Australian Government

Australian Centre for International Agricultural Research

# Final report

*project*

## Developing agricultural policies for rice-based farming systems in Lao PDR and Cambodia


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# Contents

# 1 Acknowledgments

We would like to acknowledge the contribution of the late Dr Tim Purcell of Agricultural Development International (ADI) to the design and early planning of this project. Tim was based in Phnom Penh and had an intimate knowledge of policy processes and outcomes in Cambodia and elsewhere in the region through his many consultancies to national governments and international agencies, including the World Bank and the Asian Development Bank. He was relishing the prospect of bringing his skills and detailed knowledge to bear on the policy issues being researched in this project. Tim died tragically at his home in Phnom Penh on Sunday 11 March 2012, barely 9 months into this project. He is greatly missed by the project partners and his many friends and colleagues, and will be remembered for his sharp mind, his energy, and his generosity in the pursuit of better policies for poor farmers in the developing world.

# 2 Executive summary

Rapid agrarian change in the Mekong region coupled with recent shocks to global food, fertiliser, and fuel prices have accentuated the risks and challenges facing farmers engaged in rice-based farming systems, particularly in the marginal environments of Laos and Cambodia. Preliminary research in 2010-11 indicated that: (1) there is a lack of detailed empirical studies providing reliable quantitative estimates of the farm- and regional-level impacts of current or proposed policies and of the trade-offs between them, and limited capacity within government to undertake such studies and derive well-supported implications and options for policy makers; (2) there is a need for strategic empirical research on specific policy options for rice-based farming systems, particularly where technical possibilities for improved food security and farmer incomes are constrained by current policy settings. In particular, three key policy issues were identified, concerning the institutional arrangements governing farmers' access to (1) affordable, high-quality farm inputs (seed, fertiliser, technical advice, credit); (2) the key resources of land and water; and (3) the rapidly emerging regional value chains for rice and other agricultural commodities.

The project aimed to contribute to improved agricultural policies for rice-based farming systems in Laos and Cambodia, taking account of trends in Thailand and Vietnam. The project objectives were to: (1) analyse current agricultural strategies, policy processes, and policy settings in Laos and Cambodia in the context of regional social, economic, and environmental trends; (2) demonstrate the benefits of evidence-based policy development in Laos and Cambodia through feedback from selected case studies aligned with other ACIAR food security projects; (3) examine agricultural policy trends in other countries in the region, especially Thailand and Vietnam, and the implications of cross-border trade and investment for policies in Laos and Cambodia; (4) collaborate with agricultural policy agencies in Laos and Cambodia to identify improved policy options and strengthen policy development processes.

The project ran from 1 June 2011 to 30 June 2016 and achieved the following outcomes: (1) an improved understanding of policy processes in Laos and Cambodia; (2) an appreciation of the ways in which policy implementation is conditioned by circumstances at the local level, increasing our ability to interpret and address policy constraints; (3) detailed evaluation of current policy impacts on rice-based farming systems, providing important feedback to policy-makers; (4) an examination of specific, evidence-based policy options that have the potential to increase the uptake of innovations arising from ACIAR and other projects; (5) a greater understanding of cross-border value chains and their influence on the flows of inputs, outputs, information, and technology; (6) increased capacity of government policy agencies and research institutes to apply evidence from field studies to policy development and evaluation.

These outcomes have had some impact on policy making, particularly in Laos, where project personnel have had repeated opportunities to brief senior levels of government on specific issues regarding rice policy. A move away from policy based on centrally-determined yield and production targets for rice towards more of a focus on rural poverty and alternative livelihood pathways has been apparent in Laos, and the project has contributed to this discussion. Future work could focus on continuing to build the capacity of the policy research institutes within government to systematically and routinely collect and analyse policy-relevant data so as to have evidence to call on at short notice to meet the demands of policy makers.

# 3 Background

Rapid agrarian change in Asia, recent shocks to global food, fertiliser, and fuel prices, and the prospect of climate change have accentuated the risks and challenges facing farmers engaged in rice-based farming systems, particularly in the rainfed lowland and upland environments of the Mekong basin (World Bank 2007, Byerlee et al. 2009, Johnston et al. 2010). In response, ACIAR embarked on a broad research program with institutions in partner countries directed towards 'safeguarding food security in the rice-based farming systems of South and South-East Asia'. This Food Security Research Program (FSRP) was based on: (1) increasing the productivity of rice-based farming systems; (2) fast-tracking the development of new staple crop varieties with advanced informatics and biotechnology; (3) underpinning institutional arrangements with policy research relevant to production and trade. This project was designed to address Component (3), with particular reference to Laos and Cambodia.

A Small Research Activity (SRA) (ASEM/2009/039) was undertaken in 2010-11 to review the status of agricultural policies for rice-based farming systems in the countries of the region. The SRA drew on a compilation of policy documents at the national level, reviews of policies by major donors (notably the World Bank and the Asian Development Bank), case studies by local and international researchers and consultants, issues identified by other ACIAR projects, and the experience and observations of the project team. These reviews were presented and analysed at a workshop in Siem Reap, Cambodia, 23-25 February 2011. The Siem Reap workshop identified two broad research themes and a number of specific research issues to be addressed in the current project.

The first broad theme concerned the policy process itself. The SRA highlighted a dearth of detailed empirical studies providing reliable quantitative estimates of the farm- and regional-level impacts of current or proposed policies and of the trade-offs between them. In addition, and obviously related, there was seen to be limited capacity within government (in terms of personnel, skills, experience, and resources) to undertake such studies and derive well-supported implications and options for policy makers. While major donors such as the Asian Development Bank (ADB) have commissioned policy studies and recommended strategies at the sectoral level (e.g., ADB 2010; ADI 2011), such activities do not necessarily enhance the capacity of government agencies to develop, evaluate, and refine agricultural policies in response to empirical evidence at the local level.

Such policy discussions can be greatly assisted through well-designed quantitative studies using conventional techniques in farming and agrarian systems analysis (including farm typologies, partial and parametric budgeting, value chain analysis, benefit-cost analysis, and risk analysis). There is both need and scope to build capacity in policy research by working collaboratively with mid-level and senior policy analysts in the countries of the region, particularly in the conduct and interpretation of such empirical studies.

The second broad theme, underpinning the first, concerns the need for strategic empirical research on specific policy options for rice-based farming systems, particularly where technical possibilities for improved food security and farmer incomes are constrained by current policy settings. Three particular issues identified by the SRA stand out, centring on the local-level institutional arrangements governing farmers' access to (1) affordable, high quality farm inputs (seed, fertiliser and other chemical inputs, technical advice, credit); (2) the key resources of land and water; and (3) the rapidly emerging value chains for crop and livestock commodities in the region.

With respect to the first set of issues, there is ongoing research in ACIAR and other projects on the response of rice and post-rice crops to fertiliser, variety, and irrigation, but for farmers to realise the benefits of these technical options, key constraints to adoption need to be lifted (Mutert and Fairhurst 2002; Fukai and Cramb 2010a, 2010b; Haefele et

al. 2010). For example, farmers are deterred by the price, availability, and quality of fertiliser and other inputs. It may be possible to influence these variables by government policies that reduce transaction costs, improve delivery infrastructure for poor regions, and better regulate suppliers regarding input quality and the provision of technical information. Extension services can also be enabled to demonstrate improved practices to farmers more effectively and provide a wider range of appropriate technical information and advice. Empirical studies can quantify the benefits and costs of such policy options and investments, and thus assist in policy development for rice-based farming systems.

Policies affecting access to the key resources of land and water also need to be closely examined (Ducourtieux et al. 2005, Fujita and Phengsopha 2008, Zola 2008, Wright 2009, So 2010, Fujita 2010, ADB 2010). In particular, land tenure uncertainties, village land allocation processes, and large-scale land concessions are having a much greater influence on rural poverty and food security than (e.g.) fine-tuning of fertiliser recommendations for rice. Likewise, policy decisions about mega irrigation projects versus development of small-scale supplementary irrigation (electrified pumps, tubewells, farm dams), and funding the rehabilitation, operation and maintenance of existing irrigation infrastructure, are having a major effect on the capacity to intensify and diversify crop and livestock production within rice-based farming systems. Though these may seem controversial matters, policy advisers within government are keen to get well-documented answers about the impacts of these and alternative policy options on rural poverty and food security. Hence, given appropriate consultation and collaboration, they are key researchable issues.

The third issue relates to the inherent difficulties of making the transition from subsistence-oriented to market-oriented farming, given that farmers, traders, processors, and other actors along the value chain are all venturing into new and risky activities and investments, governed by uncertain institutional arrangements and low levels of social capital (Purcell et al. 2008). The SRA found that various forms of (often cross-border) contract farming are growing rapidly in importance in Laos and Cambodia, following an earlier trend in Thailand and Vietnam (M4P 2005a, 2005b; Zola 2008; Walker 2009; Wright 2009). These arrangements have the potential to overcome some of the key constraints facing rice-based farming systems, not only in terms of access to reliable markets for new commercial crops, but also by providing access to capital for inputs and to technical advice, thus filling gaps in the public provision of these crucial inputs.

However, experience has been mixed, with both farmers and traders getting ‘burned’ as they seek to meet each other’s expectations while protecting their own short-term interests. There are also equity issues as agribusiness entrepreneurs prefer to contract better-resourced and hence more reliable farmers, while those left out of contracts may face a narrower market than in the absence of contracting arrangements (M4P 2005b). There is an urgent need to study current and alternative contractual arrangements for short-term crops such as maize, medium-term crops such as cassava and sugarcane, and longer-term crops such as rubber and timber, and to draw implications for policy.

Partly to deal with the relatively unregulated spread of contract farming arrangements, there has been a renewed policy emphasis on grouping farmers into local organisations to strengthen their market power in relation to agribusiness actors, whether the latter are supplying inputs, credit, marketing, or a combination, as well as to facilitate provision of government extension and credit. Again, experience is highly variable and there is an opportunity for micro-level policy research to identify cost-effective options to augment these arrangements.

# 4 Objectives

The overall aim of the project was to contribute to improved agricultural policies for rice-based farming systems in Laos and Cambodia, taking into account trends in Thailand and Vietnam, in line with ACIAR's food security initiative for the Mekong region. The specific objectives and associated activities were:

### *Objective 1: To analyse current agricultural strategies, policy processes, and policy settings in Laos and Cambodia in the context of regional social, economic, and environmental constraints and trends*

1.1 Review agricultural constraints, trends, and strategies in the region through interviews with key informants, further review of policy documents, and analysis of secondary data. Prepare a comparative analysis and synthesis of these constraints, trends, and strategies.

1.2 Conduct key informant interviews with policy actors and observers, participant observation, and reviews of literature to document agricultural policy processes in each country and influences on the selection and implementation of policy options.

### *Objective 2: To demonstrate the benefits of evidence-based policy development in Laos and Cambodia through feedback from selected case studies aligned with other ACIAR food security projects*

2.1 Use locally-grounded case studies to explore the implementation and impacts of selected policies. Case studies to be planned by the project team in consultation with a Project Advisory Group and other ACIAR food security projects. Case studies to be conducted by team members, staff, and postgraduate students, in collaboration with policy staff in government agencies, and written up as individual policy working papers in local languages and English.

2.2 Conduct project workshop to review, compare, and analyse case studies in Activity 2.1 in relation to constraints, trends, strategies, and processes described in Activities 1.1 and 1.2. Feedback to policy actors through Project Advisory Group, reports and policy briefs in Years 2 and 3, and in-country policy forums in the middle of Year 3.

### *Objective 3: To examine agricultural policy trends in other countries in the region, especially Thailand and Vietnam, and the implications of cross-border trade and investment for policies in Laos and Cambodia*

3.1 Identify key policies and trends in Thailand and Vietnam of relevance to Laos and Cambodia (e.g., agricultural commercialisation, crop diversification, rural credit, mechanisation, contract farming) based on published reports, secondary data, and selected field studies.

3.2 Case studies of direct impacts of traders and investors from Thailand and Vietnam on agricultural development in Laos and Cambodia, including cross-border value chain studies on rice and livestock, with implications for policies in the latter countries.

### *Objective 4: To collaborate with agricultural policy agencies in Laos and Cambodia to identify improved policy options and strengthen policy development processes*

4.1 Involve policy staff in training workshops, field studies, analysis of data, and preparation of policy options for rice-based farming systems.

4.2 Organise in-house reviews of policy studies and policy forums in Laos and Cambodia in conjunction with collaborating policy agencies to present and discuss project findings.

4.3 Prepare a manual on evidence-based policy analysis, incorporating case studies, for use in on-going training of policy practitioners in government, universities, and non-government organisations.

# 5 Methodology

The research strategy was to focus on the three sets of practical issues affecting rice-based farming systems outlined in Section 3 and to work on these in collaboration with policy practitioners and advisers in Laos and Cambodia. In this way it was hoped to simultaneously address the need to build capacity in policy research and to develop specific policy options to help alleviate key constraints facing rice-based farming systems in the region, especially with regard to the adoption of technologies emerging from ACIAR's Food Security Research Program. The selected policy issues were to serve as case studies or worked examples of the use of an evidence-based approach to policy development.

The SRA highlighted the need for this research strategy to place policy development for rice-based farming systems firmly within the context of:

- farm-household livelihood strategies and constraints (not just rice production and marketing but including livestock and off- and non-farm activities);
- village institutions, such as those governing access to and management of land, water, and forests, or farmer organisations for acquiring inputs and credit or processing and marketing outputs;
- bio-physical (e.g., topography) and socio-economic (e.g., road access) differences in local agrarian systems that greatly modify the impacts of generalised policies (e.g., land allocation in remote versus accessible uplands);
- wider trends and trajectories generated by regional agrarian change, such as the outmigration of rural labour, the allocation of land for large-scale concessions, the emergence of contract farming, and increased cross-border trade, particularly with Thailand and Vietnam.

In other words, agricultural policies were viewed within the context of agrarian systems and their dynamics (De Koninck 2005; Byerlee et al. 2009; Cramb 2011).

To maintain this perspective the project adopted an agrarian systems approach to understand and evaluate agricultural policies and their impacts on rice-based farming systems (FAO 1999; Sacklokham and Baudran 2005; Fig. 1). Central to this approach is the diagnosis of critical constraints to improved agricultural performance, leading to the identification and ranking of strategic areas for policy intervention or reform. This is essentially a micro-level application of the macro-level 'growth diagnostics' or 'binding constraints' approach advocated by Haussman et al. (2004, 2006) for the prioritisation of national policy reforms. ADI (2009) applies this macro-level diagnostic approach to Cambodia.

From an agrarian systems perspective, agricultural development policies can be viewed as providing the local institutional arena or 'rules of the game' (access to resources, price signals, incentives, sanctions) for actors within the rice-based farming sector (farmers, village authorities, traders, district officials) (Ellis 1992, 2000; Long 2001; Ye et al. 2009). There is thus a need, not only to review stated policies at the national level, but to examine how these policies are interpreted and implemented at the local or operational level (Ciriacy-Wantrup 1971). For example, water policies developed in national-level ministries are translated into organisational decisions (budget allocations, staff deployment, regulations, and procedures) at provincial and district levels, which in turn impact on the availability and use of water by operating farm-households and water-user groups at the local level, with consequences for yields, farm incomes, and poverty (Lebel et al. 2007).

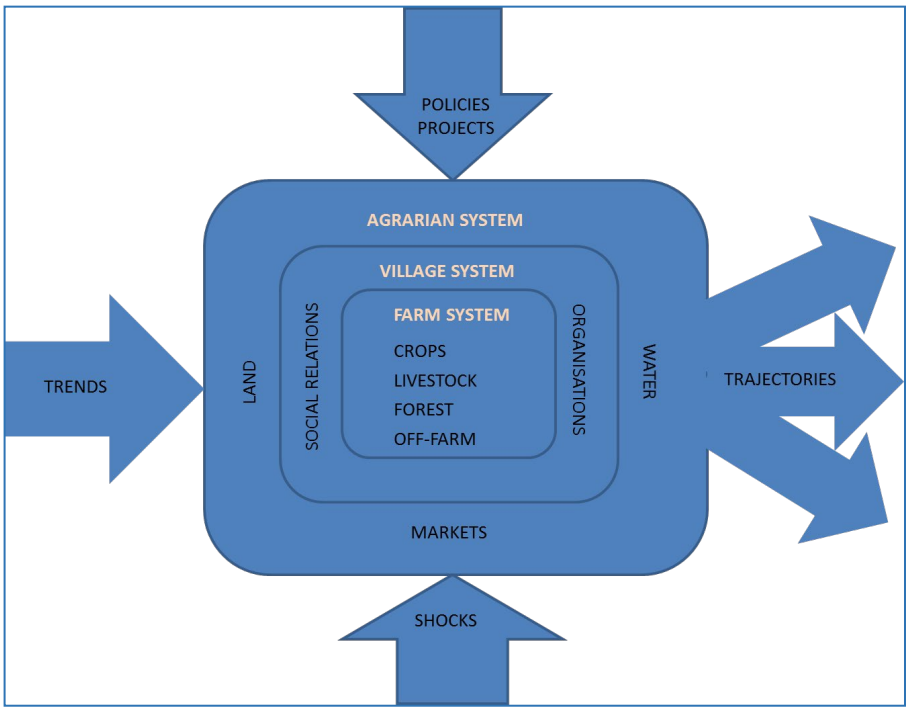


Fig. 1. Policy interventions seen through the lens of agrarian systems analysis

However, in the process of implementing national policies, actors at the local level can frequently modify the outcomes, e.g., finding ways to circumvent inconvenient land-use constraints, resulting in diverse practices of which central policy-makers may be unaware, or which they may be unable to control (Wittapayak and Vandergeest 2010). For example, a declared national moratorium on land concessions in Laos did not appear to prevent provincial and district authorities from continuing to allocate land to foreign investors (ADB 2010). Hence the impacts of policy are highly contingent on the room to manoeuvre at the local level (Lestrelin and Giordano 2007; Jakobsen et al. 2007).

Moreover, different policies may be contradictory when implemented at the local level, creating unintended consequences, e.g., restrictions on shifting cultivation in the absence of sustainable alternatives for upland farmers in specific agro-economic zones may worsen rather than reduce poverty and environmental degradation (ADB 2010). Policy research needs to monitor these diverse and unintended impacts and routinely feed them back to the policy-making level.

To capture these issues of 'policy in practice', the project focused primarily on proximate impact variables – those that directly influence practices and outcomes at the farm and village level within an agrarian system – rather than on aggregate indicators at the sectoral or macro-economy scale (Fig. 2). This involved first understanding the dynamics of rice-based farm-households of various types, defined by agro-economic variables, some of which can be represented spatially, e.g., irrigated, partially-irrigated, rainfed lowland, rainfed upland, each intersecting with different degrees of market access (Cramb 2000, Ellis 2000, Sacklokham and Baudran 2005). These farm-households are embedded in village-level social networks and extended value chains (Purcell et al. 2008) – that is, they draw on a variety of inputs and resources (including land, hired labour, fertiliser, and water) and produce outputs which either directly supply household needs (e.g., rice for subsistence) or enter domestic and trans-boundary market networks (e.g., rice, livestock, labour), as well as influencing village-level environmental variables (e.g., soil erosion, vegetation cover, water quality).

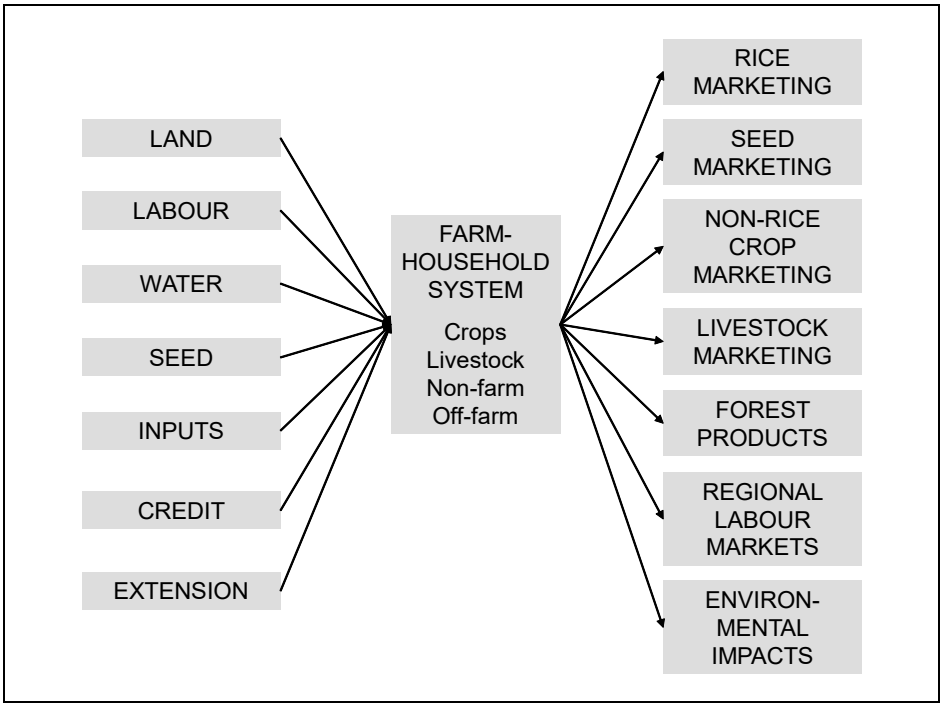


Fig. 2. Proximate impact variables of policies for rice-based farming systems

These policy variables were examined individually and in terms of their interactions (synergies and trade-offs) with other policies. For example, policies affecting the importation, transportation, and price of suitable fertilisers for rice-based farming systems needed to be seen in relation to other policies that enhance the returns from improved fertiliser use, such as seed supply, farm credit, supplementary irrigation, extension, and rural roads. Similarly, policies for contract farming take in issues of land tenure, credit, input supply, knowledge transfer, road infrastructure, marketing, and trade.

Following Ellis (1992) and Chang (2009), policies were defined and assessed according to their impacts on these inputs and outputs of rice-based farming systems. As mentioned, this was consciously a micro-level, partial-equilibrium approach to policy analysis. This strategy was followed because it is this level of empirical analysis that is most urgently needed. Moreover, high-quality micro-level research can feed into and enrich concurrent or subsequent work from a macro-level (multi-market or general equilibrium) perspective (e.g., Agrifood Consulting International and Camconsult 2006, Warr 2008). Nevertheless, even with this micro-level focus, agrarian systems diagnosis ensures that individual policies are seen in their wider context and prioritised according to their strategic importance in alleviating binding constraints to the system in question.

As well as building on the SRA, the project's strategy was to underpin and interact with other, more technical projects in ACIAR's Food Security Research Program, which provided an initial problem-focus for the policy case studies. These and other projects had already identified a number of key constraints to the intensification and diversification of cropping systems, particularly in the rainfed and partially-irrigated lowland environments of Laos, Cambodia, and northeast Thailand, all of which provided potential issues for field-based policy development (Connell 2000; Dao 2010; Fukai and Cramb 2010a, 2010b; Haefele et al. 2010):

- the availability of quality seed of locally adapted varieties of rice and non-rice crops
- the availability, affordability and quality of appropriate inorganic fertilisers
- access to on-farm demonstrations and reliable technical advice

- access to and management of various sources of supplementary irrigation (diverting or pumping from streams, wells, or farm ponds)
- the production risks associated with using purchased inputs (e.g., fertiliser use may be profitable on average but entail a financial loss in a season affected by droughts and floods)
- the increasing scarcity and cost of farm labour
- the availability and cost of farm equipment and machinery, including for small-scale processing (e.g., rice driers)
- the difficulties associated with marketing new crops on a small scale

In addition to these technical research projects, there were major investments by many different international development agencies in support of agricultural development, food security, and poverty alleviation for rice-based farming systems in the region. Many of these projects were based on detailed policy analyses and were even tied to specific policy reforms. The strategy in this project was to keep abreast of these projects but not to attempt to duplicate their approach, which has been characterised as 'donor-driven policy development'. The comparative advantage of this project was in (a) being well-grounded in empirical research at the level of farm and agrarian systems and (b) working closely with policy practitioners within government agencies to build the capacity for evidence-based policy analysis in the course of researching specific policy options.

The first step, therefore, was to assemble a team from the region with experience in policy-relevant research at the local level (farm, village, district, and market chain) and with established links to policy agencies in Laos and Cambodia. This team included researchers from the National University of Laos (NUOL) and the Cambodian Development Resources Institute (CDRI). To include perspectives from Vietnam and Thailand, researchers from the Centre for Agrarian Systems Research and Development (CASRAD) in Hanoi and from the Multiple Cropping Centre and Department of Agricultural Economics at Chiang Mai University (CMU) were contracted to augment the activities of the Lao, Cambodian, and Australian team members. After extensive consultation, this team was assembled in Siem Reap from 23 to 25 February 2011 to plan this project (Table 1).

The next step was to link the team and the project's activities directly to senior policy practitioners within the Governments of Laos and Cambodia through the formation of a Project Advisory Group (PAG). The intention was to invite two government officials from Laos – the Director of the Department of Planning in the Ministry of Agriculture and Forestry (MAF) and the Director of the Agricultural and Forest Policy Research Centre (PRC) in the National Agricultural and Forestry Research Institute (NAFRI) – and two from Cambodia – a Secretary of State in the Ministry of Agriculture, Fisheries and Forestry (MAFF) and a Secretary of State in the Supreme National Economic Council (SNEC). The identified individuals had all completed doctoral studies and were supportive of policy research, while also deeply involved in policy development within their respective agencies. As their time was scarce, their involvement in the project was to take the form of regular short meetings and in-house reviews with the Project Leader and Project Coordinator for the country in question. However, they were also to be asked to participate in project workshops where possible.

The members of the PAG were to be key informants in relation to Activity 1.2, providing insight into the policy process. They were to help identify key policy issues for the project to work on and provide suggestions and advice for the conduct of case studies in Activity 2.1. They were to be instrumental in identifying and seconding staff to collaborate in the conduct of these case studies. Their comments on the findings of these case studies were to be sought through sharing of draft reports and policy briefs, regular PAG meetings, in-house reviews, and policy forums (Activities 2.2, 4.1, and 4.2). They were also to be asked to advise and provide comments on drafts of the policy manual (Activity 4.3).

While the PAGs were formed in 2011-12, in practice they did not perform the roles envisaged in the project document. Interactions with the PAG in Laos, while valuable, were mostly in brief, one-on-one meetings and emails. One member of the PAG attended one of the project meetings in Vientiane. However, project inputs were sought on an ad hoc basis by policy-makers and advisers in Laos. For example, the DG of NAFRI was briefed at his request to assist in his presentation to the Politburo on rice policy. Similar briefings were also requested by MAF. In Cambodia it took longer to appoint PAG members (those initially approached wanted top-end commercial fees for their contribution) and their input was less constructive, potentially inhibiting the free flow of research. On the advice of the CDRI team, it was decided not to renew their appointments for a second year. Nevertheless, project findings were incorporated in CDRI policy briefs and thus widely circulated in Cambodian policy circles. Moreover, policy makers in both Laos and Cambodia were actively involved in the 'Policy Dialogue on Rice Futures' in Phnom Penh, 7-9 May 2014, at which project findings were presented.

The project began with an inception workshop in Luang Prabang in August 2011 (Table 1). The purpose of this workshop was, taking into account the findings of the SRA and the inputs of the PAG, to plan in detail the analysis of regional trends and policy processes (Activities 1.1 and 1.2) and the policy case studies to be undertaken in Year 1 (Activities 2.1 and 3.2). At this workshop a preliminary typology of rice-based farming systems and an analysis of key constraints was undertaken to further guide the prioritisation of policy case studies. This analysis of constraints was continually refined during the course of the project.

Table 1. Schedule of project meetings and workshops

| Meeting | Dates | Location |
|---|---|---|
| Project planning meeting | 23-25 February 2011 | Siem Reap |
| Inception meeting | 22-24 August 2011 | Luang Prabang |
| Annual meeting | 17-18 July 2012 | Danang |
| Project leaders' meeting | 3-4 December 2012 | Bangkok |
| Annual meeting | 4-6 November 2013 | Siem Reap |
| Policy forum | 7-9 May 2014 | Phnom Penh |

The analysis of regional trends (Activity 1.1) built on the desk studies completed in the SRA and, with the additional inputs of colleagues from CMU and CASRAD, provided a more comprehensive update of key agricultural trends, constraints, strategies, and policies in the Mekong region through interviews with key informants, further review of policy documents, and analysis of secondary data. This was to provide a comparative analysis and synthesis of strategies, settings, and regional trends. Characterising the policy processes in Laos and Cambodia (Activity 1.2) involved key informant interviews with policy actors, participant observation, and reviews of literature to document the formal and informal processes and the variety of influences on the selection and implementation of policy options at various scales (national, provincial, district, and local). The results of these studies were discussed at the first annual meeting in July 2012 in Danang (Table 1).

The main activities of the project revolved around conducting, analysing, reporting, and comparing the policy case studies (Activities 2.1, 2.2, 3.1, and 3.2). Studies were short-listed in the 2011 Siem Reap workshop on the basis that they addressed key issues affecting rice-based farming systems and there was a lack of empirical evidence to guide policy (re)development. Deliberations in the August 2011 workshop in Luang Prabang,

including the inputs of the PAG, gave rise to the studies listed in Table 2. Each of these policy case studies were intended to involve the following steps:

- Development of a short proposal for discussion by the project team and advice from the PAG.
- Formation of a study team, including designated project team members, staff, and postgraduate students in collaborating organisations, and seconded government staff at national, provincial and district levels. However, the secondment of government staff to the project did not eventuate.
- Literature review, including grey literature (e.g., government and donor project documents and impact studies), and identification of gaps in existing knowledge (data, analysis, or both).
- Planning and implementation of data collection, including selection of study sites and data collection methods (e.g., key informant interviews, small group interviews, farm surveys, direct measurement). Where possible, the same sites were used for more than one study to maximise cost effectiveness, e.g., studies of inputs, credit, and marketing drew on the same populations.
- Preliminary analysis and reporting. Analysis involved an array of quantitative and qualitative techniques depending on the requirements of the case study, including statistical analysis of survey or census data, content analysis of group discussions, budgeting of alternative production, marketing, and contractual options, risk analysis of these options, value chain analysis, and benefit-cost analysis of incremental policy changes (Casley and Kumar 1988; McConnell and Dillon 1997; FAO 1999; Cramb and Purcell 2001; Campbell and Brown 2003; Hardaker et al. 2004; Purcell et al. 2008).
- Workshop and synthesis. Each of the studies were presented to full project workshops in July 2012 and November 2013 (Table 1) to discuss, compare, and synthesise the findings. This permitted analysis of the specific policy options arising from the case study and contributed to refining the overall analysis of binding constraints and policy priorities.
- Writing report. Writers and editors were designated to produce standardised project reports and to design and produce policy briefs demonstrating how policy conclusions were drawn from the empirical study. Progress with these reports was reviewed at the Project Leaders' Meeting held in December 2012 in Bangkok (Table 1). It was decided not to pursue the translation of reports into local languages due to personnel and budgetary constraints.

The case studies were reviewed, compared, and analysed in relation to the constraints, strategies, and processes described in Activities 1.1 and 1.2. In May 2014, the project leaders from Australia, Cambodia, and Laos presented their analyses to the ACIAR 'Policy Dialogue on Rice Futures' held in Phnom Penh on 7-9 May 2014 in conjunction with collaborating policy agencies, other ACIAR project personnel, and other interested parties (Table 1). The proceedings were published in ACIAR Proceedings No. 142. However, there was a delay in producing the final monograph incorporating the case studies and integrated analyses. This monograph is now in draft form and will be published in 2018 as 'The Commercialisation of Rice Farming in the Lower Mekong: Policy Insights from Field Studies'. A policy manual was also to be prepared incorporating the methods used in the case studies and the policy options and priorities that emerged. However, it was decided to incorporate this in the methods section of the monograph.

Table 2. Final List of Case Studies

| No. | Study title | Nature of study |
|---|---|---|
| 1 | Overview of Rice Policy in Laos | Desk study |
| 2 | Rainfed and Irrigated Rice Farming on the Savannakhet Plain | Field survey |
| 3 | The Supply of Inputs to Rice Farmers in Savannakhet | Field survey |
| 4 | Rice Marketing and Cross-Border Trade in Savannakhet | Field survey |
| 5 | Economic Constraints to the Intensification of Rainfed Lowland Rice in Central and Southern Laos | Field surveys |
| 6 | Overview of Rice Policy in Cambodia | Desk study |
| 7 | The Production, Marketing and Export of Rice in Takeo | Field survey |
| 8 | The Role of Irrigation in Rice Farming in Takeo and Kampong Speu | Field survey |
| 9 | The Supply of Fertiliser for Rice Farming in Takeo | Field survey |
| 10 | The Use of Credit by Rice Farmers in Takeo | Field survey |
| 11 | Contract Farming of High-Quality Rice in Kampong Speu | Field survey |
| 12 | Overview of Rice Policy in Thailand | Desk study |
| 13 | Commercialisation of Rice-Based Cropping Systems in Thailand | Desk study |
| 14 | Commercialisation of Rice Farming in Three Northeast Thai Villages | Field survey |
| 15 | Farmer Organizations in Three Northeast Thai Villages | Field survey |
| 16 | Overview of Rice Policy in Vietnam | Desk study |
| 17 | Trends in Rice-Based Farming Systems in the Mekong Delta | Desk study |
| 18 | The Domestic Rice Value Chain in the Mekong Delta | Field survey |
| 19 | Cross-Border Trade in Rice from Cambodia to Vietnam | Field survey |
| 20 | Cross-Border Trade in Sticky Rice from Laos to Vietnam | Field survey |
| 21 | Implications of Case Studies for Interventions in Rice-Based Farming Systems | Analytical review |

# 6 Achievements against activities and outputs/milestones

### *Objective 1: To analyse current agricultural strategies, policy processes, and policy settings in Laos and Cambodia in the context of regional social, economic and environmental constraints and trends*

| No. | Activity | Outputs/ milestones | Completion date | Comments |
|---|---|---|---|---|
| 1.1 | Analyse constraints, trends, and strategies in the Mekong region | Comparative working paper on constraints, trends, and strategies | May 2014 | Paper presented at 'Policy Dialogue on Rice Futures', Phnom Penh, 7-9 May 2014 |
| 1.2 | Document policy processes and influences at various scales | Comparative report on policy processes and influences | Dec 2017 | Chapter in forthcoming monograph. |

### *Objective 2: To demonstrate the benefits of evidence-based policy development in Laos and Cambodia through feedback from selected case studies aligned with other ACIAR food security projects*

| No. | Activity | Outputs/ milestones | Completion date | Comments |
|---|---|---|---|---|
| 2.1 | Conduct case studies of selected policy issues conducted in collaboration with policy staff in government agencies | Completed policy working papers and policy briefs in local languages and English | Case Studies 1 to 4, Dec 2012<br><br>Case Studies 5 to 8, Dec 2013 | Decided not to produce reports in local languages. First case studies completed, presentations made at Danang workshop, July 2012; most drafts completed by Dec 2012; second set of case studies completed by Dec 2013. Studies carried out by project partners without direct involvement of staff in government agencies. |
| 2.2 | Review, compare, and analyse case studies in 2.1 in relation to trends, strategies and processes in 1.1 and 1.2. | Interim project report | Dec 2017 | Chapter in forthcoming monograph. |
| | Provide feedback to policy actors | Presentations to PAG, in-house briefings, dissemination of working papers, policy briefs, and interim project report | From time to time during project | PAGs formed in 2011-12, with 2 senior policy-makers in Laos and 2 in Cambodia. Interaction with PAG in Laos was in brief, one-on-one meetings and emails. Ad hoc briefings given to DG of NAFRI to present policies to Politburo and to MAF to advise Minister.<br><br>In Cambodia PAG less useful and it was decided not to renew appointments for a second year. Project findings were incorporated in CDRI policy briefs.<br><br>Policy makers in Laos and Cambodia were actively involved in 'Policy Dialogue on Rice Futures' in Phnom Penh, 7-9 May 2014. |
| | | Policy forums in Laos and Cambodia | May 2014 | These forums were incorporated in the 'Policy Dialogue on Rice Futures', Phnom Penh, 7-9 May 2014. |

### *Objective 3: To examine agricultural policy trends in other countries in the region, especially Thailand and Vietnam, and the implications of cross-border trade and investment for policies in Laos and Cambodia*

| No. | Activity | Outputs/ milestones | Completion date | Comments |
|---|---|---|---|---|
| 3.1 | Analyse policies, trends, and lessons learned in Thailand and Vietnam of potentially wider relevance | Cross-country comparative working paper on trends, strategies and policies (see 1.1) | Dec 2016 | Individual studies of relevance to rice policy presented at annual meeting in July 2012; drafts completed Dec 2012; edited and revised Dec 2016; cross-country paper update and incorporated in forthcoming monograph. |
| 3.2 | Conduct case studies of impacts of traders and investors from Thailand and Vietnam on rice-based farming systems in Laos and Cambodia | Completed policy working papers and policy briefs in local languages and English (see 2.1) | Case Studies 1-4 Dec 2012<br><br>Case Studies 5-8 Dec 2013 | Presentations of case studies made at annual meeting in July 2012; draft reports in English only completed by Dec 2012; edited and revised Dec 2016. |

### *Objective 4: To collaborate with agricultural policy agencies in Laos and Cambodia to identify improved policy options and strengthen policy development processes*

| No. | Activity | Outputs/ milestones | Completion date | Comments |
|---|---|---|---|---|
| 4.1 | Involve policy staff in training workshops, field studies, analysis of data, and preparation of policy options | Formation of Project Advisory Group (PAG)<br><br>Secondment of policy staff to work on case studies | 2011-2012<br><br>Not achieved | PAGs formed in Laos and Cambodia in 2011-2012. Decided to discontinue PAG in Cambodia due to political sensitivity of some of the topics under study.<br>Secondment of policy staff did not occur; studies undertaken by partner organisations only. |
| 4.2 | Organise in-house reviews of policy studies and policy forums in Laos and Cambodia with collaborating policy agencies | In-house reviews organised and completed<br><br>Policy forums organised and completed | July 2012 and June 2013<br><br>Policy forum May 2014 | In-house reviews incorporated in annual meetings<br>Policy forums were incorporated in the 'Policy Dialogue on Rice Futures', Phnom Penh, 7-9 May 2014. |
| 4.3 | Prepare a manual on evidence-based policy analysis | Final draft sent to publisher | Dec 2017 | Discussion of approaches to evidence-based policy analysis incorporated in forthcoming monograph |

# 7 Key results and discussion

Rather than attempt to summarise the many individual case studies, selected studies from Laos and Cambodia are presented here. The full set of reports will appear in the forthcoming monograph, as outlined in Section 8.4. The numbering of tables and figures is internal to each case study report.

### 1. Rice Farming on the Savannakhet Plain: A Survey in Champhone District

The aim of this study was to characterise rice production in the Savannakhet Plain, which has long been a major rice bowl for Laos. As this is one of the most productive and commercialized rice-growing regions in the country, an understanding of farmers' circumstances and strategies can give a good indication of how rice policy is working out in practice. If rice farmers in this region are facing substantial constraints on production, those in other settings will be even less able to meet government policy targets.

**The Study Area**

Savannakhet Province is the largest in Laos, covering 21,774 km$^2$, bordered by the Mekong River in the west and the Annamite Range in the east. The Province is drained by the Banghiang River, which originates in the mountains of Vietnam and empties into the Mekong about 90 km south of Savannakhet City. The river system has a comparatively steep fall and is subject to flash flooding in the upper catchment and longer-term flooding in the lower catchment, where several irrigation schemes have been established. The major rice-growing areas are found along the alluvial plain adjacent to the Mekong, with secondary areas on the residual terraces in the central part of the Province. The Province is traversed by three national roads – Route 13, which runs north-south along the Mekong corridor, Route 9, which runs on an east-west trajectory from Savannakhet City to the Vietnam border, and Route 1, which runs north-south along the eastern border range. Most of the provincial roads connecting district towns with major villages are unpaved, and most local roads are in poor condition and unusable during the wet season.

In 2011-12 Savannakhet Province accounted for 23% of the country's rice production and 25% of irrigated rice production (NSC, 2012). Within the province, rainfed wet-season (WS) rice accounted for 78% of total production and irrigated dry season (DS) rice for 22%. The yield of rice in Savannakhet averaged 3.4 tons per ha for WS rice and 4.1 tons per ha for DS rice, above the national average. Among the 15 districts of the Province, by far the largest rice producers were the five districts in the Mekong corridor, which together accounted for 60 per cent of the total rice area in the Province and 86 per cent of the irrigated area. The average WS yield in these five districts was 3.7 tons per ha and the average DS yield was 4.5 tons per ha, somewhat higher than the provincial average.

The survey was conducted in six villages in Champhone District, the second largest rice producer in the Province, accounting for 16% of total production (Table 1). The District lies just to the east of Route 13 and the south of Route 9 and spans the middle reaches of the Champhone River, a major right-bank tributary of the Banghiang. Several irrigation schemes have been constructed along the Champhone River to service rice farmers in the district. Given its irrigation infrastructure of reservoirs and canals, Champhone produced more DS rice than any other district, accounting for 41% of the Province's irrigated rice output in 2011-12.

The villages were selected based on being located within this important rice-producing area and having potential to produce rice for the market. The characteristics of the villages and sampling details are presented in Table 1. The survey households were selected randomly from a list of all households in each village. The survey questionnaire focused on rice production in each season, including the area cultivated, the working calendar, input costs, production, sales, constraints, and potential. The survey was conducted in March 2012 by staff of the Faculty of Agriculture at the National University of Laos.

### Village and Household Profiles

The six villages were representative of the range of conditions in Champhone District. Ban Phalaeng was located in the Champhone Village Cluster about 10 km from Champhone Town and 1 km east of Route 13. Phalaeng was established in 1809 by two groups that migrated from other villages in the region. In 2011, the village had 142 households and 192 families, with a total population of 971. All but a few households owned land and those without land rented fields for cultivation. Phalaeng had a total area of 825 ha including about 500 ha of cultivated land. Rice farming was the main source of income. WS rice was cultivated on about 440 ha and around 150 ha were used for irrigated rice and vegetables in the dry season. Water for irrigation was sourced from the Sou and Champhone reservoirs. The livestock in the village included an estimated 118 cattle, 57 water buffaloes, 83 pigs, 169 goats, and about 1,800 ducks and chickens. The primary land use in the village was rainfed and irrigated rice cultivation, some cash crop cultivation, fishing, and livestock production (cattle and buffaloes). In the wet season, rice and fish culture were the main activities. Irrigated rice was grown in the dry season in the fertile floodplain near the reservoirs and along the canals. Vegetables were grown in the houseyards and in irrigable paddy fields after harvesting the WS rice crop. As the village was close to the main road and Champhone town, the villagers were quite commercialised. They could take their surplus rice and other produce to sell in Kengkok Market in Champhone every day. Moreover, local Lao and Vietnamese traders came to the village to provide fertilizer on credit. The villagers had set up a farmer group to produce rice seed for other villages with the assistance of a government agency. More than half the farmers had joined this program.

Ban Phiaka was established more than 200 years ago about 15 km north of Champhone. The village had 66 households and a total population of 566. The village area was 520 ha, supporting 218 ha of rainfed rice in the wet season and 92 ha of irrigated rice in the dry season, as well as 30 ha of vegetable gardens and fruit tree orchards. Livestock included 319 cattle, 167 water buffaloes, 69 pigs, 75 goats, and around 10,000 poultry. More than half the villagers had their own hand tractor and there were two rice mills, six threshing machines, and three water pumps. The village had a diversity of rice ecosystems. Water for DS irrigation and WS supplementary irrigation was pumped from the adjacent Champhone River. With this source of irrigation, rice farming was the main source of income in both seasons. However, WS rice was affected by flooding in some years, though these flooded areas had fertile soil and were suitable for irrigated DS rice. Phika had also established a farmer group to produce rice seed, which provided a good income for the farmers involved. Fishing and other agricultural activities also contributed to household income. Local and Vietnamese traders came to the village to buy rice and other products. Vietnamese traders often provided fertilizer to farmers on credit early in the season.

Ban Beukthong was located 16 km from Champhone. The village had 187 households and a population of 1,306. The village area was 3,997 ha, including 436 ha of rainfed lowland rice. Livestock included 312 cattle, 218 buffaloes, 211 pigs, and about 2,000 poultry. The landscape in Beukthong ranged from middle-level lowlands to floodplain. DS rice could be cultivated in parts of the floodplain area with irrigation from natural ponds or a small stream. Rice farming was the main source of income. A seed production group had also been established in the village. As with the above villages, Vietnamese traders came to Beukthong early in the season to provide fertilizer on credit, with the cost being repaid after harvest, including interests of 20%.

Ban Dondaeng was established in 1937 and about 8 km east of Champhone. It was the result of a merger of smaller villages to comply with government policy. At the time of the survey the village had 154 households and a total population of 1,328. The village territory was 4,100 ha, with 710 ha of rainfed rice in the wet season and 147 ha of irrigated rice in the dry season. The landscape comprised two zones – a middle-level lowland area and a floodplain area. In the former, farmers used land for rainfed rice and animal raising in the wet season. In the latter, flooding prevented some areas from being used for rice in the wet season but they could be used for irrigated rice in the dry season. The source of water for

irrigation and supplementary irrigation was the Talong reservoir; some farmers used water from natural ponds and small streams for their DS rice. Dondaeng had good road access to both the Kengkok markets in Champhone and the market in Xounabouly to the south. Farmers sold surplus rice as their main source of income. However, some farmers had low yields due to water shortage in the wet season and low soil fertility in the middle-level lowlands.

Table 1. Characteristics of survey villages

| Village | No. of house-holds | No. inter-viewed | Characteristic of village |
|---|---|---|---|
| Phalaeng | 142 | 38 | - Most farmers produced rice for market<br>- Rice Seed Farmers Group<br>- Irrigated DS rice in lowland areas near canal<br>- Easy access in both seasons (1 km from road) |
| Phiaka | 66 | 22 | - Irrigated DS rice in lowlands and along river<br>- Some paddies flood in WS in some years<br>- Large farmers with DS rice produced for market<br>- Access to village very difficult in WS |
| Beukthong | 187 | 42 | - Most farmers grew WS rice<br>- Some DS rice near reservoir or small stream<br>- Some sold rice surplus after harvest<br>- Rice Seed Farmers Group<br>- Can access village in both seasons |
| Dondaeng | 154 | 50 | - Most farmers grew WS rice<br>- Some grew DS rice near stream using pump<br>- Some sold surplus rice<br>- Can access village in both seasons |
| Khaokad | 127 | 32 | - Most farmers grew WS rice, a few grew irrigated DS rice near natural ponds<br>- Very few farmers sold rice after harvest<br>- Can access village in both seasons |
| Khamsida | 178 | 44 | - Farmers grew WS rice only<br>- Low yield; infertile sandy soil in upper paddies<br>- Most farmers produce rice for home consumption, some have insufficient rice in DS<br>- Can access village in both seasons |
| Total | 854 | 228 | |

Ban Khaokad was established more than 300 years ago. It was located 7 km north-west of Champhone. There were 127 households and a total population of 802. The village territory was 591 ha, including 268 ha of rainfed paddies. The landscape was similar to the other villages, ranging from upper-level lowlands to lowlands, but with no irrigated rice. Rice production was mainly for household food security. Some farmers grew watermelon and vegetables in the paddy fields after the rice harvest. These activities enabled villagers to earn income to contribute to village development. A village fund had been established to lend money to villagers to develop a business or buy agricultural inputs.

Ban Khamsida was established about 200 years ago. There were 178 households and a total population 1,284. The territory was 590 ha, with 300 ha of rainfed rice (some of which could be irrigated), a garden area of 80 ha, and a forest area of 70 ha. The village was located in the upper-level lowlands and had poor soil. Hence some households had insufficient rice for 2-10 months of the year. Only a few paddy fields had access to water in

the dry season to grow irrigated rice. With poor soils and limited irrigation, farmers needed capital to buy inputs to increase the yield of rice.

Of the households interviewed, 80% were Lao or Phouthai and 20% were Khmu. The Khmu and related groups were the earlier settlers in Savannakhet, while the Lao and Phouthai had begun moving into the region from further north in the sixteenth century. The modal household size was 6-7 and the range was from 2 to 15. The modal number of workers per household was 3, ranging from 1 to 8. Households had from 1 to 5 plots of land. The mean farm size was 2.8 ha and the range was from 0.3 to 11.2 ha. The distribution of farm size is shown in Table 2, indicating that 38% of respondents had between 1 and 2 ha and 62% had between 1 and 3 ha. Almost all households (96.5%) reported that they worked on their own land, while 4 worked on their parents' land and only 2 rented land from other villagers.

Table 2. Distribution of survey households by farm size

| Farm size (ha) | No. of households | % of households |
|---|---|---|
| < 0.5 | 14 | 6.1 |
| 0.51 – 1.0 | 39 | 17.1 |
| 1.01 – 2.0 | 87 | 38.2 |
| 2.01 – 3.0 | 54 | 23.7 |
| > 3.0 | 34 | 14.9 |
| Total | 228 | 100.0 |

**Rice Production in the Wet Season**

All survey farmers cultivated WS rice in 2011. The cropping calendar for WS rice is shown in Table 3. Nursery preparation began in April, preparation of the paddy field in May, transplanting in July, and harvesting in November. The mean area cultivated with WS rice in 2011 was 1.9 ha but varied between villages, from 1.3 ha in Khamsida to 2.8 ha in Beukthong (Table 4). The range was from 0.3 to 7.5 ha.

Hand tractors were almost universally used for land preparation. Over two thirds (68%) of households reported that they used their own hand tractor, 18% hired a hand tractor, 10% borrowed a hand tractor from a relative, and only 4% still used a buffalo-drawn plough. This traditional practice was found among some of the poorest farmers in Dondaeng and Khamsida.

Farmers reported using 16 different rice varieties in the wet season, almost all glutinous, including 14 improved varieties that had been bred and distributed by Ministry of Agriculture and Forestry (MAF) research stations (Table 5). Most farmers (86%) reported using an improved variety, with 32% using Thadokham (TDK) 10 (a recent release) and 15% using Phonengam (PNG) 3 (an IRRI cross released in 2005 that was high-yielding and relatively drought-tolerant). The major reason given for using improved varieties was that they yielded better than traditional varieties.

Most farmers (85%) used chemical fertilizers for WS rice production, including urea (46-00-00) (34%), ammonium phosphate (16-20-00) (46%), and compound fertilisers such as 10-08-08 (16%) and 15-15-15 (4%). The quantity used varied between households depending on the fertility of their land and their working capital.

The mean yield was 2.2 t/ha, well below the reported mean for Savannakhet as a whole (Table 4). Four villages averaged 2.3-2.4 t/ha but in Dondaeng and Khamsida the mean yield was only 1.7-1.8 t/ha due to lower soil fertility and the impact of drought where farmers did not have access to supplementary irrigation.

Table 3. Cropping calendar for wet-season and dry-season rice production

| Activity | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D |
| Fertilizing | | | | | | | | | | | | |
| Sowing | | | | | | | | | | | | |
| Land preparation 1 | | | | | | | | | | | | |
| Land preparation 2 | | | | | | | | | | | | |
| Transplanting | | | | | | | | | | | | |
| Fertilising | | | | | | | | | | | | |
| 15-15-15 | | | | | | | | | | | | |
| 16-08-08 | | | | | | | | | | | | |
| 16-20-00 | | | | | | | | | | | | |
| 46-00-00 | | | | | | | | | | | | |
| Management | | | | | | | | | | | | |
| Harvesting | | | | | | | | | | | | |
| Post-harvest | | | | | | | | | | | | |

Key: Wet season Dry season

Table 4. Mean area and yield of wet-season rice in survey villages, 2011

| Village | Mean area cultivated (ha) | Mean yield (t/ha) |
|---|---|---|
| Phalaeng | 1.90 | 2.43 |
| Phiaka | 2.27 | 2.45 |
| Beukthong | 2.79 | 2.29 |
| Dondaeng | 1.36 | 1.81 |
| Kaokad | 1.99 | 2.24 |
| Khamsida | 1.34 | 1.67 |
| All villages | 1.94 | 2.24 |

A representative enterprise budget for WS rice was prepared based on the survey data (Table 6). Given a yield of 2.2 t/ha and a farm-gate price of LAK 2,000 per kg of unhusked rice, the gross revenue was LAK 4.48 million per ha. Enterprise expenses or paid-out costs (i.e., excluding the opportunity cost of family labour) totaled LAK 2.89 million per ha, or nearly two thirds of gross revenue. Fertiliser was the largest item, accounting for a third of expenses.

Subtracting paid-out costs from gross revenue gave a gross margin (GM1) of LAK 1.60 million per ha (Table 6). Calculated as a return to the input of family labour, this resulted in a figure of LAK 32,000 per day, roughly equal to the prevailing agricultural wage. Thus if the opportunity cost of family labour is valued at LAK 30,000/day, total enterprise costs were LAK 4.39 million, consuming almost all of the gross revenue and giving a gross margin (GM2) close to zero (LAK 95,500 per ha).

Table 5. Rice varieties used by respondents in wet and dry seasons, 2011-12

| Variety | Wet season | | Dry season | |
|---|---|---|---|---|
| | No. of households | % of households | No. of households | % of households |
| **Improved varieties** | | | | |
| Thadokham 1 | 8 | 3.5 | 2 | 1.7 |
| Thadokham 5 | 5 | 2.2 | 22 | 19.0 |
| Thadokham 6 | 25 | 11.0 | 9 | 7.8 |
| Thadokham 7 | 5 | 2.2 | 2 | 1.7 |
| Thadokham 8 | 30 | 13.2 | 15 | 12.9 |
| Thadokham 10 | 73 | 32.0 | 25 | 21.6 |
| Thadokham 11 | 10 | 4.4 | 9 | 7.8 |
| Phonengam 1 | 2 | 0.9 | - | - |
| Phonengam 3 | 35 | 15.4 | 9 | 7.8 |
| Phonengam 5 | 21 | 9.2 | 9 | 7.8 |
| Phonengam 6 | - | - | 2 | 1.7 |
| Thasano 3 | 2 | 0.9 | 8 | 6.9 |
| Thasano 6 | - | - | 2 | 1.7 |
| Thasano 7 | 4 | 1.8 | 2 | 1.7 |
| Glutinous Mali | 8 | 3.5 | - | - |
| Non-Glutinous Mali | 7 | 3.1 | - | - |
| **Local varieties** | | | | |
| Dodaeng | 24 | 10.5 | - | - |
| Phanpae | 2 | 0.9 | - | - |
| **Other** | - | - | 9 | 7.8 |
| **Total** | 228 | 100.0 | 116 | 100.0 |

The observed farm-gate price in 2011 was LAK 2,000 per kg, which was just enough for farmers to break even, given an average total cost of LAK 1,950 per kg. However, the government subsequently introduced a minimum farm-gate price of LAK 2,500 per kg for paddy rice. If this price is applied to the budget in Table 5, GM1 increases to LAK 2.72 million per ha and LAK 54,000 per day. A 25% increase in price thus results in a 70% increase in the return to the family's resources of land and labour.

However, the WS crop is traditionally seen as providing the household's own rice supply rather than as a major source of cash income. With little or no alternative use of paddy land and farm labour during the wet season, to break even while ensuring the staple food supply would be considered a satisfactory outcome. In fact, many farmers also sold surplus rice from the WS harvest, converting otherwise unpaid family labour into a source of cash income for the household.

Farmers identified the major constraints facing their WS rice production. The most frequently mentioned constraints were biophysical, notably insect and pest infestation (27%) and drought (22%), followed by socioeconomic constraints such as lack of capital (13%) and shortage of labour (13%).

Table 6. Representative enterprise budget for one hectare of wet-season rice

| Item | Quantity | Price (LAK/unit) | Value (LAK) | % of gross revenue |
|---|---|---|---|---|
| Gross revenue | 2.24 t | 2,000/kg* | 4,480,000 | 100.0 |
| Seed | 75 kg | 3,500/kg | 262,500 | 5.9 |
| Fertilizer | 150 kg | 6,780/kg | 1,017,000 | 22.7 |
| Fuel | | | 500,000 | 11.2 |
| Threshing/hauling | 50 bags | 5,000/bag | 250,000 | 5.6 |
| Land tax | | 35,000/ha | 35,000 | 0.8 |
| Other costs | | | 100,000 | 2.2 |
| Family labour | 50 days | 30,000/day | 1,500,000 | 33.5 |
| Hired labour | | 720,000/ha | 720,000 | 16.1 |
| Total paid-out costs | | | 2,884,500 | 64.4 |
| Total costs | | | 4,384,500 | 97.9 |
| Gross margin 1 | | | 1,595,500 | 35.6 |
| Gross margin 2 | | | 95,500 | 2.1 |
| GM1/day of family labour | | | 31,910 | |

* Farm-gate price in 2012

**Rice Production in the Dry Season**

Just over half the survey households (51%) reported that they grew irrigated rice in the 2011-12 dry season. The cropping calendar for DS rice is shown in Table 2 above. Nursery preparation began in December, straight after the WS rice harvest. Land preparation and transplanting occurred in January and harvesting in April-May. Hence the DS crop was on a tighter schedule than the WS crop.

The area of DS rice cultivated averaged 1.0 ha and ranged from 0.2 to 5.0 ha. However, 25% of those with DS rice cultivated less than 0.5 ha and 51% cultivated between 0.5 and 1.0 ha. Only 20% had 1-2 ha and 5% had more than 2 ha. Given the lower incidence of DS rice cultivation and the smaller area cultivated by each household, the total area cultivated was around a quarter of that in the wet season.

Farmers used only improved varieties in the dry season (Table 5). The most popular of these were, as in the wet season, TDK10 (22%), TDK8 (13%), TDK11 (8%), TDK6 (8%), and PNG3 (8%). However, TDK5, which only 2% of farmers used in the wet season, was also relatively popular due to its short duration, with 19% of DS farmers reporting its use.

Almost all farmers growing DS rice (96%) applied chemical fertilizer. As mentioned above, Vietnamese traders came to most villages at the beginning of the season to supply fertilizer on credit, to be repaid with interest at harvest. The same types of fertilizer were used as in the wet season, including ammonium phosphate (39%), urea (38%), and the compound fertilisers 16-08-08 (18%) and 15-15-15 (8%).

Another representative enterprise budget was prepared for DS rice, again based on the survey data (Table 7). With a higher yield of 3.0 t/ha but a lower farm-gate price of LAK 1,800 per kg, the gross revenue was 20% higher at LAK 5.4 million per ha. Paid-out costs were 35% higher, totaling LAK 3.9 million per ha, or nearly three quarters of gross revenue. The major cost was again for fertilizer, accounting for 24% of revenue, but there was also an irrigation fee and higher post-harvest costs due to the higher yield.

Subtracting paid-out costs from gross revenue gave a gross margin (GM1) of LAK 1.74 million per ha, only marginally higher than for the WS crop (Table 7). The return to family labour was LAK 29,000 per day, marginally lower than in the wet season and just below the agricultural wage. This reflected the higher labour input for the DS crop. Thus costing family labour at LAK 30,000 per day meant that total enterprise costs exceeded gross revenue, resulting in a gross margin (GM2) close to zero (- LAK 60,000 per ha).

If the government's minimum price of LAK 2,500 per kg was applied, the calculated returns became more acceptable. The GM1 per ha increased to LAK 3.54 million and the GM1 per day to LAK 59,000, almost double the farm wage. The GM2 per ha was LAK 2.04 million.

The major constraints reported for DS rice were similar to those for the wet season – pest and insect infestation (34%), drought and inadequate water supply (24%), lack of capital (19%), shortage of labour (10%), and the absence of an irrigation scheme in the village (9%).

Table 7. Representative enterprise budget for one hectare of dry-season rice

| Item | Quantity | Price (LAK/unit) | Value (LAK) | % of gross revenue |
|---|---|---|---|---|
| Gross revenue | 3.0 t | 1,800/kg* | 5,400,000 | 100.0 |
| Seed | 90 kg | 3,500/kg | 315,000 | 5.8 |
| Fertilizer | 200 kg | 6,500/kg | 1,300,000 | 24.1 |
| Fuel | | | 500,000 | 9.3 |
| Irrigation fee | | 300,000/ha | 300,000 | 5.6 |
| Threshing/hauling | 75 bags | 5,000/bag | 315,000 | 5.8 |
| Other costs | | | 150,000 | 2.8 |
| Family labour | 60 days | 30,000/day | 1,500,000 | 27.8 |
| Hired labour | | 720,000/ha | 720,000 | 13.3 |
| Total paid-out costs | | | 3,960,000 | 73.3 |
| Total costs | | | 5,460,000 | 101.1 |
| Gross margin 1 | | | 1,740,000 | 32.2 |
| Gross margin 2 | | | - 60,000 | |
| GM1/day of family labour | | | 29,000 | |

* Farm-gate price in 2013

**Household Rice Consumption and Sales**

Of total annual rice production, over half (56%) was retained for household consumption and about a third (32%) was sold, including 1% as seed. About 6% was given to relatives and 6% kept for seed and poultry feed.

Nearly two thirds of households interviewed (62%) reported that they sold rice in one or both seasons. The average quantity of rice sold was 2.3 tons. The quantity sold varied with farm size and season (Table 8). For those selling only WS rice (46% of all sellers), the mean quantity varied from 0.5 tons to 4.0 tons as farm size increased from less than 1.5 ha to more than 4.5 ha. Only a few households (4%) sold only DS rice, averaging around 3 tons. Half of the rice sellers sold both WS and DS rice, the mean quantities varying from 1.7 tons for those with less than 1.5 ha to 4.5 tons for those with more than 4.5 ha.

Table 8. Quantity of rice sold by farm size and season

| Season | Farm size (ha) | % of those selling | Sales per household (tons) | | |
|---|---|---|---|---|---|
| | | | Maximum | Minimum | Mean |
| Wet season only | <1.5 | 20 | 0.7 | 0.1 | 0.5 |
| | 1.51-2.5 | 15 | 2.8 | 0.4 | 1.4 |
| | 2.51-4.5 | 9 | 7.4 | 0.9 | 2.6 |
| | >4.5 | 2 | 10.0 | 1.3 | 4.0 |
| Dry season only | <1.5 | 3 | 3.0 | 1.4 | 2.7 |
| | >1.5 | 1 | 4.0 | 1.8 | 3.4 |
| Both seasons | <1.5 | 6 | 4.5 | 0.2 | 1.7 |
| | 1.51-2.5 | 20 | 5.2 | 0.4 | 2.7 |
| | 2.51-4.5 | 18 | 6.6 | 0.6 | 3.0 |
| | >4.5 | 6 | 10.8 | 1.1 | 4.5 |

Nearly half of households selling rice did so in August and September (Figure 2). Farmers sold rice at this time as they had enough rice in storage for household consumption and the price of paddy rice tended to rise to LAK 2,000 per kg during these months, preceding the WS rice harvest. During 2012 the price fluctuated from LAK 1,500 to LAK 2,000 per kg for eating rice and from LAK 3,000 to LAK 3,500 per kg for rice seed.

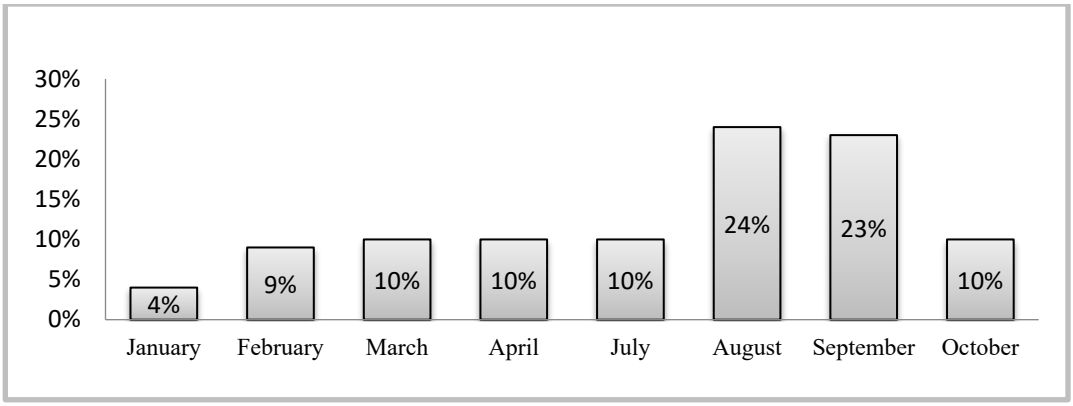


Figure 2. Incidence of selling rice throughout the year (% of those selling)

On the other hand, about a fifth of households (19%) produced insufficient rice for their consumption needs, especially in Ban Khamsida and Ban Kaokad. These households experienced a period of rice shortage of from 1 to 8 or more months (Figure 3). Of these rice-deficit households, most (55%) experienced a shortage of 1-4 months, but as many as 31% were short of rice for more than half the year. The main reasons given for facing a rice shortage were limited land (26%), poor soil (26%), and drought in some years (19%). Other problems affecting yield were pests and diseases, flooding, lack of water, and weeds. Ban Khamsida was especially prone to these problems, with mainly upper-level paddies with sandy soils that were more drought-prone and lacked irrigation. However, farmers in other villages with small holdings (23% had 1 ha or less) may also have struggled to meet their subsistence needs.

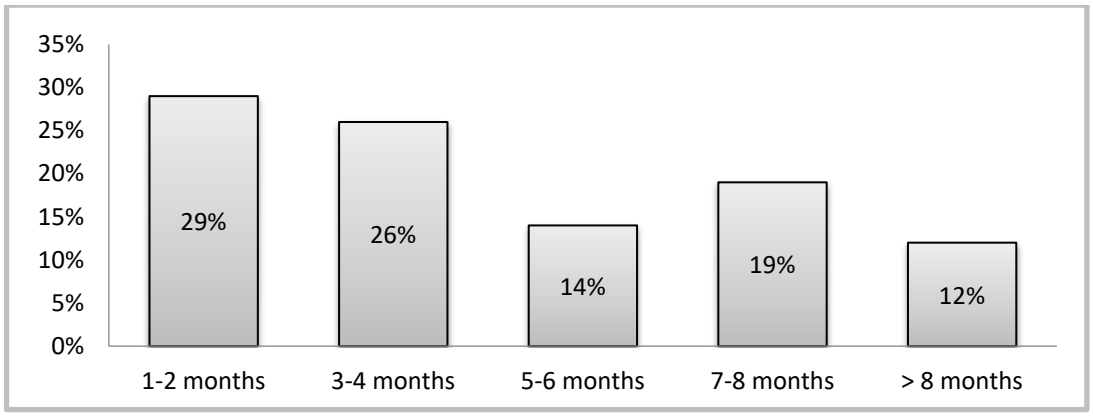


Figure 3. Incidence of rice shortage (% of households producing insufficient rice for consumption)

## Conclusion

The survey villages had been growing rice on the Savannakhet Plain for centuries, gradually expanding the cultivated area as population increased. Though situated in this generally favourable environment for rice, the villages encompassed a variety of agro-ecosystems. Upper paddies with sandy soils were drought-prone and without irrigation, hence could only support WS rice with lower yields. Lower paddies were more fertile and often had access to pump-irrigation from rivers, canals, or ponds, hence they could often support WS and DS rice crops with somewhat higher yields. Lower paddies along the floodplain of the Champhone River also had fertile soils but were frequently flooded in the WS, hence only DS rice could be cultivated, depending for moisture on the receding floods and irrigation. The villages had different combinations of these agroecosystems, affecting their surplus-producing potential.

Farms were generally small. The mean size was 2.8 ha and 62% of households had 1-3 ha. Almost all farmers planted WS rice, cultivating about 2 ha on average, while only half of them planted DS rice, averaging about 1 ha – a function of access to reliable irrigation. Hence the total DS cultivated area was about a quarter of the WS area. Despite widespread use of improved varieties, fertiliser and, where available, irrigation, the WS yield averaged only 2.2 t per ha and the DS yield, 3.0 t per ha – well below the Ministry of Agriculture and Forestry's target yield of 4.2 t per ha. Farmers highlighted pest infestations, drought, and insufficient irrigation as the main constraints on yield, and, less frequently, shortages of land, labour, and capital.

For the yields and prices encountered in the survey, the returns to rice cultivation were low. Given a price of LAK 2,000 per kg of paddy, the WS crop gave an average gross margin (without imputing a cost to family labour) of LAK 1.60 million per ha and LAK 32,000 per day, enabling a household to just break even. At the government's minimum price of LAK 2,500 per kg, the gross margin was LAK 2.72 million per ha and LAK 54,000 per day, a somewhat more attractive return. With a higher yield but a lower price of LAK 1,800 per kg, the DS crop gave a gross margin of LAK 1.74 million per ha, but only LAK 29,000 per day due to the higher labour input. In this case a household would just fail to break even. Once again, at a price of LAK 2,500 per kg, the gross margin jumped to LAK 3.54 million per ha and LAK 59,000 per day, making the crop somewhat more profitable.

Though more than half (56%) of total rice production was for subsistence, most of the survey farmers were highly commercialized, taking fertilizer and other inputs on credit, hiring labour and machinery, paying for irrigation, and regularly selling rice. Nearly two thirds (62%) of households sold rice; nearly half of these sold only from the WS crop and half sold from both the WS and DS crops. Overall, about a third of total production was sold. The quantity sold by each household was directly proportional to farm size – about 0.7 t per ha for those selling only WS rice and about 1 ton per ha for those selling in both seasons. Farmers sold

throughout the year, but half (presumably mainly DS producers) sold at the time of highest price in August-September. Farmers in some villages produced seed rice which they sold at almost double the price for eating rice.

However, even in this surplus-producing district, about a fifth of surveyed households with less-favourable resource endowments (mainly smaller, less-productive farms) were unable to meet their subsistence requirements, let alone produce a marketable surplus. In most cases (55%) the shortage was for 1-4 months. While the surplus producers would benefit from higher paddy prices, these net purchasers of rice would be worse off.

Overall, the survey shows that, even with low yields and low returns, rice production in the Savannakhet Plain can generate a sizeable surplus for marketing within Laos and internationally. However, farmers are going to remain poor unless they can achieve higher yields and obtain higher and more stable prices. Low incomes will increase the incentives for younger household members to migrate to Vientiane or to Thailand for employment, adding to the shortage of farm labour. Nevertheless, given its comparative advantage in rice production, the Savannakhet Plain is a good focal area for increased investment in research, extension, input supply, mechanisation, and infrastructure to boost productivity and farm incomes.

## 2. Economic Constraints to the Intensification of Rainfed Lowland Rice in Laos

### Introduction

Rice production in the rainfed lowlands of Laos faces a number of constraints at the farm level, including poor soil fertility, droughts and floods, and various pests and diseases (Schiller et al. 2001; Linquist and Sengxua 2001; Fukai and Ouk 2012). Furthermore, factors beyond the farm boundary such as rising input costs, fluctuating output prices, and uncertain trade policy continue to limit farmers' incentive to intensify production beyond that required to achieve household self-sufficiency. Hence, in recent years, household labour and capital have been redirected into a range of other farm and non-farm activities rather than into intensifying rice production (Manivong et al. 2012). With high levels of yield- and price-risk, and limited opportunities for consumption smoothing through market mechanisms (credit, insurance), households adopt income-smoothing strategies by adopting low-input production systems and income diversification, most notably through migration of family members to earn wages.

While the constraints are numerous, lowland rice production systems have been evolving over the past two to three decades. The traditional farming system that relied on draught animal power, traditional varieties, and organic fertiliser now accounts for a very small proportion of the country's lowland rice area, with widespread adoption of mechanised land preparation, improved varieties, and low levels of inorganic fertiliser. Despite the achievements of these "green revolution" technologies in terms of increased output, lowland rice production remains an economically marginal activity, providing limited economic incentive for farmers to intensify production beyond household consumption needs.

This poses a challenge for the Government of Laos (GOL) that seeks to keep the price of rice affordable for urban consumers (and net buyers of rice in rural areas), while providing incentives for farmers to intensify production to achieve food security (and even export) objectives. Attempts to maintain national food security, equated by policy-makers with rice self-sufficiency, have included the setting of official yield targets that are high relative to the current situation (4 tons/ha for the rainfed wet-season (WS) crop and 5 tons/ha for the irrigated dry-season (DS) crop), as well as ad hoc trade restrictions prompted by seasonal shortfalls and price spikes. However, in many cases the strategies fail basic economic viability tests at the household level and have created further market uncertainty.

The limited intensification of lowland rice systems reflects the relative resource endowments and livelihood objectives of farm households. Induced innovation theory predicts that farming systems will respond both to changes in resource endowments and to growth in

product demand, with new technologies developed and adopted that facilitate the substitution of relatively abundant and low-cost factors for those that are relatively scarce (Hayami and Ruttan 1985). In practice, this depends on the extent to which farmers' circumstances and national government policies align, and the ability of farmers to influence research and development priorities. In considering the economic and institutional constraints to improved fertility management, Pandey (1999) classifies rice production systems using a matrix of population density and the stage of economic development (as indicated by income levels). He argues that, in situations with low population density and low income levels (in which he includes Laos), farms tend to be subsistence-oriented, with limited demand for improved nutrient management technologies that increase yields and returns to land. Such technologies will only be adopted if they also help save labour, the relatively scarce resource. He further argues that, in order to stimulate the demand for yield-increasing technologies, policies need to focus on improving the profitability of rice production. This may include the development of export markets and improved market infrastructure, factors that lie outside the farm boundary. Nevertheless, in rainfed regions, production risk will continue to influence the demand for fertility management technologies.

In this chapter we aim to explain farmers' decisions regarding intensification of rainfed lowland rice systems in the context of current resource endowments, product demand, and production and market risk. We first describe the current rice production system in two major lowland provinces in central and southern Laos – Savannakhet and Champasak. We demonstrate that while the rainfed production system remains largely subsistence-oriented, farmers have selectively adopted a range of new technologies and continue to respond to changing incentives. However, to date this has largely involved the adoption of low-input, more labour-efficient, and more stable production systems rather than commercially oriented, high-input, high-yield systems. We use activity budgeting and sensitivity analysis to explore the economic performance of several input scenarios, ranging from farmers' practice to input levels required to achieve GOL policy targets. This analysis can be used to reassess aspects of rice policy for the rainfed lowlands in Laos.

**Methods**

Savannakhet and Champasak are two of the most important rice-producing provinces in Laos. In 2009 they accounted for around 40% of the national WS harvested area and a similar proportion of total production (Ministry of Planning and Investment 2010). A diagnosis and assessment of farming systems in these two provinces was undertaken in several phases of field work, including key informant interviews with district agricultural staff, village group discussions, household surveys, and household case studies.

The fieldwork was conducted along transects reflecting different farm types, from irrigated lowlands through rainfed lowlands to uplands. However, only data from lowland villages are considered here; upland villages surveyed in the east of Savannakhet have been excluded from the analysis. Thus for present purposes the study region included six villages in Outomphone, Phalanxai, and Phin Districts in Savannakhet and six villages in Phonthong and Sukhuma Districts in Champasak (Figure 1). A household survey was carried out with 30 randomly selected households in each village, making 360 households in all. Information was sought regarding household composition and assets, cropping practices, livestock practices, off-farm and non-farm employment, migration and remittances, forest collection and hunting activities, access to water, access to credit, group membership, information sources, and rice security. More detailed case studies were conducted with 13 households in Savannakhet and 18 households in Champasak.

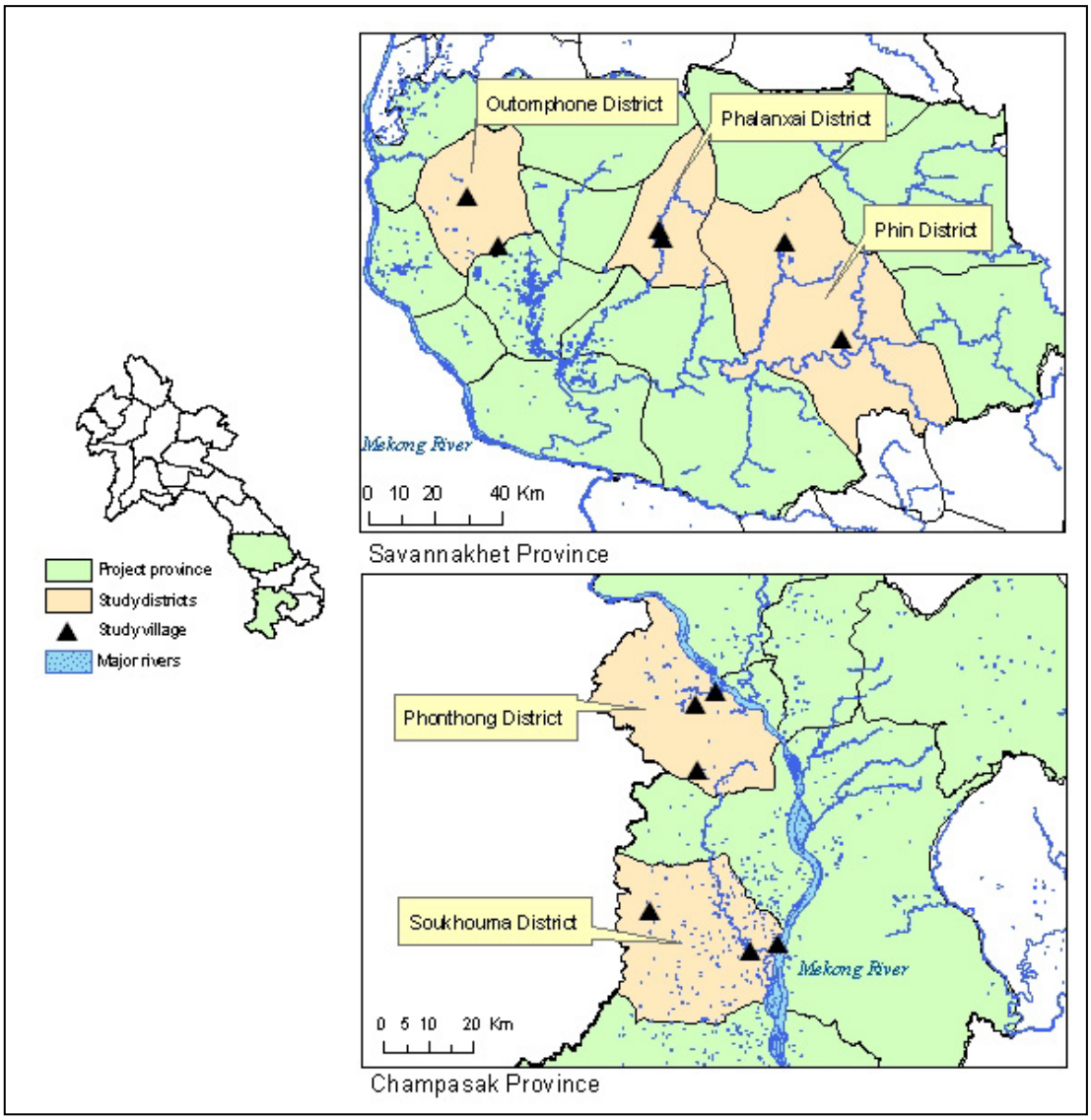


Figure 1. Location of study villages in Savannakhet and Champasak Province

Survey and case-study data were supplemented with project and historical agronomic trial results in order to construct model budgets for various input scenarios. These include data from fertiliser response trials conducted by IRRI and NAFRI over more than a decade (Linquist and Sengxua 2001; Linquist and Sengxua 2003; Heafele et al 2010). Official yield data were not used as these tend to overestimate actual farm yields (Pandey and Sanamongkhoun 1998), presumably a reflection of the pressure to show progress in achieving policy targets. In 2013 the model budgets were presented to a farmer focus group for validation and updating with input and output prices relevant to the 2012 wet season. Sensitivity analysis, threshold analysis, and risk analysis (using the @Risk software package) were conducted for each scenario.

**Status of Lowland Rice Farming in the Study Villages**

The cultivation of paddy rice remains an important livelihood activity for the majority of households in the lowland regions of Laos and creates the platform on which other activities and household decisions are based. Decisions regarding labour utilisation and migration, livestock management, even religious and cultural festivals, are all made with reference to the paddy production cycle. Around 96% of surveyed households cultivated paddy rice in WS 2010. Household access to paddy land varied within and between villages, from less than a hectare to over 10 ha with an average across all villages of around 2 ha (Table 1).

There was a similar proportion of households with 1 ha or less (33%), 1-2 ha (34%), and over 2 ha (33%). Beyond farm size, other factors such as soil type, position in the toposequence, and access to water sources all affected the productivity of the land, even before any management decisions were overlayed. The stability of the livelihood platform thus varied between households and seasons.

Table 1. Status of rice-growing in surveyed villages, 2010 (n=360)

| District and village | % of hh* growing paddy rice | Mean hh* size | Mean WS cultivated area (ha) | Mean WS yield (kg/ha) | Mean % of production sold |
|---|---|---|---|---|---|
| Outomphone | 100 | 6.6 | 2.5 | 1,466 | 9.7 |
| Nagasor | 100 | 6.1 | 2.1 | 1,618 | 8.2 |
| Phonegnanang | 100 | 7.0 | 3.0 | 1,314 | 11.2 |
| Phalanxai | 98 | 6.2 | 1.9 | 1,572 | 3.8 |
| Phanomxai | 100 | 6.8 | 1.3 | 1,987 | 2.1 |
| Phontan | 97 | 5.7 | 2.6 | 1,157 | 5.5 |
| Phin | 88 | 7.2 | 1.2 | 1,740 | 7.2 |
| Khamsa-e | 87 | 7.3 | 1.2 | 2,545 | 14.1 |
| Geang Xai | 90 | 7.0 | 1.1 | 965 | 0.5 |
| Phonethong | 97 | 7.0 | 2.8 | 1,582 | 24.5 |
| Phaling | 97 | 7.3 | 2.4 | 1,718 | 22.3 |
| Oupalath | 97 | 7.0 | 2.4 | 1,933 | 27.0 |
| None Phajao | 97 | 6.8 | 3.5 | 1,100 | 24.1 |
| Soukhuma | 98 | 6.3 | 1.8 | 1,996 | 22.6 |
| Boungkeo | 100 | 6.7 | 1.4 | 2,219 | 26.2 |
| Khoke Nongbua | 100 | 6.5 | 1.7 | 2,109 | 24.1 |
| Hieng | 93 | 5.8 | 2.4 | 1,645 | 17.1 |
| Mean | 96 | 6.7 | 2.1 | 1,689 | 15.3 |

* hh = household

WS 2010 was considered by farmers and researchers to be a drier than normal year, with reported yields (calculated from farmers' estimates of cultivated area and production) somewhat lower than in previous years (Table 1). Droughts and floods are a common occurrence in the region, with large areas impacted by these climatic shocks. According to Schiller *et al.* (2006), over a period of 37 years (1966-2002) the central region (which includes Savannakhet) was affected by extreme events in 32 years, while the southern region (which includes Champasak) was affected in 22 years. These events have a profound impact on household rice self-sufficiency, given that many operate close to a subsistence threshold. Nevertheless, this means that the 2010 yields were not greatly different from the normal run of seasons. It is significant that they were below official yield data for the same season, and well below the official target of 4 t/ha.

Households produced limited surplus rice for sale in WS 2010, averaging only 15% across the 12 villages (Table 1). Only 40% of surveyed households who were growing paddy rice sold any rice, with the rest either producing rice exclusively for home consumption or buying rice to cover a deficit. However, sellers included some households that had access to irrigation water for the subsequent DS crop (particularly in Bounkeo and Phaling in

Champasak).[1] The proportion of households selling rice, just self-sufficient, and buying rice varied significantly between the villages, as shown for the six Champasak villages in Figure 2. There was also a group of households that sold rice immediately after harvest to pay off debt and re-entered the market later in the year as buyers to make up shortfalls. These households received low paddy prices when they sold their rice after harvest and incurred higher prices when they re-entered the market to make purchases.

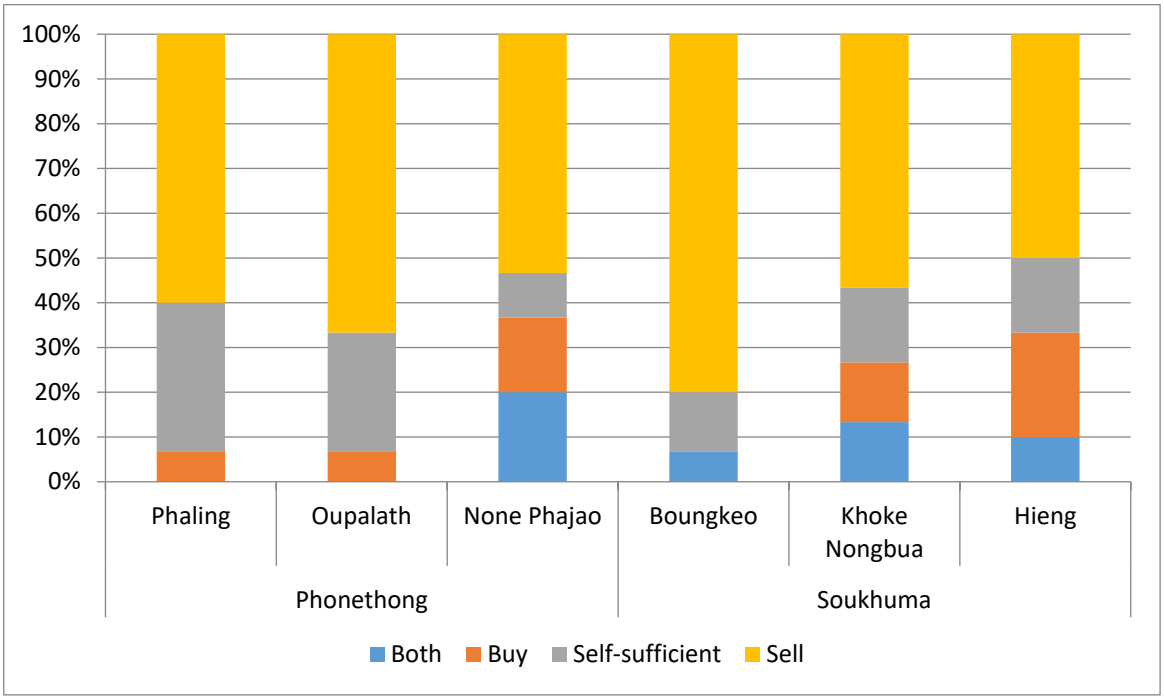


Figure 2. Household rice status in Champasak for 2010, by district and village

The household's rice status is a function of the number of household members (or, strictly, the number of people who share the harvest); the area of paddy land available for cultivation; and the yield of the rice crop (Table 1). Given that yields fluctuate between years and many households are close to subsistence levels, the household's rice status is likely to change from year to year. Hence households formulate their livelihood strategy each year depending on crop performance. For example, the migration patterns of young people in some case-study households were determined by the performance of the WS rice crop and whether cash income would be required to make up shortfalls.

The average household size in the survey was 6.7 members, but this is complicated by household dynamics throughout the year. Members of the household may migrate for periods of the year and not consume from the household's rice stock. On the other hand, sometimes the rice harvest is shared beyond the immediate household, including relatives who have moved away from the village. Similarly, there are other social obligations involving sharing rice with others, including offerings to monks. Acknowledging these nuances, it is useful to take as a benchmark the national criterion for self-sufficiency, which is 350 kg of unmilled rice per household member per year.

Figure 3 shows the yield required for an average household to achieve self-sufficiency for a range of paddy areas. The "self-sufficiency curve" indicates the large difference in required yield as land size varies. For example, a household with 2 ha of paddy land only requires a yield of around 1.2 t/ha to achieve household self-sufficiency, while a household with only 1 ha would require a yield of close to 2.5 t/ha. The scatter plot presents the yield and area combinations for WS 2010. Self-sufficient households tend to track the "self-

[1] WS rice remained largely rainfed in these villages unless subsidies were given for irrigation fees during drought years.

sufficiency curve", suggesting that households are trading off yield and paddy area, pursuing higher yields only when farm size is limited. As expected, most net purchasers of rice fall below the "self-sufficiency curve" in Figure 3 and most net sellers are above the curve (remembering that actual family sizes vary between points). Some households remain net purchasers of rice, despite relatively large paddy area, due to low yields, while other households achieve relatively good yields but, due to area constraints, still fail to meet household requirements.

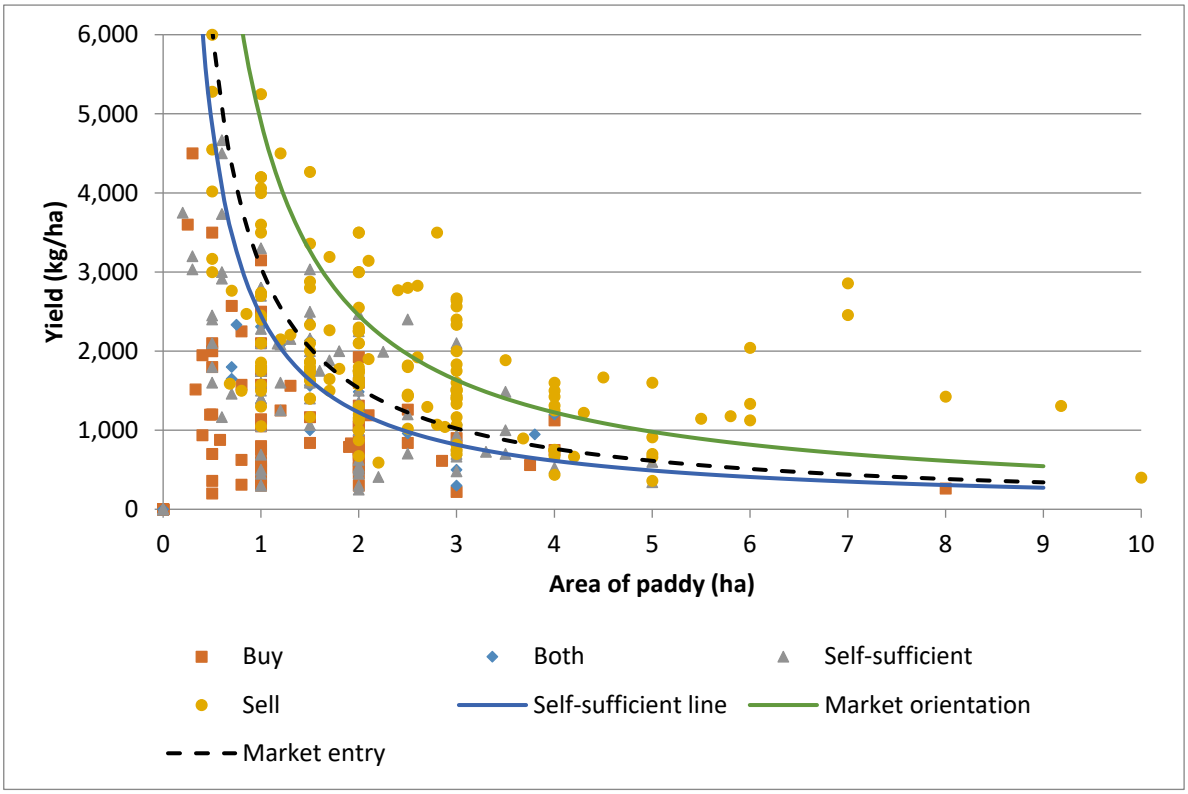


Figure 3. Yield-area combinations by household rice status

The "market-oriented curve" in Figure 3 shows the yield-area combinations enabling the average household to sell 50% of production, and the "market entry curve" shows the combinations for sales of 20% of production, reflecting an incipient market orientation. There were few households above the "market-oriented curve", especially in Savannakhet. As indicated in Figure 3, a large proportion of households selling rice in 2010 were from Champasak, reflecting the higher average yields in 2010 in that province. Again, the scatterplot shows that the opportunity for a household to meet these market criteria varies considerably with paddy area. Households with 3 ha or more could achieve a 50% surplus with 2 t/ha or less, while the few market-oriented households with less than 2 ha were achieving yields of 3-4 t/ha.

In general, the data suggest that currently the majority of households remain largely subsistence-oriented (with respect to rice farming) and are willing to trade-off yields with paddy area to meet household requirements, limiting the incentive for intensification. Even in cases where households have access to irrigation water allowing double cropping, significant areas of the land were left fallow as rice prices fell to the extent that only 3 ha of DS rice were planted in Phaling village in 2012 compared to around 50 ha for the survey year in 2010.

### Adoption of Modern Technology

While there are many physical and biological constraints that continue to limit rice productivity in the rainfed lowlands, the farming system has by no means remained static over the past two decades. The traditional production system that relied on draught animal

power for land preparation, traditional varieties, and organic fertiliser has almost completely disappeared from the landscape. Indeed, only 11 households from the 347 households surveyed that were growing paddy rice had not adopted any of the three main technologies – mechanised land preparation, improved varieties, or inorganic fertiliser. The current status of adoption of these technologies is summarised below.

### *Mechanisation*

Economic growth in Laos and neighbouring countries has created considerable employment opportunities away from the farm. Migrating to Thailand is a well-established livelihood strategy for young people from lowland households; 43% of households surveyed in Champasak had at least one member working in Thailand (Manivong et al. 2012). In Outomphone, Savannakhet, 42% of households had at least one family member working in Thailand, with the incidence falling away as distance from the border increased. At the same time, employment opportunities within Laos, both in urban areas (including the construction and service sectors) and rural areas (such as working in rubber plantations) is also drawing labour away from traditional, semi-subsistence agriculture. This is not only impacting on the availability of household labour, but also increasing the cost of hiring labour, especially during peak periods such as transplanting and harvesting. Wage rates varied from LAK 25,000 to 50,000 per day depending on location, season, and activity. However, even in remote Phin District, the wage rate for transplanting was reported to have reached LAK 50,000 per day (USD 6.25).

Mechanisation of rice production in Laos remains in its infancy, but with labour becoming increasingly scarce, changes are rapidly occurring as technology spills across the borders (Table 2). Around 75% of survey households utilised two-wheel tractors for land preparation rather than relying on draught animal power (mainly buffaloes). The ownership of two-wheel tractors had expanded to over 60% of households, while only 21% of households continued to use draught animal power exclusively. As Table 2 shows, the area of paddy land owned did not have a major impact on adoption. Moreover, adoption had extended into some more remote areas where rice productivity remained low and almost no surplus rice was produced. While the technology is not divisible like seed or fertiliser, the extent of adoption is not surprising given the versatility of the tractors and the extent of labour saved in both production and non-production activities, e.g., transport to regional centres. However, in one village in Phonethong District (None Phajao) ownership of two-wheel tractors remained low compared to all other villages.

Other forms of mechanisation were less common, with the first transplanters, drill seeders, and harvesters only beginning to be utilised in the past few years and only in small areas. It is expected that their use will continue to expand as labour becomes increasingly expensive. Currently, in order to minimise cash outlays, households tend to extend the period of transplanting and utilise the declining household labour resource rather than hire labour or transplanters (with obvious tradeoffs in terms of yield).

### *Improved varieties*

According to Eliste and Santos (2012a), the adoption of improved varieties has been the single most important factor in achieving significant productivity increases since the 1990s. The first improved varieties were released in Laos in the 1970s, and over the past two decades there has been widespread adoption. Indeed, the majority of households now grow at least one improved variety that has come out of breeding programs in Laos or neighbouring countries,[2] with the area of traditional cultivars contracting. The adoption of improved varieties has occurred at similar rates among different farm size classes (Figure 4). The impact of various projects can be seen in years (such as 2000) where significant jumps in adoption occurred.

[2] Thai varieties such as RD6 were common in lowland areas of Savannakhet.

Table 2. Mode of land preparation by paddy area and district

| | Land preparation method (% of households in each category) | | | |
|---|---|---|---|---|
| | Buffalo | Own tractor | Hired tractor | Buffalo and hired tractor |
| Land preparation by paddy area | | | | |
| Small (n=113) | 21 | 57 | 16 | 4 |
| Medium (n=121) | 19 | 69 | 7 | 4 |
| Large (n=113) | 23 | 67 | 6 | 4 |
| All (n=347) | 21 | 64 | 10 | 4 |
| Land preparation by district | | | | |
| Outomphone (n=60) | 18 | 78 | 2 | 0 |
| Phalanxai (n=59) | 19 | 56 | 20 | 3 |
| Phin (n=53) | 9 | 85 | 6 | 0 |
| Phonethong (n=87) | 47 | 43 | 3 | 5 |
| Soukhuma (n=88) | 6 | 69 | 16 | 8 |
| All (n=347) | 21 | 64 | 10 | 4 |

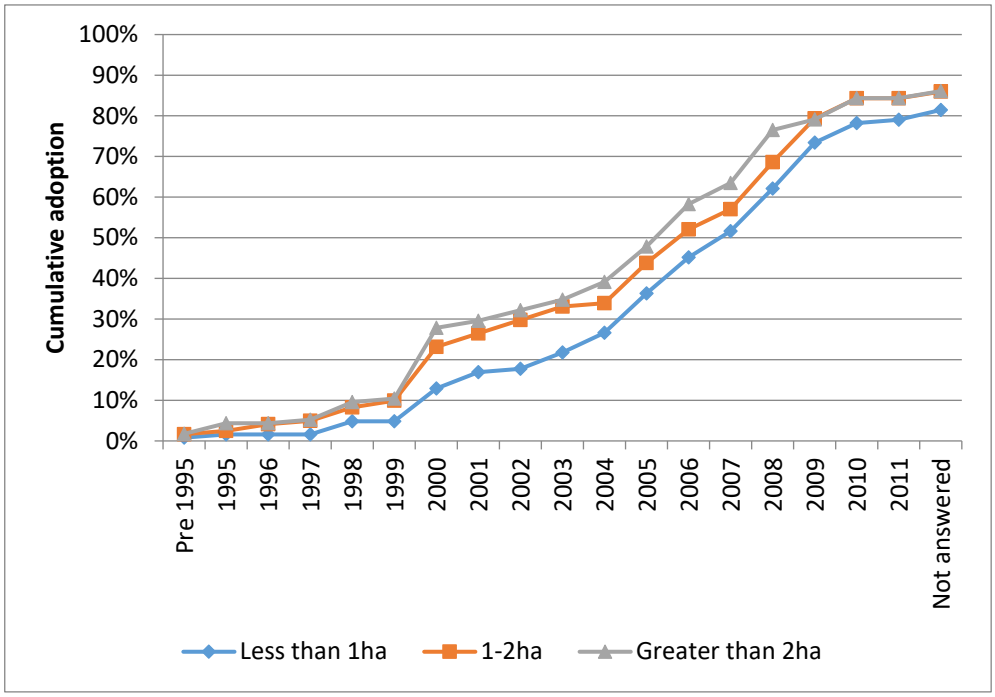


Figure 4. Cumulative adoption of improved varieties by paddy area

***Fertiliser use***

Soil fertility has long been recognised as one of the major constraints to rice production in Laos. The soils throughout the main lowland rice-growing areas in the central and southern plains have been described as generally infertile, highly weathered, old alluvial deposits that comprise a series of low-level terraces with an elevation of about 200 metres above sea level (Lathvilayvong et al. 1996). Previous studies have identified nitrogen (N) as the most limiting nutrient in all regions of the country. In much of the central and southern regions phosphorus (P) deficiency is also acute. Potassium (K) is the least limiting of the three tested nutrients in the central region, yet the need for K inputs is expected to increase

as production is increased through double cropping or as rice yields increase through changes in management (Schiller et al. 2001).

The use of both organic and inorganic fertilisers has long been promoted in Laos. Linquist and Sengxua (2001) developed broad fertiliser recommendations based on fertility management research throughout the country. They recognised that the rainfed lowlands constitute a risky environment for crop production, hence their recommendations required relatively low investment and used nutrients with maximum efficiency rather than aiming for maximum yields. The recommendations were also based on the three fertilisers that were readily available.

For the first year of application, the recommendation is to apply 60-X-25 kg/ha NPK, with the P rate varying according to soil texture. The rate of N recommended is lower than that required for maximum yields and reflects farmer risk in the rainfed environment. Higher rates of 90-120 kg/ha of N usually result in higher yields but only under good growing conditions. The recommended rate of P is 8.5 kg/ha in sandy soils, 13 kg/ha in sandy loam soils, and 19-26 kg/ha in loams and clay loams. In the second and subsequent years, the recommendation is modified to account for P that was not removed by the crop. These recommendations have been used in the scenario analysis presented in the following section.

The use of inorganic fertiliser by farmers in the lowland rainfed environment has historically been low. Surveys by Villano and Pandey (1998) for the 1996 WS crop in Champasak and Saravan Provinces found that 66% of households were using some chemical fertiliser and 48% of the area was fertilised. Of those applying fertiliser, about 54% did so to both the seedbed and the main field, 16% only to the main field, and 30% only to the seedbed.

The use of small amounts inorganic fertiliser had expanded to around 80% of surveyed households in 2010. A range of fertility management strategies was used, including only applying fertiliser to seedlings and various combinations of basal applications and topdressing. Only around 18% of households were applying fertiliser to seedlings plus a basal application to the main field, followed by a topdressing (as recommended). Most households not using inorganic fertiliser were from the two villages in Phin District, Savannakhet. However, the reasons for not using fertiliser were very different between the two villages. The average WS yields in Khamsa-e were the highest across the Savannakhet survey, with households growing longer-duration varieties due to favourable conditions. Farmers reported that they did not use fertiliser because the land was still fertile, hence additional (purchased) nutrients were not required. Some households reported that they had experimented with fertiliser in the past but had problems with lodging. On the other hand, Geangxai had the lowest average yields of the survey, with almost no household producing a surplus crop in 2010. Farmers in this village had frequent problems with drought as well as lower cash incomes compared to Khamsa-e. In Champasak the lowest rate of adoption was in the relatively remote village of None Phajao. Similar to Geangxai, this village had some of the lowest rice yields in the survey.

While the percentage of households using inorganic fertiliser has increased significantly, the level of use remains well below recommended rates. The limited use of fertiliser reflects both the high cost of purchasing inputs, the limited access to credit, the high level of production risk, and market uncertainty should a surplus be produced. Physical access, counterfeit products, and limited knowledge about appropriate rates and timing contribute to the problems. Table 3 presents the average N-$P_2O_5$-$K_2O$ rates for each village. The overall average of 15-12-2 kg/ha of N-$P_2O_5$-$K_2O$ converts to 15-5-1.5 kg/ha of NPK – well below the conservative recommendation developed by Linquist and Sengxua (2001) of 60-[8/26]-25 kg/ha NPK, with the P rate varying according to soil texture.

The distribution of N rates varied with size of paddy (Figure 5). While households with less than 1 ha were less likely to be using inorganic fertiliser, if they did use it they were likely to apply more kilograms of N per hectare than those with larger areas. It should be noted that these average amounts assume that farmers spread the fertiliser equally across their paddy

fields. In practice, farmers tend to vary their application rates based on previous crop performance and perceived risk. Figure 5 suggests that households with larger areas required less fertiliser to meet self-sufficiency and lacked the economic incentive to lift production further, and/or that households had a limited budget for fertiliser purchases.

Table 3. Average nutrient application rate by village (kg/ha)

| District/Village | Mean quantity of nutrient applied (kg/ha) | | |
|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ |
| Outomphone | 10.2 | 8.9 | 1.8 |
| Nagasor | 13.1 | 10.6 | 2.2 |
| Phonegnanang | 7.5 | 7.2 | 1.4 |
| Phalanxai | 14.4 | 13.0 | 1.1 |
| Phanomxai | 18.2 | 17.4 | 2.1 |
| Phontan | 10.9 | 8.9 | 0.2 |
| Phin | 9.5 | 6.9 | 0.0 |
| GeangXai | 10.0 | 6.4 | 0.0 |
| Khamsa-e | 7.3 | 9.2 | 0.0 |
| Phonethong | 21.1 | 10.5 | 3.2 |
| None Phajao | 5.8 | 5.5 | 1.7 |
| Oupalath | 27.4 | 13.6 | 3.1 |
| Phaling | 20.8 | 9.5 | 3.8 |
| Soukhuma | 15.9 | 15.3 | 1.7 |
| Boungkeo | 21.8 | 22.5 | 2.5 |
| Hieng | 7.1 | 8.1 | 0.1 |
| Khoke Nongbua | 17.0 | 13.3 | 2.3 |
| All | 15.3 | 11.8 | 1.9 |

**The Economics of Intensifying Fertiliser Use for Rainfed Rice**

To help understand the adoption patterns for fertiliser use, enterprise budgeting scenarios were developed for a hectare of WS rainfed rice based on household survey data and field experimental results. These representative budgets were first developed using average values for prices and yields, then sensitivity analysis was applied to allow for variability in these two key parameters. A range of indicators was used to capture farmers' decision criteria with regard to input use, including net returns to land (NR), with imputed costs for household labour deducted; net returns to household resources (NRHR), with no costing of household labour or land; and net returns to household resources per day of household labour (NRHL). When presenting the representative budgets to groups of farmers, these three indicators were assessed in terms of their usefulness for evaluating activities. Farmers preferred the NR measure to the NRHR measure as it explicitly placed a value on their own labour, but they also found the NRHL measure an easy way to compare the returns they received to the wage rate at different times of the year and for different household members.

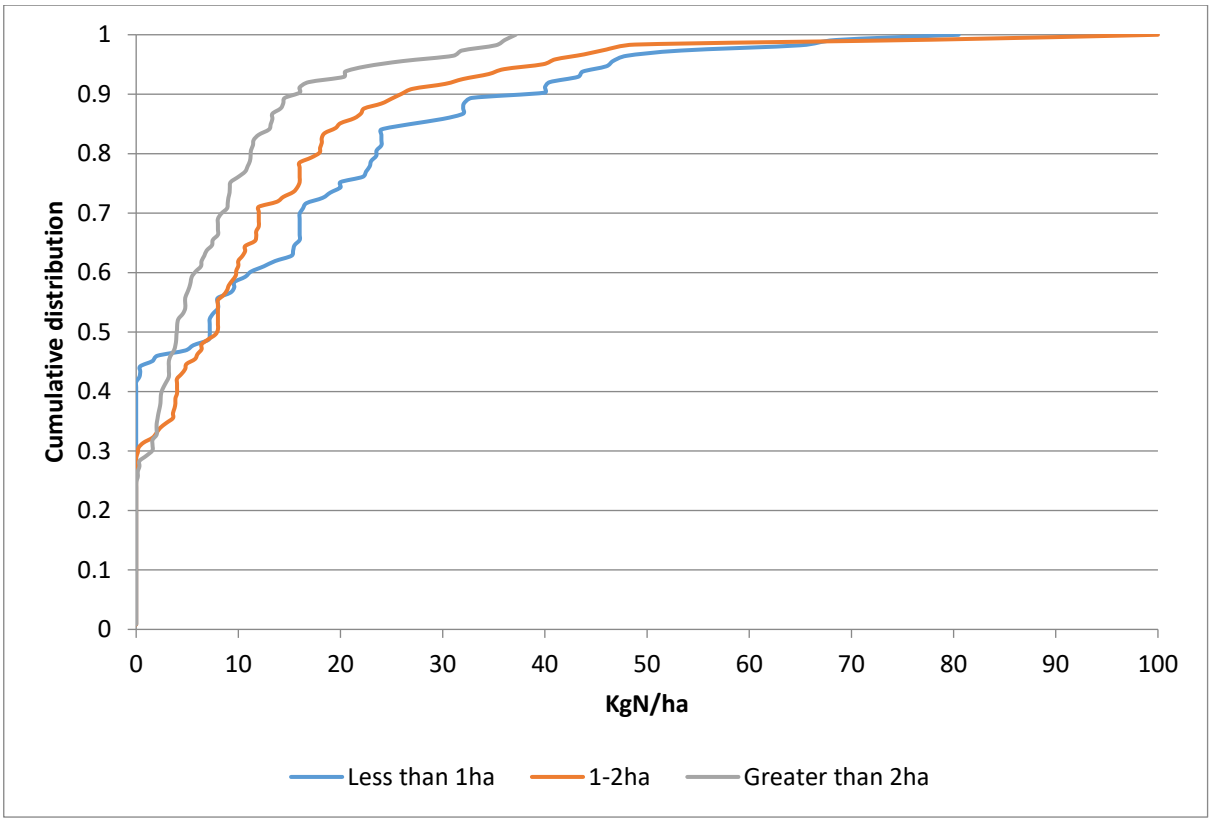


Figure 5. Cumulative distribution of N application rate by paddy area

### *Fertiliser-yield scenarios*

The four budget scenarios represented successively greater intensification as indicated by increasing fertiliser rates and yields.

**Scenario 1 (No-Input)** – Yield estimates were based largely on experimental results in which no inorganic fertiliser is added to the transplant crop. The household survey suggests that this represents around 30% of households. Both survey and experimental results show wide variation in the yields obtained where no inorganic fertiliser is used due to factors such as the indigenous soil fertility, soil-water balance properties, and other management practices. An average yield of 1.5 t/ha was assumed.

**Scenario 2 (Low-Input)** – This was based on the current low-input system that many households practice. It assumes again that households use inorganic fertiliser to establish seedlings but then apply 1 bag (50 kg) of 16-20-0 as a basal application, followed by a topdressing of 1 bag of urea. This results in a rate of 31-10-0 kg/ha of N-$P_2O_2$-$K_2O$. An average paddy yield of 2 t/ha was assumed.

**Scenario 3** (**Medium-Input**) – This was developed using the current broad recommendation of 60-30-30 kg/ha of N-$P_2O_2$-$K_2O$ (or 60-13-25 kg/ha of NPK). This is applied through a basal application of 15-15-15 (200 kg/ha) with the remaining N coming via topdressing with urea. The yield assumption was based on adjusted experimental results (allowing for the well-known yield loss when moving from small to large plots). Again, experimental results have shown a range of responses to applied nutrients according to location. An average yield of 3t/ha was assumed.

**Scenario 4 (High-Input)** – This was based on recent experimental work in the two provinces where a high rate is used in an attempt to achieve the Government target yield of 4 t/ha. The recent trials had site-specific application rates with no replications and therefore it was necessary to develop an average treatment with a rate of NPK of 120-60-

60 kg/ha, resulting in a yield of 3.75 t/ha, based on experimental results from the 2011 and 2012 wet seasons.

Other key assumptions are presented in Table 4, including the values used for sensitivity analysis. Sensitivity analysis was conducted on the farm-gate price of paddy based on the high 2010 price and the 2012 price in Champasak which was extremely low. The farmer focus group also considered this to be the lowest price that traders would offer before not coming to purchase rice at all. Threshold analysis was conducted on the farm-gate price of paddy to achieve various criteria. The labour required for each scenario was only varied for harvesting, threshing, and hauling, which are related to crop yield. The variation in labour for fertiliser application is minor and typically occurs during other operations.

Table 4. Assumptions for budget scenarios

| Parameter | Base assumption | Sensitivity analysis |
|---|---|---|
| Farm gate price (LAK/kg) | 2,000 | 1,200 and 3,300 |
| Fertiliser price (LAK/bag) | | |
| 16-20-0 | 230,000 | 250,000 |
| 46-0-0 | 220,000 | 250,000 |
| 15-15-15 | 250,000 | 300,000 |
| Wage rate (LAK/day) | 30,000 | 40,000 |

USD 1 = LAK 8,000

### *Enterprise budgets for the four scenarios*

All four scenarios confirm the low profitability of rice farming in the rainfed lowlands of Laos, and the challenge facing farmers and government alike if they are to intensify the production system (Table 5). The gross return (GR) was calculated as the total market value of production, regardless of how much was sold. The total variable cost (VC) included all physical inputs and labour (but not land), with imputed market values used for non-cash costs. The net return (NR) was the GR less VC, with all labour (household and hired) costed at the assumed value of LAK 30,000/day.

For the No-Input scenario the NR was negative. However, there was a positive result for the net return to household resources (NRHR), which does not involve deducting household labour costs. When NRHR was calculated as a ratio to the household labour input, the net return to household labour (NRHL) was below the wage rate of LAK 30,000/day (USD 3.75). That is, while there were positive returns to household-owned resources (land, labour, durable capital), these were not sufficient to provide a return greater than the opportunity cost of household labour.

The Low-Input scenario produced a positive NR and hence a NRHL slightly above the opportunity wage. Thus there was a positive marginal net return (MNR) to moving from the No-Input to the Low-Input scenario, with a marginal rate of return (MRR) of 50% on incremental investment (including household labour).

The Medium-Input scenario provided a further increase in NR and a NRHL above the opportunity wage by LAK 9,000 (over USD 1). Moving from the Low- to the Medium-Input scenario provided a MRR of 84%. Thus many farmers who currently practise a low-input system could benefit economically from adopting the broad recommendations of the medium-input system, with about double the fertiliser rate and a 50% yield increase.

However, a further movement to the High-Input scenario saw the NR to land and labour both fall, although the NRHL remained just above LAK 30,000/day. Hence the MRR to this degree of intensification was negative and the scenario was deemed to be dominated (D).

Table 5. Economic analysis of fertiliser-input scenarios for a hectare of WS rice

| | No Input | Low Input | Medium Input | High Input |
|---|---|---|---|---|
| Fertiliser (kg/ha, N-$P_2O_2$-$K_2O$) | 0-0-0 | 31-10-0 | 60-30-30 | 120-60-60 |
| Average yield (t/ha) | 1.5 | 2.0 | 3.0 | 3.75 |
| Gross returns (GR) (LAK/ha) | 3,000,000 | 4,000,000 | 6,000,000 | 7,504,000 |
| Variable cost (VC) (LAK/ha) | 3,272,000 | 3,944,000 | 5,024,000 | 6,632,000 |
| NR (LAK/ha) | -272,000 | 56,000 | 976,000 | 872,000 |
| NRHR (USD/ha) | 2,352,000 | 2,848,000 | 4,096,000 | 4,232,000 |
| NRHL (LAK/day) | 26,857 | 30,645 | 39,365 | 37,710 |
| Marginal NR (USD/ha) | | 336,000 | 912,000 | -112,000 |
| Marginal rate of return (MRR) | | 50% | 84% | D |
| Price of paddy rice (LAK/kg) needed for … | | | | |
| NR > 0 | 2,206 | 1,967 | 1,658 | 1,757 |
| NRHL = LAK 50,000/day | 3,517 | 2,994 | 2,388 | 2,387 |
| MNR > 0 | | 1,295 | 1,121 | 2,152 |
| MRR > 50% | | 1,995 | 1,755 | 3,316 |
| MRR > 100% | | 2,733 | 2,328 | 4,543 |

Note: Labour cost = LAK 30,000/day; paddy price ($P_r$) = LAK 2,000/kg; USD 1 = LAK 8,000; D = dominated scenario.

### *Threshold and sensitivity analysis*

Threshold analysis was conducted on the farm-gate price of paddy rice ($P_r$) to determine at what price (a) the NR would become positive, (b) the NRHL would be 50,000kip/day, and (c) the MRR for moving to the next scenario would be positive, 50%, or 100%. The results, shown in the last lines of Table 5, indicate that, if the paddy price decreased to below LAK 1,967/kg, the NR for a Low-Input system will become negative, but as long as the price is above LAK 1,295/kg there is still some gain relative to applying no fertiliser at all. The threshold prices for realising positive returns to the Medium- and High-Input scenarios were in the achievable range, but the price would have to be very high indeed (> LAK 4,500/kg) for the move from Medium-Input to High-Input to offer an acceptable rate of return of 100%.

In 2010 the price of fertiliser varied between locations, particularly for compound fertiliser such as 16-20-0 and 15-15-15 in more remote areas. By 2012 the price of urea had also increased across the two provinces. Furthermore, fuel prices had increased and wage rates continued to rise, adding to farmers' cash outlays. The impact of higher costs on the economic indicators is summarised in Table 6. The increase in input prices reduces the NR such that all scenarios produce a negative result. Increased fertiliser and fuel costs reduce the NRHL so that the Medium- and High-Input scenarios are barely above the previous opportunity wage (LAK 30,000), but are now below the new, higher opportunity wage. A move from No-Input to Low-Input still somewhat improves the NRHR, but only achieves a MRR of 30%. Similarly, a further increase to the Medium-Input Scenario improves the NRHR, but again falls short of an acceptable MRR.

Table 6. Sensitivity analysis of fertiliser costs and wage rates

| | No Input | Low Input | Medium Input | High Input |
|---|---|---|---|---|
| Fertiliser (kg/ha of N-$P_2O_2$-$K_2O$) | 0-0-0 | 31-10-0 | 60-30-30 | 120-60-60 |
| Variable cost (LAK/ha) | 4,184,000 | 4,952,000 | 6,336,000 | 8,264,000 |
| NR (LAK/ha) | -1,184,000 | -952,000 | -336,000 | -768,000 |
| NRHR (LAK/ha) | 2,320,000 | 2,768,000 | 3,824,000 | 3,728,000 |
| NRHL (LAK/day) | 26,514 | 29,785 | 36,779 | 33,185 |
| MRR | | 30% | 44% | D |
| Price of paddy rice (LAK/kg) needed for … | | | | |
| NR > 0 | 2,884 | 2,525 | 2,118 | 2,215 |
| NRHL = LAK 50,000/day | 3,539 | 3,039 | 2,482 | 2,530 |
| MRR > 50% | | 2,335 | 2,153 | 4,011 |
| MRR > 100% | | 3,200 | 2,856 | 5,496 |

Note: Labour cost = LAK 40,000/day; paddy price ($P_r$) = LAK 2,000/kg; USD 1 = LAK 8,000; D = dominated scenario.

The incentives for intensification worsened in 2011 and 2012 when the farm-gate price fell to as low as LAK 1,200/kg. At this price the NRHL would be less than half the initially assumed opportunity wage rate of LAK 30,000/day (Table 7). On the other hand, during the price spike in 2010 when farm-gate prices reached LAK 3,300/kg in some regions, the returns to labour from intensification strategies looked much more promising. However, farmers in group interviews did not have high expectations that prices would again be at this level in the coming season, and hoped for a return to prices around LAK 2,000/kg.

Table 7. Sensitivity analysis for low and high paddy prices

| | No Input | Low Input | Medium Input | High Input |
|---|---|---|---|---|
| Farm-gate price of paddy of LAK 1,200/kg | | | | |
| NR (USD/ha) | -2,248,000 | -2,400,000 | -2,616,000 | -3,616,000 |
| NRHR (USD/ha) | 1,256,000 | 1,320,000 | 1,544,000 | 872,000 |
| NRHL (LAK/day) | 14,309 | 14,215 | 14,856 | 7,795 |
| Farm-gate price of paddy of LAK 3,300/kg | | | | |
| NR (USD/ha) | 552,000 | 1,400,000 | 3,368,000 | 3,864,000 |
| NRHR (USD/ha) | 4,056,000 | 5,120,000 | 7,528,000 | 8,360,000 |
| NRHL (LAK/day) | 46,349 | 55,086 | 72,404 | 74,443 |

Note: Labour cost LAK 40,000/day; input prices based on Table 6; USD 1 = LAK 8,000.

### *Optimal farmer strategies*

Given these results, what strategy should a farm-household adopt? A move from the No-Input to Low-Input system improves the net return to land and labour, however the NR would remain negative under 2012 conditions. Furthermore, the MRR of the change is only 50%, falling to 30% if the higher costs are assumed. Previous studies (CIMMYT 1988) have suggested a MRR of at least 100% is required before adoption is likely, although 50% may

be sufficient for relatively small system changes. Assuming household self-sufficiency is an important objective, the small amount of fertiliser involved in moving to the Low-Input system may raise some households with small areas of paddy above their subsistence requirement, with returns to labour and capital treated as less important. For example, an average No-Input household with 1.2 ha could move from being 75% self-sufficient, with an output of 1,800 kg, to 100% self-sufficient, with an output of 2,400 kg, by adopting the Low-Input package (Figure 3 above).

Under the 2010 price conditions, a move from the Low-Input system to the Medium-Input system provides a positive NR per hectare and a NRHL above the wage rate. This move provides a MRR of 84% (or a 71% return if moving directly from the No-Input to the Medium-Input system). The threshold analysis on paddy price suggests that this scenario is likely to provide positive NR and MNR for most price scenarios, and a small increase in the price would deliver a MRR greater than the CIMMYT rule-of-thumb. This outcome holds even allowing for an increased price of fertiliser. However, the increase in the cost of labour to LAK 40,000/day pushes this scenario into negative NR unless the paddy price is above LAK 2,118/kg.

It is very unlikely that a household would adopt the High-Input scenario, given that returns to both land and labour decline compared to the Medium-Input case. Nevertheless, a land-scarce household may be forced to adopt this strategy if achieving household self-sufficiency remains the dominant objective, given that the returns to labour remain above the wage rate. However, households with acute land constraints are also less likely to have the capital to make the necessary investment.

Given that labour use does not increase much with increased fertiliser application, rising wage rates are not projected to impact greatly on WS fertility-management decisions, though they will affect the overall economic performance of all scenarios. On the other hand, for households with access to irrigation that enables cultivation of a DS rice crop, the question of wage rates becomes more important, given that self-sufficiency may be achieved in the WS, allowing labour to move off-farm and earn relatively high returns in the DS. Several case-study farmers were making this decision and not growing a DS crop; rather they made their irrigable land available to households with smaller paddy areas who had not yet achieved self-sufficiency in the WS.

**Conclusion**

The survey evidence from central and southern Laos shows that farm-households in the rainfed lowlands continue to manage rice production systems that are largely subsistence-oriented. The adoption of new technologies, especially improved varieties, has been important in helping households meet self-sufficiency objectives and has enabled some to produce a small surplus. Despite this, rice production remains an economically marginal activity that is under increasing pressure from rising costs, particularly for labour. Rural livelihoods in the study area have become increasingly diversified, with households allocating labour to a range of alternative farm and non-farm activities. However, rice production continues to be the platform on which these other livelihood activities are based. The development and adoption of technologies that enable households to achieve self-sufficiency in a labour-efficient and cost-effective manner are important to improving household welfare in this context.

The budget models show that, given their resource endowments and the high degree of production and market risk they encounter, households in the rainfed lowlands have been rational in adopting a low-input system rather than intensifying rice production to achieve government yield and production targets. As the costs of labour continue to increase, technologies that improve labour productivity and enable labour to move off-farm are likely to be adopted more readily than technologies that seek to intensify production. In the same way, the development and adoption of improved varieties that are well adapted to abiotic and biotic stresses and reduce risk in specific environments can potentially improve the profitability and stability of the rainfed lowland system. Moreover, improving the efficiency

of fertiliser application through site-specific recommendations may be more important than increasing absolute fertiliser rates.

While the improvements in profitability that these technologies bring may induce some intensification, we argue that the strategy of diversifying livelihoods while maintaining a largely subsistence-oriented rice production system is likely to persist, given the current economic trends. While this may not help lift rice production to reach national targets, it is likely to improve the livelihood outcomes of the numerous households living in this marginal environment.

## 3. Intensification and Diversification of Rice-Based Farming Systems in Southern Cambodia

### Introduction

This study explores the key constraints to rice-based farming systems in the rainfed lowlands of Cambodia and the role of different sources of irrigation in alleviating some of those constraints (Chea 2014). The research was carried out in lowland districts in Takeo and Kampong Speu Provinces in the southern part of the Central Plain, representing a major lowland rice-growing region with high population density, small farm sizes, and severe production constraints (Fig. 1). Three villages were selected with similar biophysical and socioeconomic environments but different degrees of access to irrigation.

Trapeang Run, in Tramkak District in Takeo Province, shows the full extent of the development problem facing farm-households and villages in the rainfed lowlands, with all the constraints attributed to this zone, including very limited access to irrigation, restricted to small house-yard ponds. Snao, in Prey Kabas District, also in Takeo Province, shows what options become available to farm-households with access to on-farm sources of irrigation in the form of shallow tubewells to draw on groundwater resources, in addition to farm ponds. This case also shows the potential for agricultural development with little or no intervention by government or other development agencies. Ta Daeng Thmei, in Boseth District in Kampong Speu Province, shows what farmers can do when they have access to a medium-scale, gravity-fed irrigation facility. Where public investment in such irrigation schemes is feasible, farming options are increased, though there are issues that must be addressed at the community level to maintain the irrigation infrastructure and manage water use.

A range of research methods were employed between 2010 and 2013 for data collection, including reconnaissance visits, household surveys (with 200 respondents across the three villages), discussions with village heads, key informant interviews, analysis of market trends, farm walks and direct observation, use of village data manuals and documents, surveys of pond-water and groundwater, analysis of rainfall data, soil surveys, and field crop experiments (Chea 2014). Each village was studied as an individual case, with cross-case comparison used to develop broader generalisations. It is this comparative analysis that is presented in this chapter.

### Characteristics of Case-Study Villages

#### *Village settlement and population*

The main geographical and demographic characteristics of the case-study villages are shown in Table 1. All three villages were located 70-75 km south or southwest of Phnom Penh, but Trapeang Run was more favourably situated in terms of access to district and provincial centres for both farm transactions and non-farm employment. The settlement patterns of Snao and Ta Daeng Thmei were typical of rural Khmer communities, with houses clustered on areas of higher land which are dry year-round. However, in Trapeang Run, the houses were scattered throughout the village territory, singly or in small clusters, on or adjacent to paddy fields, giving farmers greater capacity to manage their rice and non-rice crops and livestock.

The highest population density was in Trapeang Run (700 persons per sq. km), about double that of the other two villages. However, the villages had similar areas of paddy land (90-120 ha) and there was little difference in the available paddy land per capita (around 0.1 ha). There were no major differences in the demographic characteristics of farm households, except that the average age of household heads in Ta Daeng Thmei was 5-6 years lower than in the other two villages, consistent with a younger total village population and a high percentage aged under 25. This may have been due to a lower rate of outmigration, especially when compared with Trapeang Run. Between 86% and 95% of household heads considered farming as their primary economic activity, as did their spouses. Economically-active daughters (those aged 15 years and above who had finished studying) were twice as likely to be engaged in non-farm jobs as farming in all three villages. This was consistent with the predominant employment of young female workers in the nearby garment industry. Economically-active sons, however, were equally likely to be employed in farming as in non-farm activities (typically, construction).

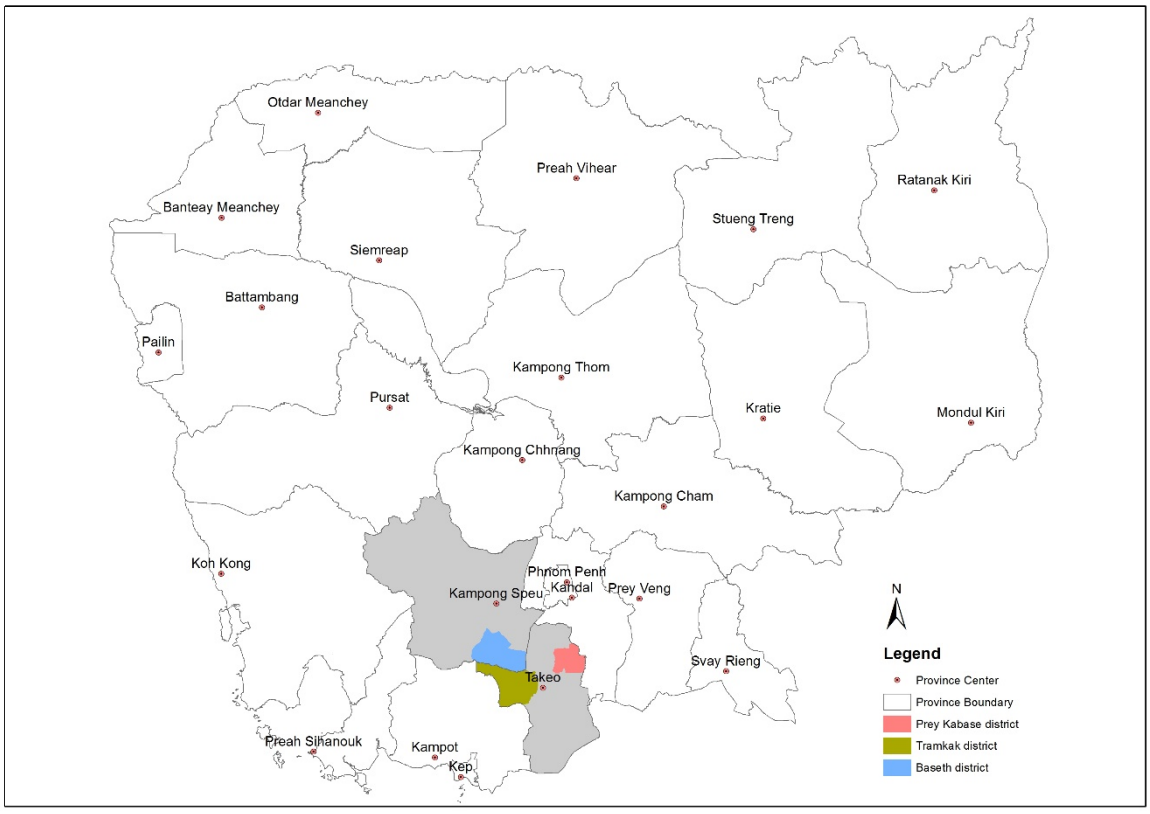


Figure 1. Locations of the three study districts in Takeo and Kampong Speu Provinces (Source: CARDI)

### *Land resources*

Trapeang Run occupied a level plain and experienced only very short periods of flash-flooding (Table 1). Snao occupied a level plain adjacent to the Tonle Bassac floodplain, hence some of the lower paddy land was subject to wet-season (WS) flooding while the upper paddy land was subject to drought. Some households in the village also had access to floodplain land that was uncultivable in the WS due to flooding but highly suitable for a dry-season (DS) rice crop. Ta Daeng Thmei was located on a gently sloping plain downstream of low hills and below a dam providing gravity-fed irrigation. It was only subject to flash-flooding when excess water was discharged from the reservoir.

Table 1. Major characteristics of the case-study villages

| Characteristic | Trapeang Run (rainfed) | Snao (on-farm irrigation) | Ta Daeng Thmei (fully irrigated) |
|---|---|---|---|
| Province | Takeo | Takeo | Kampong Speu |
| Distance to … | | | |
| - Phnom Penh (km) | 75 | 75 | 70 |
| - Provincial capital (km) | 12 | >30 | >30 |
| - National road (km) | 2 | 15 | 20 |
| Access to market | Favourable | Less favourable | Less favourable |
| Topography | Central plain (15 masl) | Next to floodplain (3-15 masl) | Gently sloping (27-36 masl) |
| Flooding regime | Flash-floods | Part flooded in WS | Flash-floods |
| Total land (ha) | 113 | 451 | 200 |
| Paddy land (ha) | 90 | 120 | 120 |
| Irrigation source | Small ponds | Groundwater, ponds | Reservoir |
| Cropping pattern (WS/DS/EWS) | Rice/fallow/rice | Rice/radish-cucumber/rice[a] | Rice/peanut-rice/rice |
| Settlement pattern | Dispersed | Clustered | Clustered |
| No. of households | 157 | 277 | 158 |
| Pop. density (pers./km$^2$) | 697 | 292 | 372 |
| % under 25 years | 35 | 55 | 62 |
| Paddy land (ha/person) | 0.11 | 0.09 | 0.16 |
| Household size | 5.4 | 4.9 | 5.0 |
| Family workforce | 4.0 | 3.7 | 3.3 |
| Household head | | | |
| - Age (years) | 46.4 | 47.0 | 41.4 |
| - Male (%) | 89 | 97 | 92 |
| - Education (years) | 6.0 | 6.0 | 5.7 |
| - Occupation (% farming) | 86 | 94 | 93 |
| Children's occupation | | | |
| - Female (% non-farm) | 42 | 42 | 38 |
| - Male (% non-farm | 35 | 22 | 23 |

[a] Cropping pattern for Snao is for WS paddy land only, excluding the DS paddy land to which some villagers had access which was flooded in the WS.

All three villages had access to three land types – WS paddy land (cultivable in wet and dry seasons), upland used for non-rice crops, and residential upland – and (as noted above) some households in Snao had access to DS paddy land (only cultivable in the dry season). The WS paddy lands in all villages were of the Prateah Lang soil type – the infertile, sandy soils that predominate in the lowland rice-lands of Cambodia. However, the DS paddy land to which some villagers in Snao had access were highly fertile alluvial soils. Almost all survey households in the three villages owned WS paddy fields. The mean area of WS paddy land was lowest in Snao (0.6 ha), intermediate in Trapeang Run (0.9 ha), and highest

in Ta Daeng Thmei (1.3 ha). However, nearly 50% of households surveyed in Snao owned on average 0.85 ha of DS paddy land in addition to their WS land.

All villages showed the spatial dispersion of paddy landholdings arising from the land reform of the late 1980s and the subsequent fragmentation of land through equal inheritance among children. However, paddy land was more dispersed in Ta Daeng Thmei, averaging 5.7 plots per household, than in Trapeang Run (3.3 plots) and Snao (2.5 plots). The more recent settlement, larger average land holding, and access to irrigation, could have influenced the greater degree of land fragmentation in Ta Daeng Thmei.

***Water resources***

Households in Trapeang Run had established small ponds close to the house for their domestic water supply, which were also used to a small extent for the irrigation of vegetables in the house-yard, and irrigation of field crops on small plots of paddy land adjacent to the house (Table 1). Pond-water was also used to supplement the water needs of rice seedlings when rainfall was inadequate early in the WS. The minimal use of ponds for agriculture was because of their limited storage capacity, such that they could potentially become dry early in the DS. Households in Trapeang Run also accessed groundwater through open wells and tubewells, but only for domestic use. Hence in terms of water resources for agriculture, it is accurate to characterise Trapeang Run as a purely rainfed village.

Households in Snao also had access to small ponds, sometimes in the farm. However, the village had made the important change to extracting groundwater through tubewells in the farms for irrigation, after which farmers have made little use of ponds for irrigation. The use of groundwater was reflected in the much higher incidence of pump ownership in this village (90%). Groundwater was a highly reliable irrigation source, sufficient to fully irrigate two DS crops of radish or cucumber, as well as provide supplementary irrigation for the early-wet-season (EWS) and WS rice crops. Despite increasing extraction over the past three decades, the water table had shown no sign of a significant drawdown. Although there was sufficient groundwater for a large irrigated area, only part of the paddy land could be irrigated because the land was fragmented and financial constraints restricted households from installing tubewells in every plot.

Ta Daeng Thmei had a community irrigation scheme, drawing water from a large reservoir, which also supplied five neighbouring villages. The water level in the reservoir decreased late in the DS due to intensive irrigation and lack of rainfall. Hence the irrigation supply could be unreliable for up to two months but gradually recovered from late May because of the large catchment area to the north. The slight slope of paddy land from north to south permitted a gravity-fed irrigation system, but some households occupied paddy lands that could not be reached in this way. Hence portable pumps were used in these cases to get water from the main canals to farmers' fields, but at a higher cost that limited the options for these less-favourable plots.

***Village characteristics in context***

The characteristics of the three case-study villages can be seen in the context of the general features of the lowland plain. All the villages had high population densities, characteristic of the rice-lands of south and south-eastern Cambodia. Hence all were experiencing the long-term rural-rural (e.g., to north-east and north-west Cambodia) and rural-urban (to Phnom Penh) migration that has been a feature of the south-east in recent decades. That the population density of Trapeang Run was twice as high as in the other two villages implies greater pressure to migrate, explaining the low proportion of the village population aged under 25 years. The potential for agricultural development in all lowland villages in the south needs to be seen against this backdrop of continuing out-migration.

All the case-study villages had reasonable access to Phnom Penh, the largest and fastest-growing agricultural market in the country, as well as having close proximity to Vietnam. Hence future expansion of agricultural production was unlikely to encounter a market

constraint. However, Trapeang Run also had particularly good access to district and provincial centres, giving it an advantage in terms of supplying fresh produce to these markets, as well as engaging in business activities, non-farm employment, and higher education, including high school and university. This was reflected in the generally higher grades of school-age children. The greater distance from national roads and market centres seen in Snao and Ta Daeng Thmei was more typical of rainfed lowland villages. Nevertheless, the widespread improvement in transport infrastructure in the southern lowlands in the past decade has created significant new market opportunities, even for these relatively remote villages.

While the dispersed settlement pattern of Trapeang Run was also atypical, it could indicate the future pattern for lowland villages as the population grows and farming becomes more intensive and diverse. The traditional Khmer pattern of clustered housing in a village centre was already beginning to change in the other two villages, as a number of young farm families had settled on their inherited paddy land rather than adjacent to the parental household.

The three villages' reliance on WS paddy land with infertile, sandy soils, and only small upland plots used for house-yards and non-rice crops, was representative of the general situation in the rainfed lowlands. The land potential of Trapeang Run was more typical in that paddy lands made up most of the village area apart from residential land, whereas the other two villages had greater access to uplands for cropping and some in Snao had access to DS paddy land beyond the village boundary (not a general feature of the rainfed lowland zone).

Establishing small ponds in house-yards has long been a practice in lowland villages, though they are mainly used for domestic purposes, as in Trapeang Run. Likewise, accessing groundwater through open wells is a traditional practice, but not generally for irrigation. However, the case of Snao, with widespread on-farm irrigation based on groundwater, reflects an emerging trend in parts of the southern and south-eastern provinces. As in Trapeang Run and Snao, there is limited potential in the lowlands for the kind of canal irrigation development seen in Ta Daeng Thmei.

The variation in ownership of WS paddy land is a feature of the lowlands and a critical determinant of economic differences between households. However, the generally small landholdings seen in the case studies, even the very low mean of 0.6 ha in Snao, is common for the south-east lowlands. The fragmentation of paddy land that was seen in all three villages, influenced by the 1980s land reform and the pattern of land inheritance, was also a general phenomenon in the lowlands, potentially hindering the adoption of both mechanisation and irrigation.

The increasing engagement of household members in non-farm employment in all three villages was characteristic of the lowlands, despite varying distances from Phnom Penh. In particular, the garment industry in Phnom Penh employs around 650,000 young female workers from a wide range of rice-growing areas. In each of the study villages, young women were twice as likely to be engaged in non-farm work as in farming. While young women from more favourably-located villages could commute to the factories, many others still opted to take up this employment and reside in Phnom Penh, rather than focus on farming. Many young men from the lowlands also took up employment in Phnom Penh, mainly in construction, but in the study villages they were just as likely to be engaged primarily in farming. In Trapeang Run, with its better access to local markets, young men and some older household members were also engaged in local trade, business, and wage employment.

**Comparative Analysis of WS Rice Production**

WS rice was the traditional mainstay of the farming system, being cultivated by every survey household in the three villages as the main or only source of household rice supply, as well as a potential source of cash income (Table 2). In each village, the available paddy land was fully cultivated. The mean cultivated area was lowest in Snao (0.6 ha), but even in Ta

Daeng Thmei, where the cultivated area was more than twice this figure, there was adequate labour to fully utilise the available land, even without mechanisation.

As elsewhere in the lowlands, traditional rice varieties were preferred in the WS, despite low yields, because of their good grain quality and adaptability to abiotic stress (Javier, 1997). Lowland farmers were still unwilling to adopt modern IR varieties for the WS crop, despite their higher yield potential, because of their inferior eating quality. There were up to 15 different traditional varieties in a village, but the suite of varieties (at least, as identified by farmers) differed between villages; only the *Srau Kraham* (Red Grain) variety was reported by every village. A few modern varieties were also grown but on no more than 5% of the total cultivated area in a village.

Table 2. Characteristics of WS rice cultivation in the case-study villages

| Practices | Trapeang Run (n=79) | Snao (n=62) | Ta Daeng Thmei (n=59) |
|---|---|---|---|
| Mean area (ha) | 0.9 | 0.6 | 1.3 |
| No. traditional varieties | 15 | 3 | 9 |
| No. modern varieties | 5 | 3 | 1 |
| Varieties/household | 2.4 | 1.2 | 2.0 |
| Land preparation | Draught animal, plough, harrow | Draught animal, plough, harrow | Draught animal, plough, harrow |
| Establishment method | Transplanting | Transplanting | Transplanting |
| Main water source | Rainfed | Rainfed | Rainfed |
| Supplementary irrigation | Small ponds | Groundwater | Reservoir |
| Irrigate nursery (%) | 39 | 77 | 29 |
| Irrigate main field (%) | 16 | 71 | 25 |
| Manure nursery (%) | 100 | 77 | 93 |
| Manure main field (%) | 85 | 66 | 34 |
| Fertilise nursery (%) | 22 | 79 | 54 |
| Fertilise main field (%) | 95 | 82 | 100 |
| Weeding (%) | 89 | 71 | 25 |
| Weeding method | Manual | Manual | Manual |
| Harvesting method | Sickle | Sickle | Sickle |
| Threshing method | Manual, thresher (11%) | Manual, thresher (35%) | Manual |
| Transport of paddy | Oxcart, shoulder pole | Oxcart, shoulder pole | Oxcart, shoulder pole |
| Drying paddy | Sun drying | Sun drying | Sun drying |
| Storage of paddy | Rice barn, bags | Rice barn, bags | Rice barn, bags |

All activities from land preparation through to storage of the paddy rice were very similar across the three sites. Land preparation was undertaken with a pair of draught cattle and a traditional plough and harrow, as has been the practice for centuries. The low level of mechanisation reflected the general situation in the lowlands. In Takeo province, the ratio of cultivated rice area to 2-wheeled tractors is 23.5 ha per unit and in Kampong Speu, 14.7 ha per unit (MAFF, 2013). In the WS, farmers had an extended window for land preparation (June-September) and in any case farms were small. Moreover, households mostly owned

enough draught cattle to manage land preparation and did not want to outlay the money to buy a tractor, or even to hire one from the few tractor-owners in each village.

The traditional labour-intensive transplanting method was used in all villages. Direct seeding by dry-seed broadcasting has been practised in north-western provinces such as Battambang and Banteay Meanchey, with larger farms, more fertile soils, and distant field locations, but there was no apparent trend to direct seeding in the south-east. This was presumably because the population density was higher, farm sizes smaller, and the household labour supply not yet limiting.

Supplementary irrigation was used for the seedling nursery and the transplanted crop. The incidence was much higher in Snao (over 70%) because of the ease of irrigating from tubewells. There was a low incidence of manual weeding in Ta Daeng Thmei (25%), reflecting a greater ability to maintain an adequate level of standing water in the paddy field. The incidence of weeding in the other two villages (70-90%) was high compared to other rainfed lowland areas (Rickman et al., 1997). Both farmyard manure and mineral fertiliser were widely applied in all villages. In Snao, there were also probably carryover effects from the heavy application of nutrients to the DS crops grown on the same land.

The harvest and post-harvest activities largely followed conventional practice across the rainfed lowlands, relying on manual techniques using family, exchange, and, in some cases, hired labour. In the 1990s there was not a single mechanical harvester or thresher used in paddy fields in Cambodia (Rickman et al., 1997). Though the numbers of reapers, threshers, and combine harvesters have grown dramatically since then, especially for commercial DS rice, every case-study village harvested the WS crop with sickles. In Ta Daeng Thmei all farmers also threshed manually, but in the other two villages a minority hired mechanical threshers. The harvest was brought back to the homestead by a cattle-drawn cart or carried on shoulder poles, with a few using two-wheeled tractors. The paddy was commonly dried on palm-leaf mats for 2-3 days after threshing and stored in sacks (if intended for sale) or in the household's rice barn.

Though cultural practices were common, there were differences in the level of material and labour inputs, as summarised in Table 3. All villages used cattle manure, averaging about 6 t/ha in Trapeang Run and Snao, but only 2 t/ha in Ta Daeng Thmei. The lower rate in Daeng Thmei probably reflected the larger cultivated area and the high application of manure for DS peanut cultivation (7 t/ha). Farmers in Snao used the highest rates of seed and mineral fertilizer, whereas these rates were not very different between the other two villages. This probably reflected the smaller cultivated area in Snao, hence both the ability and the need to intensify the use of inputs, as well as a higher cash flow (see below). Snao also had a higher average use of fuel for supplementary irrigation. With home consumption as the main objective of WS rice production, farmers appeared to utilize all available household resources to the full, but to minimise the cash outlay (e.g., in comparison with EWS and DS rice and other cash crops) because they anticipated little or no cash return from this crop (though the subsistence value of the crop, hence the saving in expenditure, was around USD 350 per year).

Table 3. Average material and labour inputs for WS rice cultivation in the case-study villages

| Input | Unit | Trapeang Run (n=79) | Snao (n=62) | Ta Daeng Thmei (n=59) |
|---|---|---|---|---|
| Seed | kg/ha | 81 | 101 | 71 |
| Fertilizer | kg/ha | 124 | 166 | 125 |
| Fuel | l/ha | 13 | 59 | 29 |
| Cattle manure | t/ha | 6.2 | 6.0 | 2.3 |
| Labour | days/ha | 132 | 97 | 83 |

Although material inputs were used more intensively in Snao, it was Trapeang Run that had the highest labour use (132 days/ha), 35-60% more than the other villages. However, Ly et al. (2012) also found labour inputs for WS rice cultivation in Takeo and Kampong Thom provinces ranging from 78 to 127 days/ha; all farmers in that study used transplanting for their WS rice crops, but land preparation performed by two-wheeled tractors was found to save up to 6 days/ha. The additional labour input in Trapeang Run was spread over the activities of land preparation, pulling, transplanting, weeding, harvesting, threshing, and transport. The limited supply of irrigation water may have added to the time needed for ploughing and transplanting, because of drier, harder soil, and may have also added to the weed burden. It is also possible that the higher labour input reflected an older farm workforce with lower productivity, given the demographic characteristics described above.

The unit costs and returns for WS rice production are summarised in Table 4. Snao, with the smallest cultivated area and the highest seeding and fertiliser rates, produced the highest mean yield (2.8 t/ha), around 20-30% higher than the other two villages; this difference was significant at the 10% level. Snao also had the highest output per capita, while Trapeang Run had the lowest at 390 kg, though this output was above the assumed per-capita consumption requirement of 250 kg. Trapeang Run also had the highest incidence of rice-deficit households (41%), despite cultivating a 50% larger area than Snao, reflecting the fact that the lower yield affected the household rice supply. Moreover, households in Trapeang Run did not have the same degree of back-up from EWS rice as in the other two villages. On the other hand, the potential of the traditional WS rice crop as a source of cash income was shown in the case of Ta Daeng Thmei, with its larger area more than compensating for a lower yield. Hence 90% of Ta Daeng Thmei households sold WS paddy rice, with a mean of 1.1 tonnes being sold, more than a third of mean production.

Table 4. Average unit costs and returns for WS rice production in the case-study villages

| Item | Trapeang Run (n=79) | Snao (n=62) | Ta Daeng Thmei (n=59) |
|---|---|---|---|
| Yield (t/ha) | 2.2 | 2.8 | 2.4 |
| Net output (t/ha) | 2.1 | 2.7 | 2.3 |
| Net output per capita (kg) | 392 | 552 | 456 |
| Rice-deficit households (%) | 41 | 18 | 15 |
| Households selling paddy (%) | 47 | 24 | 90 |
| Mean quantity sold (kg) | 313 | 200 | 1,100 |
| Farm gate price (USD/kg) | 0.28 | 0.28 | 0.28 |
| Gross income (USD/ha) | 592 | 757 | 639 |
| Input expenses (USD/ha) | 90 | 176 | 70 |
| Net return to household (USD/ha) | 502 | 581 | 569 |
| Total labour (days/ha) | 132 | 97 | 83 |
| Net return to labour (USD/day) | 4.0 | 6.8 | 7.7 |

Applying a farm-gate price of USD 0.28/kg across the three villages, the differences in gross income reflected the differences in yield. However, as noted above, input expenses (especially fertiliser) were highest in Snao (USD 176/ha), significantly higher than the other two villages (at the 1% level). This reduced the advantage of Snao in terms of the mean net return to household resources (USD 581/ha), although this was still the highest return of the three cases. The lower yield and gross income, and higher labour input of Trapeang Run, gave it a significantly lower net return to labour (USD 4/day), well below the return of USD 7-8/day in the other two villages and not significantly above the opportunity cost of labour (USD 3/day).

Though traditional farming practices predominated in all three villages, certain key factors gave farmers in Snao and Ta Daeng Thmei an edge over farmers in Trapeang Run, who more closely represented the majority of WS rice farmers in the rainfed lowlands:

(1) Access to adequate supplementary irrigation in Snao and Ta Daeng Thmei was important to save the crop from drought periods during the WS, whereas the small ponds in Trapeang Run were only sufficient to protect the crop at the nursery stage.

(2) Snao farmers used only three traditional varieties, suggesting that they had selected a small number of higher-performing varieties and avoided using low-yielding varieties. Trapeang Run farmers used 15 traditional varieties, most of them yielding less than 2 t/ha.

(3) Higher rates of input use, including seed, fertilizer, and fuel (for irrigation), along with better varieties, helped give Snao farmers a significantly higher yield than the other two villages.

(4) The small land holdings in Snao pushed farmers to intensify and diversify their cropping system, with farmyard manure, fertilizers, and on-farm irrigation being used to support up to four crops per year, thus improving the soil fertility in the WS rice fields. In contrast, in Trapeang Run, with only a single rice crop, the paddy land was baked hard by the strong sun for half the year, degrading soil properties.

(5) It may have also been a factor that an older farm workforce and involvement in local non-farm activities in Trapeang Run, helped to drag out the duration of transplanting, fertilizer application, weeding, and harvest activities, reducing the timeliness of these operations and this decreasing yield.

The integration of traditional and improved practices for WS rice cultivation in Snao could indicate a possible future pathway for resource-poor lowland households, such as those in Trapeang Run. Even with small paddy holdings, Snao farmers were mostly self-sufficient in rice and could earn some cash income from the WS crop. With somewhat larger holdings, though still only 1.3 ha on average, farmers in Ta Daeng Thmei could produce substantial surplus paddy to sell. The case studies show that there is potential to improve the productivity of WS rice within the context of a more intensive and diversified farming system with access to at least on-farm irrigation.

**Comparative Analysis of EWS Rice Production**

Between 55 and 65% of households interviewed in the three villages planted an EWS rice crop, even though the WS rice crop was generally sufficient for their domestic needs (Table 5). The EWS crop provided an additional source of cash income for those households that were already self-sufficient in rice, and a supplement to the domestic supply for rice-deficit households. Even without irrigation, the incidence of EWS rice cultivation was highest in Trapeang Run, but the small cultivated area (0.15 ha) was clearly restricted by the lack of irrigation. For the two villages with irrigation, the EWS rice area appeared to be in inverse relationship to the WS rice area. Snao, with a smaller WS rice area (0.61 ha) had a larger EWS rice area (0.37 ha), while Ta Daeng Thmei, which had double the WS area (1.3 ha), had a smaller EWS area (0.21 ha).

Three photoperiod-insensitive rice varieties were reported in Trapeang Run – the Cambodian-released varieties of IR66 and Senpidao, and the variety introduced by Vietnamese traders, IR504. However, most of the production in this village was for household consumption. In Snao and Ta Daeng Thmei, IR504 was the most widely cultivated, with a smaller number of farmers planting IR66 in Snao, and Senpidao in Ta Daeng Thmei. The cultivation of IR504 indicates that the harvest was all sold to the Vietnamese rice traders.

The EWS crop relied heavily on early rainfall in Trapeang Run, despite the availability of small household ponds, but the crop was secured by on-farm irrigation in Snao and reservoir water in Ta Daeng Thmei. Certain cultural practices in Snao were noticeably different from the other two villages. Direct seeding, the application of herbicides, and the use of

machinery for harvesting and threshing were carried out only in this village. The paddy grain was stored in plastic bags rather than in barns where the WS crop was mostly stored, which usually indicated an intention to sell the EWS produce. Following the operation of the combine harvesters or reapers in Snao, the paddy rice was commonly sold directly to the rice traders without being transported home.

Table 5. Characteristics of EWS rice cultivation in the case-study villages

| Practices | Trapeang Run (n=79) | Snao (n=62) | Ta Daeng Thmei (n=59) |
|---|---|---|---|
| % of households | 62 | 65 | 56 |
| Mean area (ha) | 0.15 | 0.37 | 0.21 |
| Rice variety | Modern (IR) | Modern (IR) | Modern (IR) |
| Land preparation | Draught animal | Draught animal | Draught animal |
| Crop establishment | Transplanting | Direct seeding | Transplanting |
| Source of irrigation | Rainfed, ponds | Rainfed, groundwater | Rainfed, reservoir |
| Weed control | Manual | Manual, herbicides | Manual |
| Harvesting | Manual | Mechanised, manual | Manual |
| Threshing | Manual | Mechanised, manual | Manual |
| Transport of grain | Oxcart, shoulder pole | Oxcart, trailer | Oxcart, shoulder pole |
| Drying | Sun | Sun | Sun |
| Storage | Bags | Bags | Bags |

The material and labour inputs for EWS rice cultivation are compared in Table 6. Snao stands out as using higher rates of all material inputs (seed, manure, fertilizer, fuel, and herbicides). Because farmers in Snao used direct seeding, they used more than three times the seeding rate of the other two villages (380 kg/ha). The practice of direct seeding with a high seed rate, as practised in Snao, can increase crop yield through a high density of plants and hence panicles per unit area, compared with the minimal tillering of short-duration varieties using the transplanting method. Many farmers in the Mekong Delta in Vietnam broadcast at up to 300 kg/ha to ensure crop establishment and minimise weed infestation, with yields of 4-6 t/ha (Nguyen and Vo-Tong, 2002).

Table 6. Material and labour inputs for EWS rice cultivation in the case-study villages

| | Trapeang Run (n=49) | Snao (n=40) | Ta Daeng Thmei (n=33) |
|---|---|---|---|
| Area (ha) | 0.15 | 0.37 | 0.21 |
| Seed (kg/ha) | 114 | 377 | 106 |
| Fertilizer (kg/ha) | 151 | 265 | 151 |
| Fuel (l/ha) | 34 | 171 | 0 |
| Herbicides (USD/ha) | 0 | 103 | 0 |
| Cattle manure (t/ha) | 6.9 | 8.7 | 3.4 |
| Labour-days/ha | 153 | 32 | 105 |

Snao farmers also used nearly twice the rate of mineral fertilizers and applied much more cattle manure than in the other two villages. Every farmer cultivating EWS rice in Snao required fuel for pump-irrigation, averaging five times the mean fuel input in Trapeang Run, where only 43% of EWS rice growers used fuel. Farmers in Ta Daeng Thmei did not require fuel because they had access to gravity-fed irrigation; if not, they did not cultivate those plots in the EWS to avoid pumping costs. Snao farmers also incurred USD 100/ha for

spraying herbicides and pesticides to control weeds and/or insects but the other two villages reported no cash outlays on agrochemicals.

The use of direct seeding, chemical weed control, and mechanised harvesting and post-harvest operations in Snao meant that the total labour requirement was very low (32 labour-days/ha), almost one fifth that of Trapeang Run and one third that of Ta Daeng Thmei. Trapeang Run had the highest labour input across all the activities – seedbed, pulling, transplanting, weeding, and harvesting – 45% more than in Ta Daeng Thmei. As discussed in relation to the WS rice crop, one reason for this difference could be the lack of irrigation in Trapeang Run, which meant there was a firm soil surface, increasing the labour-days needed for seedbed management, pulling seedlings, and transplanting. This also provided favourable conditions for weed infestation, increasing the labour input required for weeding. In addition, the engagement of younger family members in daily non-farm activities, and reliance on older family members for farm work, could have increased the number of work-days for a given task.

Both Trapeang Run and Ta Daeng Thmei used slightly more labour per hectare on the EWS crop than for their respective WS crops. The EWS rice crop required 4-5 more labour-days than WS rice for irrigating in the two villages. The firm soil surface in the EWS also doubled the labour-days required to pull young seedlings in Trapeang Run (21 labour-days, compared with 10 labour-days for WS rice). Ta Daeng Thmei also needed an extra 3 labour-days for pulling seedlings. However, the small cultivated area made these per-hectare differences less significant.

An economic analysis of EWS rice production in the three villages is presented in Table 7. Though the yields for Trapeang Run and Snao relate to the 2011 harvest, and for Ta Daeng Thmei to the 2010 harvest, the provincial yields varied little between these years (MAFF, 2011-2013), consistent with the close to average rainfall in both years. Snao had a significantly higher yield (4 t/ha) than the other two villages, despite cultivating the same IR rice varieties (mainly IR504), presumably reflecting the high seed rate and higher rates of nutrient application. Also, the intensive utilisation of the paddy fields throughout the year in Snao meant there was a likely carryover effect of mineral and organic nutrients applied in each season. Poor inherent soil properties had also been improved, with manure and crop biomass frequently being incorporated in the course of successive cultivations, and the soil was protected by almost continuous crop cover. The EWS yield in Snao was also significantly higher than the WS yield in the same village – a result of the higher yield potential of the modern varieties.

Table 7. Average unit costs and returns for EWS rice production in the case-study villages

| Item | Trapeang Run (n=49) | Snao (n=40) | Ta Daeng Thmei (n=33) |
|---|---|---|---|
| Yield (t/ha) | 2.6 | 4.0 | 2.2 |
| Net output (t/ha) | 2.5 | 3.7 | 2.1 |
| Farm gate price (USD/kg) | 0.24 | 0.23 | 0.24 |
| Gross income (USD/ha) | 602 | 843 | 505 |
| Input expenses (USD/ha) | 125 | 501 | 79 |
| Net return to household (USD/ha) | 490 | 342 | 425 |
| Total labour (days/ha) | 153 | 32 | 105 |
| Net return to labour (USD/day) | 3.50 | 11.70 | 4.50 |

The gross income per hectare in the three villages followed the same pattern as the yields. The higher expenses in Snao (USD 500/ha) reduced the net return to household resources to USD 340/ha, significantly lower than the other two villages. However, the use of labour-saving innovations (direct seeding, herbicides, and mechanized harvesting) significantly reduced the labour input, enabling farmers in Snao to achieve the highest net return to

labour (USD 12/day), about three times the return in the other two villages. This return was also double the labour return for the WS crop in Snao.

EWS rice production had been adopted in 16 of 24 provinces in Cambodia by 2012, accounting for 8% of the total harvested rice area, and the equivalent of 50% of the area used for DS rice (MAFF, 2013). The EWS rice area (242,113 ha) had more than doubled over the previous three years. Takeo had the second largest area of EWS rice (47,764 ha) but Kampong Speu had only 1,770 ha. It is likely that the area and output of EWS rice will continue to expand, both to supplement subsistence production and generate cash income. The case-study villages illustrate this trend. The main purpose of EWS rice cultivation in Snao and Ta Daeng Thmei was to generate cash income and, in Trapeang Run, to supplement domestic rice supply.

In particular, though most farmers in each village cultivated EWS rice, Snao farmers cultivated the largest area and the highest proportion (about two thirds) of their paddy holdings to EWS. The motivation was the small area available for WS rice production and the availability of on-farm irrigation. EWS cultivation in Trapeang Run was restricted by the lack of irrigation and only some plots in Ta Daeng Thmei were favourable for gravity-fed irrigation. Moreover, with a large surplus of WS rice, there was less incentive for farmers in Ta Daeng Thmei to spend money on fuel to increase the EWS rice area.

A number of specific approaches had been adopted in Snao to boost the EWS rice yield and net returns to family labour. The key cultural practices comprised mechanised land preparation, harvesting, and post-harvest operations, direct seeding, and applying herbicides, significantly reducing the total labour input. The crop also received high levels of material inputs including seed, manure, mineral fertilizers and fuel, to improve the crop yield. The yield was certainly improved by the reliable supply of on-farm irrigation. These practices suggest a way forward for less-productive rainfed villages such as Trapeang Run.

**Comparative Analysis of Non-Rice Crops**

Apart from cultivating rice in the WS and EWS, non-rice crops were also cultivated in the DS within all three villages, mainly to produce cash income but also for household consumption. Table 8 summarises the major crops and farming practices in each village.[3] The various non-rice crops in Trapeang Run comprised water melons, cucumbers, pumpkins, mungbeans, and convolvulus. In Snao, radish was the dominant crop, with some cucumber cultivation, and in Ta Daeng Thmei peanuts were the major DS crop. The radish crop was cultivated on raised beds and peanuts on slightly raised beds, but most other crops were planted on flatbeds. Because radish cultivation involved intensive cropping, a power tiller was necessary to prepare the land but draught animal power with a conventional mouldboard plough was used to raise the beds. Trapeang Run depended on small household ponds to irrigate the DS crops but, as already noted, Snao had access to a reliable groundwater supply and Ta Daeng Thmei to surface irrigation.

Radish cultivation required considerably more material inputs and labour-days than the crops in the other two villages (Table 9). The use of mineral fertilizers, cattle manure, fuel and pesticides, was much greater for radish cultivation than for peanuts or the other non-rice crops. The cucumber crop appeared to require little cattle manure because the application was made precisely in the planting holes rather than being spread across the entire planted area. The crops requiring daily watering were radish, cucumber, and convolvulus, with Snao farmers pumping groundwater for radish and cucumber for 1-2 hours/day and Trapeang Run farmers mostly fetching water from ponds to the cropped plots by watering can. Gravity-fed irrigation was applied 3-4 times for the peanut crop in Ta Daeng Thmei. Water melon, pumpkin and mungbean cultivated in Trapeang Run were watered

[3] As mentioned above, half the farmers in Snao had access to floodplain land suited to DS rice cultivation but flooded and uncultivable in the WS. This option is not available to farmers in the lowland agroecosystem, which is the focus of the comparison in this chapter.

only at planting time, with possibly 1-2 more supplementary waterings. The labour input for planting radish and cucumber was comparable to the input for other non-rice crops in Trapeang Run (over 200 labour-days/ha), but more than twice that for peanut cultivation.

An economic analysis of DS non-rice crops in the three villages is summarised in Table 10. The radish cultivation in Snao produced the largest gross income (USD 2,760/ha), six times that of the various crops in Trapeang Run and three times that of the peanut crop in Ta Daeng Thmei. Cucumber, cultivated by some non-radish farmers in Snao provided around half the gross income of radish. However, radish production had much higher input expenses. As well, planting, watering, and weeding for the radish crops all required a high labour input with a high concentration, necessitating the use of hired or exchange labour. The lower labour concentration for cucumber, peanut, and other crops meant they could be managed by the farm family; for example, the harvest of cucumber was carried out daily by one or two family workers over a period of about 20 days.

Table 8. Characteristics of DS non-rice crop cultivation in the case-study villages

| Practices | Trapeang Run | Snao | Ta Daeng Thmei |
|---|---|---|---|
| Crops | Various | Radish, cucumbers | Peanuts |
| Land preparation | Draught animals | 2-wheel tractor/ draught animals | Draught animals |
| Cultivation method | Flatbed | Raised bed | Low raised bed |
| Irrigation source | Pond | Groundwater/pond | Reservoir |
| Water requirement | Daily/occasional | Daily | 3-4 times per season |
| Pest control | Chemicals | Chemicals | n.a. |
| Weed control | Manual | Manual | Manual |
| Harvesting | Manual | Manual | Manual |
| Threshing | n.a. | n.a. | Manual |
| Transport | Bicycle/oxcart | Transported by buyer | Bicycle/shoulder pole |
| Drying | n.a. | n.a. | Sun |
| Storage | Sold at harvest | Sold before harvest | Bags |

Table 9. Material and labour inputs per ha for DS crop cultivation in the case-study villages

| | Trapeang Run | Snao | Ta Daeng Thmei |
|---|---|---|---|
| Households (%) | 44 | 82 | 80 |
| Crop cycles | 1 | 2 | 1 |
| Area (ha) | 0.13 | 0.36 | 0.19 |
| Seed (kg/ha) | n.a. | 6 | 200 |
| Fertilizer (kg/ha) | 35 | 385 | 100 |
| Fuel (l/ha) | 15 | 367 | n.a. |
| Pesticides USD/ha | 31 | 275 | 0 |
| Cattle manure (t/ha) | 3 | 12 | 7 |
| Labour-days/ha | 215 | 241 | 95 |

Table 10. Average unit costs and returns for DS non-rice crop production in the case-study villages

| Measure | Trapeang Run (various crops) | Snao (radish) | Ta Daeng Thmei (peanut) |
|---|---|---|---|
| Yield (kg/ha) | a | b | 1,214 |
| Seed (kg/ha) | a | 6 | 204 |
| Output (kg/ha) | a | b | 1,010 |
| Farm-gate price (USD/kg) | a | b | 1.0 |
| Gross income (USD/ha) | 454 | 2,760 | 1,010 |
| Input expenses (USD/ha) | 92 | 1,018 | 57 |
| Net returns to household (USD/ha) | 362 | 1,742 | 953 |
| Total labour (days/ha) | 215 | 241 | 95 |
| Net returns to labour (USD/day) | 1.70 | 7.30 | 11.00 |

a. There were many crops grown on a small scale and intermixed on the same plot, hence it was not possible to determine yield, seed, output, and price.
b. The radish crop was bought before harvest by the trader who harvested the crop, hence only gross income is known, not the physical yield and output.

Despite the high expenses, radish cultivation still provided the highest net return to household resources (USD 1,740/ha), five times that of Trapeang Run crops and double the returns of peanut and cucumber cultivation. However, the high labour input reduced the net return to labour to about USD 7/day for radish, compared with USD 11/day for peanuts. Cucumbers (UDS 4/day) and the non-rice crops cultivated in Trapeang Run (USD 2/day) gave significantly lower returns to labour, in the latter case less than the presumed opportunity cost of labour (USD 3/day). Most of the households in Trapeang Run produced very small outputs for their own consumption; only a quarter of the DS-crop growers were able to generate some cash income from their crops.

Over a decade ago, Pingali (2004: 43) made the assessment that “dry-season cropping activities in the rainfed [rice-growing] areas [of South and Southeast Asia] are limited because of technical problems related to timely and effective crop establishment, limited moisture (or excessive moisture in some cases), and generally modest or high yield instability”. However, the three case-study villages show that WS paddy land has potential for the cultivation of non-rice crops in the DS, both to improve household cash income and supply domestic consumption. The crops were able to be grown under a range of irrigation conditions, from small ponds to a large-scale reservoir. The crops cultivated also had different water requirements, ranging from daily watering to 2-3 irrigations per crop. However, the key to obtaining viable returns was a reliable irrigation source as in Snao and Ta Daeng Thmei. The limited water supply in Trapeang Run provided negligible returns and risked wasting production inputs. The improvement of on-farm irrigation would be necessary for Trapeang Run and other rainfed lowland villages to produce a significant household cash income from the cultivation of non-rice crops in the DS.[4]

Given an adequate supply of water, villages such as Trapeang Run could be expected to replicate the success of radish growers in Snao and peanut growers in Ta Daeng Thmei. To viably adopt the Snao radish cropping system, farm households would also need to have suitable soils, an available market, sufficient working capital, and an adequate supply of family labour to undertake the intensive operations required. The lower requirements for

[4] This need not necessarily be groundwater. An integrated farming project in central Thailand used 30% of the total farm area for pond excavation and generated an annual profit four times that of a single rice crop, thereby more than compensating for the loss of land (Setboonsarng and Gilman, 2009).

water, cash outlays, and labour for the peanut system in Ta Daeng Thmei make this a more feasible DS cropping option for resource-poor farmers and those with other non-farm employment options in villages such as Trapeang Run.

**Comparative Analysis of Cropping Systems in the Three Villages**

Representative farm budgets were constructed to reflect the whole-year cropping system of typical households in the three villages (Table 12). Trapeang Run, with only small ponds to provide supplementary irrigation, was restricted to an annual cultivated area of 1.2 ha per household, not much more than the mean farm size of 0.9 ha. Snao, despite a small farm size of 0.6 ha, could draw on groundwater to achieve an annual cultivated area of 1.4 ha from the same land (DS rice-land was excluded from the representative budget). Ta Daeng Thmei, being fully irrigated, could crop a total of 1.7 ha for a farm size of 1.3 ha.

Table 11. Annual inputs, outputs, and net cash flow of representative cropping systems in the case-study villages

| | Unit | Trapeang Run | Snao | Ta Daeng Thmei |
|---|---|---|---|---|
| Annual cultivated area | ha | 1.21 | 1.34 | 1.70 |
| - WS rice | ha | 0.93 | 0.61 | 1.30 |
| - DS non-rice crops | ha | 0.13 | 0.36 | 0.19 |
| - EWS rice | ha | 0.15 | 0.37 | 0.21 |
| Cropping intensity | ha | 1.3 | 2.2 | 1.3 |
| Paddy output | kg | 2,423 | 3,230 | 3,512 |
| Paddy surplus[a] | kg | 1,081 | 1,777 | 2,342 |
| Total gross income | USD | 726 | 1,847 | 1,199 |
| - Paddy | USD | 667 | 829 | 965 |
| - Non-rice crops | USD | 59 | 1,018 | 234 |
| Total cash income | USD | 351 | 1,423 | 779 |
| - Paddy | USD | 292 | 429 | 584 |
| - Non-rice crops | USD | 59 | 1,018 | 195 |
| Total labour input | days | 173 | 165 | 148 |
| - WS rice | % | 71 | 39 | 73 |
| - DS Non-rice crops | % | 16 | 52 | 12 |
| - EWS rice | % | 13 | 9 | 15 |
| Labour intensity | days/ha | 186 | 270 | 114 |
| Farmyard manure | kg | 7,129 | 11,279 | 5,033 |
| Total cash costs | USD | 124 | 722 | 118 |
| - Fertilizer | USD | 88 | 272 | 118 |
| - Fuel | USD | 28 | 231 | - |
| - Pesticide | USD | 4 | 153 | - |
| - Seed | USD | 4 | 26 | - |
| - Machinery | USD | - | 40 | - |
| Net cash flow | USD | 228 | 701 | 660 |

[a] Surplus computed based on consumption of 1,250 kg of paddy per household (assuming 5 household members).

Given the higher cropping intensity of the representative farms in Snao and Ta Daeng Thmei, these farms achieved higher paddy output (3.2 and 3.5 t, respectively) and greater paddy surpluses (1.8 and 2.3 t, respectively) than the Trapeang Run representative farm, which was much more dependent on the WS rice crop. The higher output from Snao also reflected higher yields in both the WS and the EWS, probably due to the higher year-round input of organic and inorganic nutrients. Each of the three budgets indicates household self-sufficiency in paddy, though the lower surplus in the Trapeang Run case (1 t) reflects a greater incidence of rice-insufficiency within that village population.

The Snao farm had the highest annual expenditure, mainly for the DS radish and EWS rice crops, although the WS rice crop also incurred higher expenditure than in the other two villages. Fertilizer, fuel, and pesticide were all large items of expenditure in this case. In the other two villages the major expenses were for the fertilizer input for the WS rice crop, with relatively less expenditure on the EWS rice and DS non-rice crops. As noted above, the application of farmyard manure was two to three times higher in the Snao farm (11 t/year), nearly 70% of which was applied to the DS radish and EWS rice crops, with many radish and EWS growers buying extra farmyard manure from other nearby villages. In the other two villages, most farmyard manure was applied to the WS rice crop – 81% in Trapeang Run and 60% in Ta Daeng Thmei.

The cropping systems required similar annual labour inputs of 150 to 175 days/year, that is, less than one full-time worker. It was estimated that cattle activities required a further 150 days/year in each village, and non-farm activities accounted for a significant proportion of household labour, especially in Trapeang Run. Though the total labour input for cropping was similar, the labour-intensity was highest for the Snao farm (264 days/ha), reflecting the small farm size and the high cropping intensity. WS rice absorbed a little over 70% of the total labour input in the Trapeang Run and Ta Daeng Thmei farms, but less than 40% in the Snao farm, where DS radish cultivation accounted for the largest share (54%).

The monthly labour profile was also similar between the Trapeang Run and Ta Daeng Thmei farms, with two comparable peak periods in July-September, when the EWS rice harvest coincided with land preparation and transplanting for the WS rice crop, and December-January, when the harvesting of WS rice and the planting of DS peanut and other non-rice crops were carried out. In the Snao farm, the labour concentration was also high in the July-September period but peaked from December to April due to the WS rice harvest and the intensive DS radish activity. Collecting native grasses for cattle in the WS increased the labour requirement in the July-September period in all three villages.

Besides the WS and EWS rice crops, the DS cultivation of radish, peanuts, and other non-rice crops contributed to farm income, especially for the representative farms in Snao and Ta Daeng Thmei. The Snao farm generated the highest gross income (USD 1,820/year) and cash income (USD 1,420/year), two to four times that of the other two villages. After deducting the high level of cash expenditure (USD 720/year), the Snao farm still had the highest net cash flow (USD 700), somewhat higher than Ta Daeng Thmei (USD 660) but three times the net cash flow for Trapeang Run (USD 230). The DS radish crop contributed about 90% of the net cash flow in the Snao farm, whereas the peanut crop contributed only 25% of the net cash flow in the Ta Daeng Thmei case, the majority of the cash flow coming from the sale of surplus rice from the WS and EWS. In Trapeang Run, the sale of surplus rice from the two seasons was the main source of farm cash income, the non-rice crops giving a negligible net cash return.

The representative farms in Trapeang Run and Ta Daeng Thmei experienced no land-use constraint, because the cultivation of DS non-rice crops and EWS rice occupied only a fraction of the total paddy land. Even with the late harvesting of the EWS rice crop, there was little impact on the preparation of the WS rice nursery, because the area of EWS rice was only 16% of the total paddy land in each village. There was also a short break in December between the harvest of WS rice and the planting of peanuts (Ta Daeng Thmei) or other non-rice crops (Trapeang Run), due to the wet field conditions following the rainy season.

However, the small total landholding in the Snao farm and the relatively large cultivated areas of DS radish and EWS rice meant that the farmer needed to manage the restricted land resource appropriately – through timely direct seeding of EWS rice and the careful planning of WS rice activities, such as nursery plot allocation, gradual land preparation of the transplanted field, and use of varieties with a diversity of maturation periods. The early broadcasting of the EWS rice was necessary to provide a short window between the harvest of EWS rice and land preparation for WS rice. The nursery plot designated for the WS rice was not used for the EWS rice crop. The land preparation and transplanting of WS rice were gradually carried out from available plots. An early-maturing variety of WS rice was used on the land targeted for the first DS radish crop, starting from mid-December, which also minimised irrigation costs.

### Conclusion

This comparison of representative cropping systems shows that, compared with the largely rainfed condition of Trapeang Run, typical of most of the lowland ecosystem, on-farm and (where feasible) canal irrigation can greatly increase the intensity, diversity, and profitability of land use. This can occur without being seriously constrained by available family labour, though in Snao there had been a move to adopt some labour-saving innovations in the DS and EWS to accommodate the tight turnarounds between successive crops on the limited paddy land. However, even in Snao, the potential for irrigated cropping had not been fully realised, due to the scattering of plots and the restricted investment in tubewells. The lands accessible to gravity-fed irrigation in Ta Daeng Thmei could also be extended, increasing further the potential cropping intensity.

Nevertheless, even these partially-irrigated systems not only increased land and labour utilisation, making greater use of the limited set of household resources, but improved the physical and chemical properties of the soil, reduced the risk of a household rice deficit, increased the production of a marketable surplus of rice, and increased the level and diversity of crop income. The resultant cash flow provided the necessary working capital to keep the cropping system turning over, with minimal need for credit, while providing income for household needs. It is significant that, on average, two thirds of cash income in Trapeang Run came from non-farm employment, compared with only 12% in Snao and 21% in Ta Daeng Thmei.

Thus the comparison suggests a potentially feasible strategy for lowland villages like Trapeang Run to increase food security and farm and household incomes. While outmigration from the densely-populated, rainfed lowlands of southern Cambodia will undoubtedly continue, the case studies show that the development of more intensive, diverse, and market-oriented farming systems, based on on-farm irrigation, can provide a promising alternative pathway for many rural households.

## 4. Contract Farming of High-Quality Rice in Kampong Speu

### Introduction

Contract farming is seen as one of the policies to overcome current impediments in the Cambodian rice sector. The Angkor Kasekam Roongroeung Co. Ltd. (AKR) was the first agribusiness firm to implement contract farming of rice, beginning in 1999 with about 100 farmers; it currently claims to have over 50,000 contracted farmers in four provinces (AKM 2015). The approach was later adopted by other development organisations, such as the Cambodian Centre for Study and Development in Agriculture (CEDAC). A study by Cai et al. (2008) for the Asian Development Bank Institute (ADBI) on the impacts of AKR's rice contract farming scheme on farmers' performance provides some useful insights. In general, however, little is known about rice contract farming in Cambodia in terms of its contractual arrangements, inclusiveness, benefits, and challenges.

To help fill the current knowledge gap, this study aimed to examine three aspects of AKR's rice contract farming: (1) inclusion of smallholder farmers and contractual arrangements,

(2) benefits of contract farming for farmers, and (3) challenges faced by farmers and agribusiness firms. AKR was selected as a case study because the company operates the largest scale of rice contract farming in Cambodia. Findings of this study will hopefully contribute to policy making on how to make rice contract farming more developmental.

**Understanding the Effects of Contract Farming**

Although one of the purported benefits of contract farming is to help smallholder farmers integrate into global agri-food supply chains, smallholders have not always been included because working with them incurs high transaction costs and a high risk of producer defaults (Key and Runsten 1999). On the other hand, smallholders are preferred in some cases to minimise the negative effects of crop failure, enable a flexible production portfolio, enhance the quality of produce, and reduce the drop-out rate of members (Birthdal et al. 2005). The experience of various contract farming schemes in Thailand suggests that, where production requires large amounts of capital, medium- and large-scale farmers are chosen; but when hard work and commitment are more important, small-scale farmers have a better chance to participate (Sriboonchitta and Wiboonpoongse 2008).

Findings on the effects of contract farming on farmers and agribusiness firms are mixed and inconclusive. Farmers might enjoy some benefits: increased profitability and income; better access to production inputs such as machinery, seeds, fertilisers, infrastructure, and credit; a guaranteed and stable price; a reliable and secure market; and improved technical farm management skills (Setboonsarng et al. 2005). At the same time, they can experience losses due to the failure of agribusiness firms to comply with agreed terms and conditions of the contract, whether intentionally or unintentionally. The benefits could also be negatively affected by the farmers' limited ability to apply required farming technology, resulting in failing to attain defined levels of productivity and quality. Moreover, farmers could be in debt because of their over-reliance on easily accessible credit provided by agribusiness firms.

Agribusiness firms can similarly have both positive and negative experiences. On the positive side, they could secure sources of supply with required quality and standards, reduce production and transaction costs, transfer production risks to farmers, and get more agricultural support such as credit and subsidies. On the other hand, some firms experience losses because farmers break the contract by selling to third parties when the price increases. This practice of extra-contractual marketing is an often-reported problem facing agribusiness firms involved in contract farming schemes.

**Research Methods**

The study was based on interviews with key informants in Kampong Speu Province over two periods: May 2012 and June 2013. According to Cai et al. (2008), more than 80% of contract farmers were in Kampong Speu Province. All but two interviewees were from Prey Khmeng Commune and Chom Sangker Commune in Phnom Srouch District. This district was an ideal site for the study due to AKR Company's long history there. A total of 20 key informants were interviewed – 10 farmers, 4 village heads, 1 commune clerk, 3 staff of the Society for Community Development in Cambodia (SOFDEC), a local NGO, and 2 staff of the AKR Company (whose office was in Angsnoul District). Farmer interviewees were selected through snowball sampling with the support of SOFDEC staff. Since village heads were also farmers, a total of 14 farmers were interviewed, comprising 11 former contract farmers, 2 current contract farmers, and 1 non-contract farmer. All farmers interviewed cultivated a single crop of rainfed rice in the wet season.

All interviews were done in a semi-structured manner. There were four different interview guides – for farmers, representatives of the commune association, staff of the local NGO, and representatives of the AKR Company. Some common questions were asked of former contract farmers, current contract farmers, and non-contract farmers, but there were also specific questions for each type of farmer. All interview guides covered reasons why farmers and agribusiness firms cooperated under a contract, and the terms and conditions, costs and benefits, and challenges of working under a contract.

### Inclusion of Smallholders

AKR considered several factors in deciding where to start contract farming in the early stages of its operation.[5] The first and foremost was the agronomic conditions. The company started with *Pkar Malis* (a type of aromatic rice), a variety that is selective in terms of agronomic conditions. AKR had examined agronomic conditions in several provinces and chose four to start its rice contract farming: Kampong Speu, Kandal, Takeo, and Kampot. Agronomic conditions remained a critical factor when deciding on the specific locations within the province. Not all communes, villages, and households had the conditions suitable for *Pkar Malis* rice, hence some were excluded from the contract farming scheme from the outset.

Another criterion for selecting villages was the degree of concentration of interested farmers. Due to a strong requirement for varietal purity, villages having interested farmers who were geographically dispersed were not eligible for the contract. AKR staff interviewees explained that when *Pkar Malis* rice is grown next to other varieties, pollen of other rice varieties can reduce the varietal purity of the *Pkar Malis*. To avoid this, AKR only selected villages where many farmers were interested in participating in contract farming and farmed close together.

The size of landholding was not a condition for selecting farmers when the company began its operation.[6] Nevertheless, in 2000, the share of farmers contracted with less than a hectare of land was only about 5% of AKR's total number of contracted farmers.[7] Three main reasons explain this low representation of very small holdings. First, very poor farmers could not spare their land for the production of commercial rice.[8] Second, even if they wanted to join the scheme, if their agronomic conditions were not suitable the company did not accept them.[9] Third, in some cases, farmers had a large area of land but the land that could successfully grow *Pkar Malis* rice was less than a hectare, hence the company only accepted the suitable land.

A minimum of one hectare of suitable land was enforced after a few years of operation because the company found it difficult to work with farmers owning less than this. Often the urgent need for money had forced poorer farmers to sell their rice to informal traders at the farm gate. Sometimes farmers consumed all the grain produced. Even with these breaches of contract, the company could not take measures against the farmers because they were too poor to be held responsible for their actions. Therefore, despite a few exceptions, the company decided to exclude farmers with less than a hectare of land. Exceptional farmers were those who were committed to the company, hardworking, and strongly recommended by village heads.

A subsequent significant change in the buying policy of AKR made the area of land an irrelevant condition. Due to some challenges (see below), AKR changed the policy of buying rice from individual farmers to buying collectively from each village. As long as farmers had rice to sell to AKR, they could sell through the village, regardless of farm size. Data from interviews with all the four village heads confirmed this practice. Such collective purchase prevented the company from knowing the extent of participation of very small-scale farmers in their contract farming scheme.

### Contractual Arrangements

In order to gain villagers' trust and as an efficient way to manage contract farming, AKR established "commune associations". Each association comprised the head and deputy head of the commune and the village heads. The associations had various roles, beginning

[5] Interview with staff of AKR on 21 June 2013.
[6] Interview with two village heads and staff of AKR on 19 and 21 June 2013 respectively.
[7] Interview with staff of AKR on 21 June 2013.
[8] Interview with a village head on 19 June 2013.
[9] Interview with staff of AKR on 21 June 2013.

with helping AKR persuade and select the contract farmers. After one year of attempting to introduce the concept of contract farming directly to farmers, the company realised that it was difficult to gain farmers' trust in this way.[10] This led them to seek the support of the local authority at commune and village levels in explaining the idea to farmers. Commune associations then assisted AKR in evaluating the suitability of farmers in terms of their agronomic conditions and commitment. The company delivered quality seeds and technical advice to contracted farmers through these associations. During the production stage, commune associations were obliged to monitor their contracted members and report to AKR on the production process, progress, and challenges. In exchange for the services of the commune associations, AKR provided incentives to the commune and village heads at the rate of KHR 30 and 40 respectively for each kilogram of rice sold by members of their association.

The "resource-providing" type of contract adopted by AKR seems to have worked well in the Cambodian context, where the market for farm inputs remains underdeveloped. Farmers in general often faced problems of limited access to necessary production inputs such as seeds, fertilisers, credit, and extension services. They also had difficulty selling their products in markets at reasonable prices. By signing a contract with AKR, farmers had access to quality seeds, extension services, a secure market, and competitive prices. The company advanced seed to farmers without interest.

However, the contract was not prepared in a participatory manner. The company drafted the contract and asked farmers to sign it. AKR and members of the commune association held a village meeting to explain the concept of contract farming and the terms and conditions of the contract to farmers. Village heads recorded the names of interested farmers and, together with AKR's technical team, examined their agronomic conditions. If the land was suitable, the company invited farmers to its office and explained the contract again to ensure farmers' proper understanding before having them sign the contract.

Although the contract specified a number of necessary clauses, it lacked several important aspects. It mentioned the amount of seed borrowed by farmers but did not indicate whether the company would provide seed to farmers every year. It described the obligations of AKR to provide contract farmers with fees for transporting paddy rice to the company and to pay members of the commune associations for their services. It also included conditions under which the company would buy paddy rice from farmers. The penalty clause specified the consequences for farmers who breached the contract but stated nothing about consequences for the company if it was to breach the contract. The contract failed to mention the date on which farmers needed to return the seed, the duration of the contract, and how each party could end the contract.

### Benefits of Contract Farming

#### *Access to market*

Access to an export market with a competitive price was the first and most important reason why farmers were interested in joining the contract farming scheme and was the major expected benefit for their participation. The price provided by AKR was competitive in two ways.[11] First, it was much higher than the prices for ordinary varieties grown by farmers before AKR came. In 1999, the market for *Pkar Malis* rice had not been developed in Phnom Srouch District. Farmers grew ordinary varieties for household consumption. When in urgent need of money, farmers sold their paddy rice for KHR 200-300 per kg. The AKR was the first to introduce *Pkar Malis* to farmers and the buying price was KHR 500-700 per kg. Second, the price was competitive when compared to the price offered by informal traders for the same type of rice. After the market of *Pkar Malis* rice was established, traders and

[10] Interview with staff of AKR on 21 June 2013.
[11] Interview with two village heads and a representative of Prey Khmeng commune on 19 June 2013.

CEDAC also bought this variety. However, AKR always bought rice from contract members at a higher price than other buyers.

With a well-established market for the *Pkar Malis* variety, contract farmers saw the importance of the price provided by AKR less in terms of its value and more in terms of insurance. AKR's higher price came with many production challenges (see below), which lessened its attraction for some farmers. Others, however, maintained their relationship with AKR or CEDAC, despite the production challenges, in order to keep reaping the benefit of the consistently high market price.[12]

### *Access to quality seeds*

The second most important benefit was access to quality seeds. Although CEDAC also bought *Pkar Malis* rice, it did not follow AKR's policy to advance quality seeds to farmers. Farmers increasingly appreciated this benefit. Information from interviews with former AKR contract farmers suggested that, in the early phase of contract farming when rice farming was only for the domestic market and household consumption, farmers cared less about the varietal purity of harvested paddy rice. Their main reason for participating in the contract farming scheme of either AKR or CEDAC was the access to markets with a competitive price provided by the two institutions. With the establishment of an export market, farmers were more concerned about the availability of quality seeds as a primary reason for contracting to supply AKR. These seeds produced high yields with excellent varietal purity, which was one of the conditions of the high-end export markets.

A current AKR contract farmer explained that, although she had already joined the contract farming scheme of CEDAC, she still contracted with AKR to receive new quality seeds because her old seeds were no longer pure after several years of farming.[13] A village head related that, in 2006, only 30 out of 159 households in the village expressed their interest in contract farming with AKR because they had not realised the necessity of quality seed. By 2011, 98 households had registered with AKR to obtain new foundation seed, but the company did not advance seed to them.[14]

### *Access to technology*

The third benefit of contract farming with AKR was access to quality extension services. In order for farmers to produce grain with the required standards in terms of varietal purity and yield, AKR delivered training and ongoing technical support to its contracted farmers. However, the company did not exclusively provide this benefit because CEDAC and SOFDEC also offered extension services to farmers.

AKR only delivered training on production techniques to its members during the first year of contract farming. The company trained members of commune associations who would further train their contract farmers. The content of the training covered the whole production process. The benefits of the training seem to have continued even after the termination of contract farming. For example, a former contract farmer of AKR appreciated the training since he could apply the production technology when he grew other rice varieties after quitting the AKR scheme.[15]

### *Access to credit and other benefits*

Despite their irregular provision, other secondary benefits received from AKR included access to credit with a low interest rate, fees for the services provided by the commune associations, fees for transporting rice to AKR office, and the use of trustworthy scales to weigh their crop.

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[12] Interview with a non-member of the AKR scheme but a member of the CEDAC scheme on 19 June 2013.
[13] Interview with a current contract member of AKR on 20 June 2013.
[14] Interview with a village head on 20 June 2013.
[15] Interview with a former contract member of AKR in Prey village on 19 June 2013.

The company originally provided loans to their members without interest, but the policy at the time of the study was to charge 1.4% per month. This compares with an average monthly interest rate charged by microfinance institutions in Cambodia of around 3% for loans in riels.[16] In 2011, the company gave loans to about 500 households.

In terms of the fee for the services of the commune association, AKR was not consistent in issuing this payment as stipulated in the contract. Only in the early stages of the operation did it pay the associations, although they were still working for the company by collecting paddy rice from farmers.[17]

AKR also did not consistently pay farmers the transportation fee as stated in the contract, supposedly because of the varying volumes delivered. When farmers had low yields, they were not able to sell the required amount, resulting in the company not being able to fulfil its export orders. This loss was partly made good by withholding transport fees.

Finally, farmers pointed out that AKR used reliable and trustworthy scales when weighing their paddy rice. This was another benefit compared with selling to local traders, who not only offered a lower price but, farmers claimed, always under-weighed their paddy using doctored scales.[18]

***Increased profit***

The above-mentioned benefits enabled contract farmers to increase their profit from rice farming. Based on information provided in the interviews, with a yield of 2 t/ha, contract farmers could generate a gross revenue of around KHR 2.9 million per ha, which was lower than the former contract farmers' KHR 3.4 million per ha but moderately higher than non-contract farmers' KHR 2.7 million per ha (Table 1). The same ranking was observed in gross margin per ha, with former contract farmers netting KHR 1.9 million, contract farmers KHR 1.9 million, and non-contract farmers KHR 1.7 million. This finding confirms the estimates given by Cai et al. (2008). The implication is that entering into contract farming increases the profitability of rice farming, but that farmers who "move on" from contract farming achieve even higher returns.

Table 1. Estimated costs and returns for a one-hectare rice farm, by type of farmer

| | Former contract farmer | Current contract farmer | Non-contract farmer |
|---|---|---|---|
| Yield (kg/ha) | 2,500 | 2,000 | 2,000 |
| Price (riels/kg) | 1,350 | 1,450 | 1,350 |
| Gross revenue (riels/ha) | 3,375,000 | 2,900,000 | 2,700,000 |
| Variable costs (riels/ha) | 1,230,000 | 986,000 | 1,000,000 |
| Gross margin (riels/ha) | 2,145,000 | 1,914,000 | 1,700,000 |

Source: Interviews with key informants

**Challenges of Contract Farming**

Contract farming can be regarded as successful when the agribusiness firm and the contracted farmers are both satisfied with the benefits they receive and thus maintain their business relationship. The lower revenue and gross margin of contract farmers compared to former contract farmers suggests that there were problems with the contract farming scheme in this case that made it less profitable, resulting in farmers withdrawing. The

[16] MFTRANSPARENCY Case Study on Lending Interest Rate in Cambodia: http://www.mftransparency.org/wp-content/uploads/2012/05/MFT-BRF-302-EN-Outlawing-Flat-Interest-in-Cambodia-2011-10.pdf; accessed 5 July 2013.
[17] Interview with a village head on 19 June 2013.
[18] Interview with a former contract member in Kbal Toekrom village on 7 May 2012.

interviews provided insights into the challenges faced, how these were addressed, and the support still needed.

### *High requirement for varietal purity*

One of the great challenges was the requirement for high varietal purity of the paddy rice produced. Farmer interviewees expressed different attitudes towards the difficulties inherent in the purification process. Some former AKR contract farmers raised the purification problem as one of the main reasons they left the scheme, despite the high price. However, some current farmers did not see the requirement as too difficult to meet, just needing some extra effort on their part. The policy of AKR specified that paddy rice had imperfect varietal purity if there were three or more grains of the wrong variety in every 100 sample grains.[19] Different levels of varietal purity were reflected in the different prices that farmers received. Thus contract farmers ran the risk of receiving a lower price if they had not made enough effort in rice purification. Some contract farmers avoided the challenge by leaving the AKR contract farming scheme. Although informal traders offered a lower price, they attached no conditions to their purchase.

AKR started contract farming to fulfil export requirements in terms of quality and quantity. Varietal purity was one of the quality criteria, especially for the high-end market. The company did not consider the requirement too high for contract farmers. Instead, they attributed the inability to fulfil this condition to farmers' low commitment. Such attribution resulted in selective discontinuity in the business relationship between AKR and contract farmers. To maintain high varietal purity, AKR changed the improved foundation seed for their contract members every two to three years. The company based the decision to distribute new foundation seed on the farmer's past purity levels.[20]

### *Strict requirement of moisture level*

AKR contract farmers faced a problem with drying their paddy. One of the contract conditions was that paddy rice had to have a moisture level less than 16%. The company trained their contracted farmers on how to measure the moisture level but it was not easy for farmers to dry their paddy rice to the required level due to unfavourable weather conditions and their reliance in sun-drying. Former and current contract farmers explained that, to get down to 16% moisture, they needed to dry their paddy for about two consecutive days under the hot sun, but sun-drying was unreliable. If the dried grains were exposed to rain they were likely to germinate, yellow, or rot.

AKR accepted paddy rice with a slightly higher moisture level than required but reduced its price accordingly. Farmers did their own mental calculation and reported that sometimes it was not profitable to sell to AKR. They felt that, no matter how hard they tried, the company could reduce the price due to imperfect varietal purity and/or excess moisture. Former contract farmers preferred selling their paddy rice to informal traders, who put no conditions on their purchase. Instead of purifying and drying paddy, former contract farmers chose to spend their time on other income-generating activities.[21]

The strict requirement for moisture level not only posed a difficulty for the farmers but also the company. The AKR staff observed that the company was successful in contract farming in terms of price but not in terms of flexibility when compared to informal traders. The company was able to pay a higher price but contract farmers needed to produce very pure and dry paddy rice. Since the company operated on a very large scale, it was unable to buy wet paddy rice from farmers and sun-dry it in its own facilities. Unlike the company, informal traders could buy wet paddy and dry it themselves in local drying yards. Given their credit constraints, farmers were inclined to sell to informal traders right after harvesting without any drying.

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[19] Interview with staff of AKR on 21 June 2013.
[20] Interview with staff of AKR on 21 June 2013.
[21] Interview with a former contract farmer of AKR in Prey village on 19 June 2013.

Farmers' inability to fulfil the moisture requirement had resulted in AKR not being able to satisfy export demand. To meet its export orders, the company had resorted to buying paddy from other sources. All sellers had to fulfil the requirements of purity and moisture level, though to different degrees and for different prices. Current contract farmers received the highest price because the quality of their paddy was also the highest (Table 1 above). At the time of the study, the company bought about 60% of its exported volume from traders because it could not get enough paddy from its own farmers.[22] Due to insufficient capital, AKR was not able to get to the root of the problem of unfilled export orders. The company realised that, if it could buy wet paddy from farmers and dry it, it would be able to collect larger quantities of paddy. However, acquiring high-capacity drying machines was beyond the company's financial capacity.

***Limited access to high-quality seeds***

Another challenge for contract farmers and a factor affecting low varietal purity was limited access to high-quality seed. New quality seed could produce higher and purer yields, with the capacity to retain seed for the next two to three crop seasons. The continued use of retained seed beyond this period would result in lower yields and mixed varieties. AKR was the first and only agribusiness firm to advance quality seed to their contract farmers without interest. Current contract farmers in one of the selected villages expressed concern about the purity of their retained seed stocks. AKR had provided quality seed of *Angkong Seouy* to them in 2010 and they had already used their retained seed stocks in 2011 and 2012. As the company had not provided new seed for them in 2013, they continued to use their retained seed for another year, despite running the risk of lower yield and producing mixed varieties.

Farmers adopted diverse strategies to deal with the shortage of high-quality seed. Some non-contract farmers turned to AKR for new seed, but they were disappointed because the company neither advanced seed to them nor to the current contract farmers in 2013. Some former AKR contract farmers and current and former contract farmers with CEDAC were willing to join SOFDEC to obtain new seed of the *Pkar Roumdoul* variety. However, the seed provision scheme of SOFDEC had only just started in the year of the study, and the variety provided was not one that was purchased by AKR or CEDAC. Moreover, the scheme was not large enough to cover all farmers, resulting in a considerable number missing out, and in any case SOFDEC only advanced seed to farmers but did not contract to buy the harvested paddy rice.

The staff of AKR raised farmers' low commitment to the company as a reason why the company could not continue to provide quality seed to all participants. The company advanced seed to all its contract farmers in 2000 and 2001, but it was no longer the practice. The staff observed that, due to both drought and lack of commitment, contract farmers could not produce high yields of sufficient purity, causing the company a great loss. Learning from this experience, the company only advanced seed to a few communes whose farmers were committed to the company.[23]

***Breaches of contract***

Ordinary contract farmers and contract farmers who were also members of commune associations suffered from AKR's irregular payment for transportation of paddy rice to the company and for the services of the associations. As mentioned above, the contract specified that AKR would pay these fees. In reality, this was not consistently implemented, resulting in participating farmers losing some of their expected revenue from selling rice to AKR. Also, despite its promise to pay each commune and village head KHR 30 and KHR 40 respectively for every kilogram of paddy sold by their members, the company only

[22] Interview with staff of AKR on 21 June 2013.
[23] Interview with staff of AKR on 21 June 2013.

occasionally adhered to this commitment. Even though the contract was legally binding, farmers had no ability to hold the company accountable.

A long-standing problem for AKR was the extra-contractual marketing undertaken by contracted farmers. AKR staff explained that the company knew if farmers broke their contracts in this way but was not able to take any measures against them in the way commercial banks or microfinance institutions could. Interviews with contract farmers revealed that none had been fined for extra-contractual marketing. The only solution the company saw was to explain to farmers the costs and benefits of selling paddy rice to the company and to traders.

Another example of contract breach by farmers was the misuse of their membership cards. There were reports that some farmers had rented their membership card to traders or other non-contract farmers, enabling them to sell paddy rice to the company at the highest price. As noted above, the company did buy from other sources but reserved the best price for holders of current cards. A former AKR contract farmer complained that he and other farmers still wanted to continue with contract farming since it improved his livelihood, but the company had already withdrawn from his village. He suspected this was due to some farmers in the village engaging in this practice of renting out their cards.[24]

### *Credit constraints*

Credit constraints represented a serious challenge for both contract farmers and AKR. Farmers with credit constraints were under pressure to sell their paddy rice quickly to informal traders or were not willing to sell paddy to AKR on credit. This contributed to farmers' extra-contractual marketing. Informal traders made selling to them convenient for farmers by not placing any conditions in terms of moisture level or varietal purity and by paying farmers immediately. On the other hand, AKR used to buy from their contract farmers on credit (i.e., with delayed payment), resulting in a large number of farmers quitting the scheme. The company was able to improve its financial position in 2010 and paid cash on delivery to their current members, but it was unknown whether the company could sustain this practice.[25]

In addition to its past inability to pay contract farmers immediately, credit constraints prevented AKR from investing in large-scale paddy driers. Acquiring high-capacity driers would have significantly improved the company's capacity to purchase wet paddy rice from farmers, increasing their export volume and making life easier for their contract farmers.

### *Rainfall variability*

Variability in rainfall during the growing season had a direct negative impact on contract farmers and an indirect negative impact on AKR. When drought affected their crop, farmers could not produce a high yield, resulting in their inability to supply the amount of paddy rice stipulated in their contract. For example, in one of the study villages, contract farmers were not able to sell any surplus paddy rice to AKR in 2011 and 2012 due to drought.

The AKR staff reported frequent losses due to drought. In the early years of their operation, the company experienced dramatic losses since farmers could not return the advanced seed, which was very expensive. The company terminated contracts with several communes because of drought.[26] Despite otherwise favourable agronomic conditions, the company still withdrew because the communes were drought-prone.

[24] Interview with a former contract farmers with AKR on 7 May 2012.
[25] Interviews with a current contract famer and a village head on 20 June 2013.
[26] Interview with staff of AKR on 21 June 2013.

## Policy Options for Contract Farming

### *Raising awareness*

Raising farmers' awareness of the costs and benefits of contract farming could help increase their commitment to the company. As the study revealed, one of the conditions that AKR considered when terminating contracts with any village was the overall level of commitment of the farmers in that village. On the other hand, despite their limited landholdings, the poorest farmers could participate in the contract farming scheme as long as they were highly committed to the policies of the company. The Ministry of Agriculture, Forestry and Fisheries (MAFF) could provide education on weighing up the costs and benefits of participating through its extension service, or make use of existing commune associations created by the AKR to conduct the training. Such intervention would need to take the stance of an independent adviser, however, to avoid seeming to persuade or coerce farmers to enter into contracts reluctantly.

### *Rice-drying technology*

Removing technical constraints for paddy drying would create more benefits for both parties. One possible measure is to improve farmers' knowledge of new drying technology. The MAFF could collaborate with the International Rice Research Institute (IRRI) which has been working in Cambodia on adaptive technology to deal with post-harvest losses, including paddy drying. Farmer representatives could also attend a training course on agricultural mechanisation at the Don Bosco Technical School, which has received technical assistance from IRRI. However, in general, small-scale village-based driers have not been successful.

Another possible measure is to encourage the private sector, for example rice millers, to invest in drying technology. According to the 2013 report of an ADB-IRRI training course, only a large-scale rice miller and a farmer cooperative had so far provided drying services to farmers in Cambodia.[27] This practice needs to be expanded to reach farmers across the country.

Yet another measure would be to provide agricultural credit to AKR directly to invest in high-capacity drying machines. AKR would be able to buy a larger volume of wet paddy rice from farmers if the company had such drying capacity. Hence there may well be a business case for financing this investment.

### *High-quality seed*

Improving farmers' access to high-quality seed could be achieved by accelerating the implementation of the current rice policy. High-quality seed determines the production volume as well as the quality, including the level of varietal purity. The government has already included this issue as a "quick-win" measure in its policy paper, *The Promotion of Paddy Production and Rice Export* (RGC 2010). The implementation of this seed policy was observed during fieldwork. However, the varieties distributed by the local authority, for example *Sen Pidor* and *Chulsar*, were for household consumption rather than for commercial purposes. As a policy measure, the government could coordinate with rice exporters on the varieties to be exported and distribute seed accordingly.

### *Access to credit*

Due to credit constraints, farmers could not store their paddy rice long enough to sell to AKR or CEDAC for high prices, or survive the subsequent waiting period until receiving payment. The urgent need for cash pushed farmers to engage in extra-contractual marketing, undermining the viability of the contract farming scheme. Improving farmers' access to credit should be able to reduce this extra-contractual marketing. On the other hand, increasing access to credit for agribusiness firms could help overcome their current

[27] Cambodia: Postharvest project assesses outcomes: http://irri-news.blogspot.com/2013/06/cambodia-postharvest-project-assesses.html; accessed on 17 July 2013.

capital constraint to paying farmers on time (for paddy delivered as well as service fees) and investing in drying equipment. The above-mentioned policy paper specifies measures to alleviate the credit constraints facing farmers and agribusiness firms, mainly through the expansion of micro-finance institutions. However, there may be a need for an Agricultural Bank as in Thailand to increase the flow of credit for profitable investments for farmers and the agribusiness sector.

### *Contract enforcement*

The study found that contract farmers and AKR both experienced breaches of contract but were unable to take any legal measures. There was no institution to oversee compliance with the contract on the part of both parties. MAFF could consider implementing Article 7 of Chapter 2 of the Sub-Decree on Contract Farming regarding the establishment of a coordination committee. As stipulated in the Sub-Decree, the Coordination Committee for Agricultural Production Contracts (CCAPC) “shall intervene or reconcile arguments or conflicts that might occur from the implementation of the contract farming.” While the Sub-Decree indicates that the CCAPC would function at the national level, the government should consider establishing provincial-level committees for easier access by farmers.

## Conclusion

The study found that the rice contract farming scheme of Angkor Kasekam Roongroeung Co. Ltd. (AKR) was inclusive of poor farmers with small farms, even those with less than a hectare. With access to several important benefits of the scheme, contract farmers were able to increase their returns from rice farming. However, some flaws in the contractual arrangements and the requirement to deliver high-quality rice for the export market posed a number of challenges to both AKR and the participating farmers, some of which could be addressed through policy interventions. Overcoming these challenges will enhance the benefits of contract farming for both farmers and agribusiness firms and thus contribute to further development of the rice sector and rural poverty reduction.

# 8 Impacts

## 8.1 Scientific impacts – now and in 5 years

The project has provided a framework and a set of tools for analysing agricultural policies from the perspective of the farm-household (i.e., examining 'policy in practice'). By documenting and understanding how farm households are influenced by policy settings relative to other aspects of their environment, and how decisions are made at the farm-household level, this approach contributes to a more realistic assessment of agricultural policies. Through the in-depth case studies, the project has also provided a detailed account of how rice farmers in the four countries are adapting their farming systems and linking to economic opportunities within and across national borders. Perhaps the project's unique contribution has been to study the operation cross-border trade from the both sides of the border. More generally, the comparative approach has provided greater insights into the similarities and differences in the development pathways within Mainland Southeast Asia.

## 8.2 Capacity impacts – now and in 5 years

Each of the partner organisations has involved younger staff in conducting reviews and case studies, under the supervision and guidance of the project leaders. This has contributed to building the capacity of those organisations. The Danang Workshop in July 2012 was enlarged beyond the project leadership team so that these younger staff could present their findings and take part in a wider discussion of their significance. This was a high-standard international meeting that provided an excellent opportunity for these younger researchers to develop their skills. The process of training mentoring younger researchers will continue beyond the life of the project, but only gradually. A longer-term strategy would be to provide support by (a) regular training and interaction in policy research and analysis and (b) building the capacity of policy research institutes to routinely collect, analyse, and communicate policy-relevant data.

## 8.3 Community impacts – now and in 5 years

It is not possible to attribute specific community impacts, now or in five years, to the outputs of the project. Indeed, that would be to contradict the framework outlined in Fig. 1. However, the project has produced a wealth of evidence about how farmers are influenced by government policy and programs, and how their livelihood options could be improved by certain policy changes. Thus, if the capacity for this kind of 'policy in practice' approach continues to be supported and enhanced, there is a strong probability that rural households will benefit. Some specific examples are given below.

### 8.3.1 Economic impacts

The focus on rice policy in Laos has been on boosting production and exports through increasing yields and intensifying the rice cropping system by double-cropping. The emphasis on area, yield, and production targets in each season is a legacy of socialist planning and an earlier era when increasing rice production to achieve self-sufficiency was a national priority. Farm-households now have a wider range of livelihood options and can weigh up the benefits of pursuing government targets versus allocating resources (household labour of different capabilities, paddy land in the dry season, water for irrigation, scarce household capital) to other farm and non-farm activities. As policy-makers increasingly recognise the poverty-reducing impacts of more diversified livelihoods, government policy settings and resources can be oriented to providing support for these alternatives rather pressuring local governments and farmers to meet what have been acknowledged to be arbitrary targets. At the same time, recognising the continuing

importance of wet-season rice to the subsistence base of these more diversified households can help to direct resources to ensuring farmers receive high-quality seed of more resilient varieties (e.g., flood- and drought-tolerant), high-quality fertiliser, suitable farm machinery, and other inputs to maintain this subsistence base.

In Cambodia, there is much greater potential for rice farmers to profit from an expansion in exports. The project has identified the importance of the cross-border trade with Vietnam of both low-quality varieties for export and high-quality Cambodian varieties for the Vietnamese market. These cross-border links include the flow from Vietnam into Cambodia of varieties, inputs, services, expertise, and capital. The constraints to realising this potential have also been highlighted by the project, both upstream (fake fertiliser, costly credit, limited technical advice) and downstream (severe limitations in post-harvest capacity for drying and milling grain, high transport and transaction costs). Policies to address these constraints can enable many smallholder farmers in one of the poorest regions of Cambodia to increase their incomes, potentially reducing migration into Cambodia's once-forested frontiers.

### 8.3.2 Social impacts

The social impacts of these policy-induced changes largely relate to the changing nature of rural households – again, a process that has many more influences and outcomes than can be attributed to any policy, let along the policy research in this project. As households pursue increasingly diversified farming and livelihood systems, decisions are made about the comparative advantage of individual household members to continue rice farming, pursue non-farm activities locally, or to migrate to urban centres or internationally, often leaving grandparents to look after children in the village while these strategies are played out. Policy makers who recognise these changes can tailor agricultural support to suit the circumstances of the different types of household that have emerged and focus on facilitating the growth of rural businesses, ensuring the welfare of migrant workers, and safeguarding their earnings and remittances.

### 8.3.3 Environmental impacts

The project did not explicitly address the environmental impacts of the rice-based farming systems under study, nor of the policies influencing them. However, the evidence-based policy capacity advocated by the project could have important impacts in the future on such issues as the rapid increase in the use of groundwater for irrigation in southern Cambodia, which is a consequence of the intensification and diversification of farming in the region. This phenomenon is the result of private initiative and investment, with significant economic returns to farmers who are able to augment rainfall in the wet season and irrigate small areas of cash crops or forages in the dry season. While technical research is underway to better understand the nature of the aquifers being tapped, there has been little or no policy research on how to regulate the use of this resource to avoid adverse environmental impacts.

## 8.4 Communication and dissemination activities

The main forum for communicating the results of the project was the "Policy Dialogue on Rice Futures" held in Phnom Penh, 7-9 May 2014. The Australian, Lao, and Cambodian project partners all presented keynote papers at that forum, as well as participating as discussants and rapporteurs and interacting with policy makers in valuable informal discussions. These contributions were published in L. Robins (ed.), *A Policy Dialogue on Rice Futures: Rice-Based Farming Systems Research in the Mekong Region*. ACIAR Proceedings No. 142. Canberra: Australian Centre for International Agricultural Research. The individual chapters are cited below.

Some of the Cambodian studies were published as policy papers by the Cambodian Development Resources Institute:

Fertiliser Value Chains in Cambodia: A Case Study in Takeo Province. *Cambodia Development Review*, Volume 16, Issue 4, December 2012. Phnom Penh: CDRI.

Credit for Rice Farmers: A Study in Takeo Province. *Cambodia Development Review*, Volume 16, Issue 3, October 2012. Phnom Penh: CDRI.

Rice Marketing Value Chain: A Case Study of Takeo Province, *Cambodia Development Review,* Volume 17, Issue 2, June 2013. Phnom Penh: CDRI.

The main communication and dissemination output will be a monograph, *The Commercialisation of Rice Farming in the Mekong Basin: Policy Insights from Field Studies,* which is in the final stages of preparation. The monograph includes updated analyses of rice policies and their impacts in all four countries as well as in-depth field studies in particular provinces and of cross-border value chains and other forms of influence. It is planned to work with an academic publisher such as Springer to give this very wide circulation in 2018. The outline of the monograph is given below.

| | |
|---|---|
| 1. Introduction | Rob, The Anh, Benchaphun, Silinthone, Vuthy |
| 2. Trends in Rice Farming in the Mekong Basin | Rob, The Anh, Benchaphun, Silinthone, Vuthy |
| PART 1 – THAILAND | |
| 3. Intensification and Diversification of Rice-Based Cropping Systems in Thailand | Prathanthip Kramol, Pornsiri Suebpongsang, Benchaphun Ekasingh |
| 4. Agricultural Mechanisation in Thailand | Rob Cramb |
| 5. Commercialisation of Rice Farming in Three Northeast Thai Villages | Prathantip Kramol and Benchaphun Ekasingh |
| 6. Farmer Organizations in Three Northeast Thai Villages | Prathanthip Kramol, Pornsiri Suebpongsang, Benchaphun Ekasingh |
| PART 2 – LAOS | |
| 7. Rice in Laos | Silinthone |
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| 9. The Supply of Inputs to Rice Farmers in Savannakhet | Silinthone Sacklokham |
| 10. Rice Marketing and Cross-Border Trade in Savannakhet | Phengkhouane Manivong |
| 11. Economic Constraints to the Intensification of Rainfed Lowland Rice in Central and Southern Laos | Jonathan Newby, Vongpaphane Manivong, and Rob Cramb |

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| PART 3 – CAMBODIA | |
| 12. Rice in Cambodia | Theng Vuthy |
| 13. The Production, Marketing and Export of Rice in Takeo | Chhim Chhun, Theng Vuthy, and Nou Keosothea |
| 14. The Role of Irrigation in Rice Farming in Takeo and Kampong Speu | Chea Sareth, Rob Cramb, and Shu Fukai |
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# 9 Conclusions and recommendations

## 9.1 Conclusions

Farm households are at the centre of the rapid change in rice-based farming systems in Laos and Cambodia, as well as in neighbouring Thailand and Vietnam. Hence agricultural policies need to be analysed and evaluated in terms of their impact on the decisions made by these farm households and their livelihood outcomes, that is, the emphasis needs to be on 'policy in practice'. The project's field studies showed how farm households utilise a range of key *inputs* (land, labour, water, seed, fertiliser, machinery, credit) to engage in a portfolio of farm and non-farm *activities* that, in turn, generate a range of *outputs* (rice, non-rice crops, livestock, forest products). Agricultural policies can influence (but not determine) these input-output processes that make up the farm household's livelihood strategies. Some policies affect the farm household's access to inputs and resources (e.g., providing and pricing irrigation), others attempt to influence farmers' *activities* (e.g., proscribing upland rice or urging the cultivation of dry-season rice), and others affect farmers' capacity to *appropriate* the returns from their outputs (e.g. marketing and trade restrictions and levies that affect the level and reliability of farm-gate prices). From the farm household's perspective, these policies are experienced as part of the *context* in which livelihood decisions are made, along with other influences that may in fact have greater sway over decision-making than any single policy – influences such as the rising opportunity cost of labour or fluctuations in the price of rice.

The research in Laos examined the policy dilemma raised by the persistence of low-yield, subsistence-oriented rice farming in the rainfed lowlands of central and southern Laos, despite the government's insistence on achieving target yields and increasing production and exports. The analysis showed that farmers have selectively adopted improved rice technologies but that, given the economic and policy context, they are quite rational to adopt a low-input, low-yield cropping system that meets their subsistence goals, with possibly a small surplus for sale. This is because they have other uses for their resources, especially household labour, that can generate higher returns with less risk than by intensifying rice production to meet government targets. Rather than drawing the policy conclusion that investment in improved government-run extension could help farmers apply intensive rice technology and make more profit, thus meeting the government's policy targets, the analysis shows that the problem is with the government targets themselves – they have been set too high for what farmers can profitably produce. The issue is therefore more about a mismatch between the government's goals and farmers' circumstances. In particular, the price and quality of rice is generally too low to justify intensifying production in the wet season or planting irrigated rice in the dry season to meet production and export targets. Policymakers in Laos are now moving away from such a target-oriented approach that attempts to directly influence farm household *activities*, in recognition of the trend towards diversification of rural livelihoods and the benefits this provides in reducing rural poverty.

It can be questioned whether pursuing an export-expansion policy in fact makes sense for Laos, apart from specific, potentially profitable niche markets. Nevertheless, rice production for subsistence and the domestic market is still important in Laos. The research highlighted the need for policies that: (a) assure the quality of rice seed supply; (b) provide improved varieties that offer greater resilience in the face of pests and diseases, rather than being selected for maximum yield; (c) improve the supply of credit for fertilizer; (d) assure the quality of fertilizer; (e) provide advice to farmers on the efficient use of water (e.g. through crop diversification); (f) improve access to postharvest technology (e.g. drying technology to improve grain quality and price); (g) provide finance to millers to upgrade their facilities; (h) avoid sudden shifts in rice trade policy that damage farmers' and millers' incentives.

The project demonstrated that, in contrast to Laos, lowland rice farmers in southern Cambodia, given more favourable market prospects and, in particular, a cross-border value chain driven by traders and millers from Vietnam, have been able to intensify production and expand exports. This export growth has not only been due to dry-season production of Vietnamese rice cultivars for the Vietnamese export market but also exports of premium-quality fragrant rices produced in the wet season, often in contract-farming arrangements that partly address the issues of access to inputs. Nevertheless, the field research in Cambodia pointed to similar conclusions about the need for policy interventions to improve farmers' access to good-quality seed, irrigation, fertilizer, and credit, along with improved extension services. The evidence suggests that in the Mekong region there is a lack of integrated service provision, such as found in Thailand and Vietnam. There are also problems of informal marketing arrangements with Vietnamese traders, resulting in unstable demand and prices. Contract schemes with millers and exporters of high-price wet-season rice have also suffered from their reliance on contracts with individual farmers. The formation of production groups may ensure that farmers have more bargaining power with large agribusiness firms and that contract farming better addresses the input supply and marketing issues facing rice farmers in general in the Mekong region.

There has been much focus on the public-sector's role in providing knowledge and of the need to invest more resources in government extension services. However, it is clear that much of the information accessed by farmers comes through private-sector channels, such as through seed and fertiliser suppliers. The accuracy and relevance of this information is often dubious (e.g. labelling of fertilisers), and it may be that limited government resources are better directed at ensuring the quality of this information flow (and of the inputs themselves) rather than continuing to focus only on conventional and costly public-sector extension.

## 9.2 Recommendations

It was not the intention of this project simply to make a list of policy recommendations for governments to implement, though a range of suggestions have been made about specific issues in each of the case studies. Rather, the project aimed to contribute to an improved understanding of agricultural policies and their impacts, in the process building capacity for critical, evidence-based policy analysis. While the project was successful in this aim, there is both a need and an opportunity for further strengthening of in-country policy advice in Laos and Cambodia. It has emerged that there is considerable interest from policy makers and advisers, as well as donors, in developing the capacity for up-to-date policy analysis based on a detailed understanding of major types of farming system in different agro-economic zones. What is needed is (a) a set of realistic, farmer-validated whole-farm models to capture the strategies and circumstances of major types of farm household in different agro-economic zones; (b) a procedure for regularly updating the values of the key variables in these models (e.g., wage rates, farm-gate prices, farmer intentions); (c) a capacity to interrogate these models to answer specific research and policy questions (e.g., what-if scenarios about the likely response to a change in trade policy). At the same time, research is needed to document, explain, and (cautiously) predict the major trends that are changing farmers' circumstances and livelihood options, such as technological change, shifts in market demand, infrastructure development, and off-farm migration. The main recommendation, therefore, is to provide support to further develop the capacity for systematic, on-going socio-economic analysis of research and policy interventions in smallholder farming systems of Laos and Cambodia. This would entail a project/program of training, mentoring, and resourcing of the socio-economic research units in NAFRI and CARDI.

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