accessing CLICs (at least 25% women) by 2022.

The Government of Andhra Pradesh has formally requested additional Australian technical support for the APDMP through ACIAR and the Australian Water Partnership (AWP). This request has in principle support from ACIAR and is under consideration by the AWP. Led by a former CSIRO-ACCA team member, the technical support aims to bring together insights from a number of ACIAR-funded projects, including ACCA.[5] The work aims to build on the CLICs by improving the links between information and decision-making: strengthening the seasonal climate risk component with historical

5 'Improved village scale groundwater recharge and management for agriculture and livelihood development in India' (LWR/2010/015) and 'A Virtual Irrigation Academy to improve water productivity in Malawi, Tanzania and South Africa' (LWR/2014/085).

and forecast information, and examining the value of climate information for decision-making – that is, to bring in farm economics as a way of considering economic resilience.

In addition to potential for further impact through the ACIAR-AWP proposal, CSIRO, with support from DFAT and the AWP, is engaging with the World Bank on further application of the CLICs through the World Bank's Project on Climate Resilient Agriculture in Maharashtra. The project aims to reach 1.7 million beneficiaries, primarily small and marginal farmers, by providing access to knowledge, climate-smart agricultural technologies and practices, and markets.

Factors affecting adoption

Interviewees reflected on how the participatory process of developing the CLICs model (and the technical outputs that underpin it) has supported its success, for example, improvements to the agro-advisories brought together farmer ideas and feedback on what needed to change. On-farm research and crop modelling was used to guide how to make climate information useful and relevant to farmer needs. WASSAN facilitated farmer climate clubs as a forum to discuss the science outputs, which eventually led to the weather station installation and participatory monitoring (and rainfall visualiser).

One of the key challenges for the CLICs is ensuring sustainability beyond project time frames. Efforts were made during ACCA to engage with the Department of Rural Development and Department of Panchayati Raj to embed CLICs in existing institutional structures (so costs are covered by state budgets). However, these efforts were largely derailed with the separation of Telangana from Andhra Pradesh and the consequent establishment of a whole new state bureaucracy. WASSAN has actively experimented with different mechanisms to adapt the CLICs model and align it to local institutions – such as farmer producer organisations – for sustainability. This is being trialled at a large scale through the APDMP.

Partnering with an organisation such as WASSAN was an integral part of ACCA. WASSAN was critical in designing much of the concept and processes that surround the technical aspects of CLICs and has been central in translating the work from ACCA into other projects. Its role as lead technical agency for APDMP has been invaluable to ensure the lessons and insights from ACCA are taken forward and the model improved.

Limited capacity within traditional extension services in India to provide adequate advice and information to farmers was seen as a key factor driving interest in the CLICs. One interviewee reflected that CLICs provide an alternative system where people can get a range of information all at once, and this is part of what makes it so effective.

4. Impact – the difference the project will or may make

Cambodia

Community impacts

Analysis at the end of ACCA indicated that response farming offered potential gross margin gains between A$450–560/ha compared to traditional practice. While the adoption study suggests that ACCA has influenced final users through both program/institutional and technical/community pathways, it was not possible to quantify the impact of uptake of recommended practices or approaches.

Interviews consistently indicated that smallholder livelihoods have generally improved over the last 5 years. In Svay Rieng, provincial officials indicated there had been a slight decrease in the poverty rate, while livelihood activities have changed significantly since the end of ACCA, becoming more diversified and market oriented. Farmers have greater access to advice, technology and more accurate weather information (for example, from social media and from family members in off-farm employment out of Cambodia). Continued labour shortages have driven greater use of mechanisation and other forms of crop establishment, even though yields are often lower. While ACCA has contributed to these changes, it is not solely responsible for them.

Importantly, the provincial interviews provided evidence that farmers were approaching a changing and less-predictable climate in a more flexible way than at the start of ACCA and that the tools promoted by the project (and others subsequently) were being used strategically, for example, crop calendars, selection of varieties and crops according to water needs and availability.

There were significant outcomes at the policy interface and through influence on the development and implementation of programs and initiatives tasked with supporting smallholder livelihoods and resilience. Agency partners suggested that ACCA was one of the first initiatives to make sense of climate issues facing Cambodian farmers and to test and assess farmer-oriented solutions. Potentially, the policy impacts are associated with a more targeted, nuanced or informed approach to climate planning and programming in the agriculture sector.

Factors affecting magnitude of impact

Factors that may have influenced the breadth or depth of impact for farmers include:

- irrigation infrastructure (despite the proliferation of household water storage options, access to water remains a limiting factor for transformative change to farm enterprises in Svay Rieng)
- market access and trade issues (including unregulated market prices, the impact of Special Economic Zones as an additional market for Svay Rieng produce and impending changes to trade arrangements with the EU, which will impact competitiveness in a key market).

Laos

Community impacts

Use of mechanised direct seeding greatly reduces labour required for transplanting. This translates either into a freeing up of household labour resources (often women) who can seek alternative income opportunities, which contributes to household income, or a reduction in the amount of external labour hired by the household, with direct cost savings.

A gross margin analysis conducted in 2015 by Laing et al. found LAK2,053,200/ha return on transplanted rice compared to LAK3,128,400/ha for direct-seeded rice with good weed management. Importantly, where weeds were not controlled well, the gross margin fell to LAK1,409,000/ha.

The Crawford Fund has supported a small weed survey and the use of Australian volunteers to try to address weed management issues in direct-seeded rice. The lead researcher on this work describes the situation as a critical juncture for bringing in herbicides in a way that they are used properly. Laos is surrounded by chemical-using countries, and there is a significant risk of herbicide resistance and other environmental and health problems if chemicals are not used correctly. There is a critical need to improve the current policy and regulation around chemical use, as well as training and information for farmers and extension on locally relevant weed identification and management strategies.

If weed management issues can be resolved, mechanised direct seeding provides another crop management option for farmers to ensure rice production given seasonal conditions and labour constraints. In 2016, Clarke et al. found that the consecutive late monsoon starts in 2014 and 2015 have contributed to farmer decisions to use the direct seeder, as it enables them to establish a crop even when rains are late.

Important factors when considering who can benefit from this technology and its overall relevance include:

- field conditions (for example, NAFRI and PAFO currently recommend the seeder is used in the middle toposequence)
- accessibility for different households (for example, direct seeders would be most suitable for households who have some access to irrigation water to control weeds, or those who have small areas of land, for whom weeding would potentially be more manageable, although poorer households are not yet using direct seeders, either because they cannot afford to or because the risks of experimenting are too high).

Factors affecting magnitude of impact

The major factors currently limiting impact for farmers are weeds and the lack of strategies to support weed management. This negates the labour saved in transplanting, negatively impacts on rice yields and may lead to herbicide use (contributing to herbicide resistance and negative human and environmental health impacts). A related factor is the lack of information and guidance available to farmers in using direct seeding on their farms and in weed management.

The ongoing presence of projects that incorporate direct seeding as part of their activities has contributed significantly to the magnitude of impact. Without these projects, organisations like NAFRI and PAFO would lack the operational resources to support farmers with technical advice and resources as part of their experimentation with seeding. However, for in-country partners, the number of projects, particularly when funded by the same organisation, can become confusing and frustrating.

The recent opening of a large commercial rice mill in Savannakhet may also have an influence on the impact of direct seeder use for farmers where rice is for sale rather than home consumption. Due to quality concerns, the mill currently is not currently accepting rice grown by direct seeding.

India

Community impacts

The primary impact of the CLICs and associated crop-management practices is the reduced risk of crop loss, and potential for improved yield, from application of the practices:

- The sowing rule reduces/prevents the risk of crop loss after sowing, which saves labour required to re-seed, which often coincides with other critical activities like weeding.
- Strategic irrigation of rainfed crops were shown to dramatically reduce the chances of low yields (i.e. below 2t/ha for cotton, and below 4 t/ha for maize).

Given the range of options for how a household could choose to apply the different practices under ACCA, a full economic analysis has not been done. However, a gross margin analysis was conducted for certain scenarios at the end of the project. For example, for a farming household that sowed cotton according to the sowing rule on soil moisture content, a gross margin gain of US$128/household was calculated compared to traditional practice (sowing after 2 consecutive days of rain). Significantly higher gross margins of US$389/household were possible if the household also strategically irrigated the cotton.

There is some evidence that CLICs have increased access to climate and agricultural information for some households. Initial surveys into agro-met advisories found limited access/use of information by households from traditionally marginalised groups and non-members of the climate club. Efforts to broadcast information and provide graphics and multi-media information were implemented to overcome some of the access challenges. The 2015 evaluation of CLICs indicated that over 50% of women and marginalised groups interviewed had accessed the CLICs.

Practices such as the sowing rule may be accessible to most households, but access to irrigation facilities limits the ability of many households to implement strategic irrigation.

The expansion of services and information provided through the CLICs under APDMP to include livestock is beneficial, providing business models for CLIC sustainability do not inadvertently exclude those who cannot afford to pay for the information.

Factors affecting magnitude of impact

Inclusion of the CLICs model into large-scale development programs like APDMP, and potentially the World Bank climate resilience work in Maharashtra, have greatly increased the magnitude of impact from the CLICs. However, as CLICs become embedded in new programs, its structure, content and underpinning processes for farmer engagement are changed.

One interviewee reflected on the challenge in maintaining the integrity of the CLICs as a learning interface, underpinned by participatory engagement as the concept is taken on by other programs and actors. For both APDMP and the World Bank project, this risk is mitigated to a degree by the ongoing involvement of WASSAN and technical support from CSIRO but it is still present.

Project-level factors affecting the magnitude of the impact

Interviewees in Laos and India both raised the short duration and presence of ACCA as limiting the overall ability to ensure long-term impacts. In India, this was in relation to technical support provided to the CLICs. In Laos, this related to the emergence of the full extent of the weeds problem only after the project finished.

In both Cambodia and India, ACCA has had significant influence through large-scale development projects. Behind this successful influence in India are several other engagements (for example, Department of Rural Development, India; Department of Gram Panchayat; RKVY; and CGIAR Research Program on Climate Change, Agriculture and Food Security) that have shown initial promise and fallen away over time. The ongoing championing of CLICs through WASSAN, supported by CSIRO, has allowed post-project opportunities to be capitalised on. In Cambodia, ACCA deliberately targeted the PADEE and ASPIRE programs throughout the project. What is common to both Cambodia and India is well-positioned project partners with strong capacity and understanding in the project's work who could champion and promote the approaches in other programs after the project finished.

Benefits to Australia

Contributing to an integrated understanding of farm-based climate adaptation:

The project determined plausible pathways through which farmers could effectively adapt to climate change and increase their incomes, based on strong science. Over 30 peer-reviewed papers have been published that capture insights from ACCA across agriculture, climate science, economics and social science.

One interview articulated the impact of the integration on how they approach climate adaptation: '[I became] aware that farmers have livelihood portfolios and make decisions and choices in the context of a livelihood portfolio and not as a rice farmer … I realised it is not just about growing rice at a different date with different varieties … it seems blatantly obvious these days, but back then we weren't thinking like that.'

Improving methods for climate projections based on point/weather stations

A key activity at the outset of ACCA was to develop downscaled future climate scenarios (to 2030) for specific regions. Unique approaches were developed to deal with sparse data, errors and aggregation of observations, amalgamation of observed trends and model-derived temperature and rainfall projection information. This approach has been used in subsequent activities, for example, Long Paddock in Queensland and work done with BHP Billiton.

Validating APSIM model and building modelling capability

The APSIM-ORYZA[6] model was comprehensively validated as part of ACCA and has been shown to perform well, modelling multiple rice-based farming systems, including the ability to dynamically model salinity impacts on rice. APSIM is used in most of CSIRO's international farming systems projects and by a growing number of Australian and international researchers. ACCA not only advanced the utility of APSIM and APSIM-ORYZA, but provided a platform for building capability of researchers in using and training others (see Gaydon [submitted] for examples of impact in South Asia).

Australian science capacity for integration

ACCA continued a long tradition of international (often ACIAR-funded) work that helped many disciplinary CSIRO scientists to build experience and skills in multidisciplinary and interdisciplinary research experience in-country. For many of the project team, ACCA provided a first experience of a complex, impact-oriented, multicountry project that genuinely sought to integrate across disciplines.

ACCA provided key leaders within CSIRO with the evidence and experience to champion further CSIRO investment in research-to-impact processes. ACCA was a key case study for this activity, which distilled key principles for research design in complex research-for-development contexts.

Many former team members have adapted what was learned in ACCA to other projects (often in different geographies), not only the specific methods that were used in ACCA, but also processes for supporting cross-learning and working across disciplines.

6 The Agricultural Production Systems SIMulator (APSIM) is internationally recognised as a highly advanced simulator of cropping systems. ORYZA is APSIM's rice systems module (www.apsim.info).

Lessons

Approaches to climate adaptation

Framing climate adaptation within the more practical and immediate concerns of farmers in dealing with climate variability was important to get traction and engagement. Building on this, the project emphasised the need to address climate variability issues through a livelihood lens, rather than a focus on individual enterprise components (for example, rice). A toolkit of management options can help farmers and extension practitioners better manage climate variability by allowing them to respond flexibly to the progress of a particular season, including building capacity to relate weather observations to farming decisions.

Benefits and challenges of large-scale multicountry projects

The rationale for having ACCA operate across 4 countries was to strike a balance between developing adaptation options that are grounded in local contexts and challenges, but that can contribute to broader impact.

Working in 4 countries in 2 regions created high transaction costs in terms of travel and significant demands to adequately understand each context (culture, farming system, policy processes and stakeholders). Across 4 countries, the ability to have meetings that bring all partners from all countries together to deeply engage and facilitate cross-learning was limited.

From a science perspective, ACCA's multicountry focus was highly valuable for the APSIM component, providing data from numerous environments, practices and crop varieties that were essential to improve and test the model. The participatory approach to on-farm adaptation research in each case led to different focus areas in each country, but with opportunities for cross-learning, contributing to valuable insights and understanding across countries.

Scaling, sustainability and measuring impact

A key strategy in scaling of impacts was to take principles and practices from ACCA and engage with well-resourced donor agencies to inform their programs and approaches. This was always part of the project design, but it was strengthened and made explicit through the development of the project's impact pathways.

What is consistent across successful examples in Cambodia, Laos and India is the involvement of key in-country partners as champions or advocates in the design of new programs (for example, the Cambodian Department of Agricultural Extension, under MAFF, in Cambodia for PADEE and ASPIRE, and WASSAN in India for IFAD).

Systems for formal monitoring, evaluating and learning in ACCA were lacking. A broad (largely implicit) framework is represented in the pathways to impact, however collection of data to track outcomes and impacts varied in each country. In part, this was due to the adaptation options only becoming clear as the research process was conducted over a number of seasons, the diversity of the adaptation options/intervention points in each country, and the lack of broader expectations for monitoring and evaluation as part of research-for-development at that point in time.

Considerations for future ACIAR research

The design of ACCA highlights some of the tensions in research-for-development work that is expected to deliver research-based interventions, capacity building, proof of concept and impact at scale in relatively short time frames.

There is a role for ACIAR to play in creating links and ensuring a balanced research agenda across its research programs within a country. Creating better links between projects to ensure complementarity of research could help support greater impacts for households.

Longer-term commitments in terms of funding or research programs, or better coordination across linked projects, have the potential to step through the dynamics associated with introducing new technology and approaches and mitigate the risks of problems derailing initial success.

Increased productivity and reduced risk in pig production and market chains

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Project number	AH/2009/001, AH/2010/019
Project title	Increased productivity and reduced risk in pig production and market chains
Collaborating institutions	Australia: Australian Animal Health Laboratory; Murdoch University; University of Melbourne Laos: International Center for Agriculture in the Tropics; National Agriculture and Forestry Research Institute (NAFRI); National Animal Health Laboratory within the Department of Livestock and Fisheries; Ministry of Health Others: Mahidol-Oxford Research Unit, Thailand; Institute of Tropical Medicine, Belgium; University of Edinburgh, United Kingdom; International Livestock Research Institute
Project leaders	John Allen (Australian Animal Health Laboratory) and Tassilo Tiemann (International Center for Agriculture in the Tropics)
Project duration	2010 to 2015
Funding	ACIAR: A$1,239,911 (AH/2009/001); A$859,945 (AH/2010/019)
Countries involved	Laos and Australia
Commodities involved	Livestock and forage
Related projects	Management of pig associated zoonosis in the Lao PDR (AH/2006/161) Management of CSF and FMD at the village level in Lao PDR (AH/2003/001) Forage legumes for supplementing village pigs in Lao PDR (AH/2004/046) Understanding livestock movement and the risk of spread of transboundary animal diseases (AH/2006/025) Extension approaches to scaling out livestock production in northern Lao PDR (ASEM/2005/124)

1. Motivation – what the project aimed to achieve

The smallholder pig systems project was the culmination of a long chain of independent ACIAR-funded animal health and animal production projects in Laos and neighbouring countries that led project leaders from both tracks to the conclusion that a combined approach might be needed to tackle persistent problems in pig production. With the One Health approach gaining momentum at the time, it was a good opportunity to shape the project according to One Health principles and develop a project with an animal and human health component and a production and market component, which would work together under the same umbrella and only be separated administratively.

The ACIAR-funded project 'Understanding livestock movement and the risk of spread of transboundary animal diseases' (AH/2006/025) demonstrated inappropriate pig production in Laos to meet domestic or export demand, and the increasing supplementation with piglets from Thailand, with a general movement of fattened pigs for export to Vietnam. At the same time, pigs were found to be an integral part of the farming systems throughout rural Laos, and pigs had been identified as of particular importance to poorer families who have limited land and limited capacity to invest in cattle and buffalo. The country-wide pig population was large and in many places greatly exceeded the human population. Nevertheless, pigs were not produced in a systematic way for sale and herd turnover was low.

The fact that women are generally involved in the gathering and preparation of pig feed and in most aspects of pig management gave the project an additional gender focus. This also aligned well with the human health component, which would draw strongly on women's initiative as carers and health keepers. It was expected at the time of project development that pig-raising systems were to change rapidly throughout the country, especially in districts within the reach of major towns and close to the borders with Thailand, Vietnam and China. While changes had been predicted to be slower in the more remote upland areas, the potential impacts were seen as significant, as pigs were one of the few cash income-generating opportunities in these areas.

With this in mind, the project objectives were to:

- establish comprehensive baseline information on representative smallholder pig production and marketing chains in selected provinces
- improve pig productivity by increasing output per sow, piglet survival and growth performance through improved feeding and animal health interventions
- develop better strategies to manage the risk to farmers and traders in the marketing chain from diseases in pigs, especially classical swine fever
- develop and test strategies to better define and manage the risk from zoonotic diseases at critical control points in the selected production and marketing systems
- link with other research and development projects by facilitating a multistakeholder alliance to scale out research results on pig production, pig health and associated human health risks.

It was envisioned that productive pig-production systems would provide stable and reliable income to smallholder families, improving their living conditions and providing a commodity that could be traded to neighbouring countries to spur national trade. The vision involved establishing a competitive sow–piglet production system with several smallholder farmers that feeds into fattening operations of the same or other farmers in the same or neighbouring villages. A pig-production cluster would be established in which a short value chain allows for personal relationships between stakeholders and fast tackling of emerging problems.

On the health side, questions about how much zoonotic diseases from village-based pig production could affect the health of villagers, and what effective measures could be taken to tackle these and other production-stifling diseases, were of central interest.

For the implementation of this fully ACIAR-funded project, a large number of institutions contributed expertise and resources:

- CSIRO Australian Animal Health Laboratory
- Murdoch University, Western Australia
- Mahidol-Oxford Tropical Medicine Research Unit, Faculty of Tropical Medicine, Mahidol University, Thailand
- Department of Livestock and Fisheries, National Animal Health Centre, Laos
- Department of Hygiene and Disease Prevention, Ministry of Health, Laos
- several guest scientists from other institutions (component 1)
- International Center for Tropical Agriculture and the Livestock Research Center of the National Agriculture and Forestry Research Institute (NAFRI) under the Ministry of Agriculture and Forestry (component 2).

At the start of the project, 2 districts were selected, based on a consultation and suitability assessment process:

- Sayabouly district, close to the Thai border and part of a northern west-east corridor
- May district in Phongsaly province, bordering with northern Vietnam and close to China in the north.

While Sayabouly district had seen certain economic development in recent years, mainly based on large-scale energy infrastructure projects, May district was chosen despite its remote geographic location at the crossroads to China and Vietnam due to its lack of infrastructure. Choosing these contrasting locations aimed at hedging risks for project implementation by assuming that the more developed Sayabouly district would be easier to work in; and at comparing data from different specific development situations within the regional value chain and the same national context.

2. Outputs – what the project produced

The project set out to lay the foundation for transforming the smallholder-based pig value chain in Laos. In order to do this, technical, policy and capacity constraints had to be properly identified and addressed.

Technical outputs

Only a little detailed information about smallholder-based pig value chains was available at the time of project development, especially about the spreading of pig diseases through the value chain. The project therefore developed an innovative market-chain analysis methodology to include serological studies and risk factor analyses for several pig-associated diseases. This systems-based approach offers several potential solutions to the problem of understanding rapidly changing pork production patterns, taking into account the economic role of pigs and their public health concern. Choosing cross-border market chains also made recommendations arising from this research more relevant to neighbouring countries, which are stakeholders in the value chain.

Dynamics of Lao smallholder pig herds were documented and analysed for the first time, following the fate of every individual in the pig population the project worked with over a period of 1.5 years. Results from this study contribute to a sparse number of research attempts to better understand the effect of individual farmer management practices on overall population dynamics. Gender-specific labour contributions to pig raising were also recorded, documenting the sometimes contrasting perceptions of the personal contributions of male and female family members.

A seroprevalence survey of villagers and pigs from a northern, predominantly upland, province (Luang Prabang) and a southern, predominantly lowland, province (Savannakhet) was conducted in collaboration with the International Livestock Research Institute. This survey produced a large amount of data that revealed different clusters of population with varying degrees of health risk exposure. It provides a solid foundation for future work on human health education and intervention in Laos.

The project delivered a proof of concept for *Taenia solium* control in hyperendemic focuses of disease in the north of the country, achieving a 77.4% ($p < 0.0001$) reduction in parasite prevalence over a 2-year period. This presented a timely contribution to the World Health Organization's Neglected Tropical Disease Roadmap, while leaving in-country awareness and solutions to a formerly undocumented health problem. Secondary outcomes of this intervention, such as identifying the origin of cysticercosis in one of the villages, provide Laos with the knowledge and tools for effective parasite control across broader geographical areas, proving the cost efficiency of such approaches.

To overcome the notoriously small local pork demand in Mai district, the project established a new functioning value chain for smallholder fattened pigs into Vietnam at an above-average price, from piglets delivered by Vietnamese traders. While profitable for the farmers with access to this value chain, the created farmer groups were not equipped to reach out to other farmers and act as extension agents. In consequence, only a relatively small number of farmers benefited from this achievement.

Last but not least, pig fattening speed was increased by introducing improved fattening and management practices, which led to reduced mortality rates and increased production efficiency. This, combined with improved market access, led in some villages to a sixfold increase of income from pigs, making pigs the main income source for farmers. Still, piglet mortality remained a serious problem and was as high as 30–50%, often due to whole litters being stillborn or piglets dying within the first 2 weeks, for which no reason could be identified.

Policy outputs

Although a need for policy change was identified early as essential, the project lacked the resources, expertise and mandate to get deeply involved into political dialogue. Influencing governance was therefore more focused on direct interaction with institutional heads, such as leading DAFO officials or their provincial equivalents, as well as through shaping views of project partners from NAFRI, Department of Livestock and Fisheries and Department of Hygiene and Disease Prevention. Those included:

- perceptions about improved pig-production mechanisms and ways to reduce the risk of pig-associated zoonotic diseases
- reasons for and the nature of human health risks from zoonotic diseases, how to address them and the economic benefits from such interventions
- how to interact with farmers in a more effective way, build trust and lasting relationships and take farmer needs into consideration when outlining development agendas.

The impact of this experience is reflected in changed management approaches of the respective DAFO offices and their staff.

Through feeding into the World Health Organization's Neglected Tropical Disease Roadmap, the political agenda in this field might be influenced on a national level, based on the abovementioned technical outputs.

Capacity-building outputs

Capacity development is likely to have had the most lasting effects and was an essential part for all project stakeholders, including farmers, district and provincial national health and agriculture staff, laboratory personnel and national and international students. In future, most polymerase chain reaction, serology and parasitology tests could be conducted in-country by the National Animal Health Laboratory, which means a strong diagnostic and research capacity improvement for Laos. Capacity now exists to undertake a range of ELISA tests for pig production and zoonotic diseases, and a number of newly graduated veterinary students have been trained in pig parasitology.

Livestock Research Center staff attended the international grassland congress in Sydney and have received ongoing training in English and research techniques. The project supported PhD studies of Livestock Research Center staff at the Agricultural University in Uppsala, Sweden, with technical and financial support from the project for fieldwork and feeding trials, as well as master's degree studies in Vietnam for DAFO staff from Mai district. Two national students received logistical and technical support to undertake their studies on the Field Epidemiology and Training program in conjunction with the World Health Organization. A total of 12 agricultural students from different Lao universities conducted field studies on pig production and wrote their graduation thesis as part of this assignment. A number of international postgraduate students from Australia and the United Kingdom were involved at both MSc and PhD levels.

Farmers were exposed to new concepts such as disease types, transmission mechanisms and remedies. They received training in basic veterinary approaches and acquired basic skills in disease identification, drug application and post-mortem sampling. They were trained in feed-quality criteria, animal feed requirements and pig-management strategies. They also learned how to complete a fattening cycle in under 6 months and how to calculate basic gross margins to assess their actual profits. Additionally, cross-provincial visits and exchange with farmers from the previous International Center for Tropical Agriculture–funded Legume for Pigs Project in Xiengkhouang province widened the farmers' perspectives, provided new ideas and fostered new personal connections.

3. Adoption – how the project outputs are being used

While no information could be obtained about the adoption of the developed tools and frameworks, the published articles have been read several hundred times and already cited, according to researchgate.net statistics. While the World Health Organization's Neglected Tropical Disease Roadmap initiative is still running, public domain information does not reveal how far external information was considered for their activities in Laos.

Local adoption of pig health and production methods has stopped mostly as result of the collapse of commercial smallholder pig production in the target villages. This happened in Mai district in the wake of serious investments in infrastructure and contract farming (mainly rubber, coffee and cardamom) for the Chinese market. With currently stable and high prices for these commodities, pigs have again moved to their traditional position as a cash reserve and secondary income source.

In Sayabouli district, banana and maize contract farming, together with Job's tears (*Coix lacryma-jobi*) and large livestock production for export (mainly to China), has become the driving market force. In this district, pigs also serve as a backup in case of crop failure or excessive rodent damage, as was the case in 2018.

However, the underlying reasons that local adoption has stopped are more complex. The construction of the China-built high-speed train track through Laos means high demand for pork from construction sites. Although the low market price for pork is often mentioned, farmers did not start more focused production even when the farm gate price offered by traders delivering to the railway project was 10–20% above market price. While the exact reason for this lack of enthusiasm remains partly speculative, most farmers admitted that they saw intensive pig production as too labour intensive and the profit margins too small and volatile. Based on project experience, farmers would have to manage a pig-production operation with a monthly output of at least 6 fattened pigs to compete with the income from a single hectare of rubber. This would require a minimum of 40 animals in constant circulation under the given situation, but 50 to 60 animals would be more likely. Keeping this number of animals would require management skills most farmers do not feel confident they possess. It requires a high initial investment and is a high-risk operation in a disease-laden environment. This all favours alternative high-value, crop-based income strategies.

Despite all these challenges, farmers have retained a better understanding of animal health and are still vaccinating their animals, applying drugs in case of disease and castrating their young boars themselves. They feel more confident in managing the pig stock they keep, and perceive a lower risk of their mature pigs dying. Piglet mortality still remains a serious problem.

The use of specifically grown pig feed was entirely abandoned as it was too cumbersome and not necessary for maintaining a small number of animals. Natural resources are generally sufficient to at least bring stock through the dry season. Some female farmers did adopt the use of concentrate feed for sows during lactation. Those with a focus on piglet production for sale showed a stronger inclination to spend money on commercial feed.

4. Impact – the difference the project will or may make

It became clear in this study that farmers used pig production as a bridging activity until their tree crops reached maturity, at which point the crops became the primary income source. Pigs played an important temporary role for family income during the 5 to 7 years required to establish tree crops. During this period, income was significantly improved due to increased sales of pigs and the available funds were used for child education, health and better nutrition.

While it was not possible to assess how farmers would have fared without this project, the farmers themselves asserted that the project activities had a positive impact on their livelihood and knowledge base. Capacity building was one point every project stakeholder mentioned as of prevailing impact and importance to them. Farmers found the technical experience they gained useful but they also mentioned other aspects, such as new contacts established with other farmers during visits to other provinces, and new ways to build farmer–trader relations.

Staff from national extension and research agencies also attributed many positive impacts to capacity building, including promotions, higher confidence at work and a better understanding of the various difficulties farmers face depending on diverse contexts. DAFO staff in leading positions could contribute more meaningfully to other projects and understood the importance of developing a vision of the future of their district. The personal connections built between DAFO staff and Livestock Research Center researchers was evaluated as beneficial from both sides, allowing each to get information that is otherwise difficult to access. Livestock Research Center staff found the work meaningful as it strengthened their conviction to continue to work in research for the good of their country.

As a result of the learning experience during the project, DAFO seems to have started to build stronger personal relationships with farmers and change their model of interaction. This leads to farmers and veterinary workers relying more often on DAFO to get vaccines for their animals.

On a community level, the mass drug administration and concurrent pig intervention in Ompalong has seen a significant reduction in the prevalence of *Taenia solium* and several other soil-transmitted helminths and improved human health levels (especially in the most affected villages), and it also created awareness of the underlying problems among both villagers and health professionals. It was also demonstrated that the used double-track approach was far more effective than common one-track approaches, while simultaneously being far more cost-effective.

The general conclusions drawn from this study are that a number of factors are currently acting against the adoption of improved pig production by smallholders in Laos:

- high labour intensity of small-scale pig production relative to profits
- high commercial feed prices
- high risk and few possibilities of risk hedging
- low profit margin due to a capped market price
- high income uncertainty due to fluctuations within this small margin
- availability of profitable tree crop contract farming as a more attractive option
- prohibition of cross-border piglet trade from Vietnam into Laos for small traders
- reversal of pig flows leading to direct competition with Vietnamese producers.


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