Working Paper No. 109

Smallholder Market Participation, Structural Transformation and Inclusive Growth in Lao People's Democratic Republic

By **Upali Wickramasinghe, Boundeth Southavilay and Savanh Hanephom**

CAPSA
Centre for Alleviation of Poverty through Sustainable Agriculture

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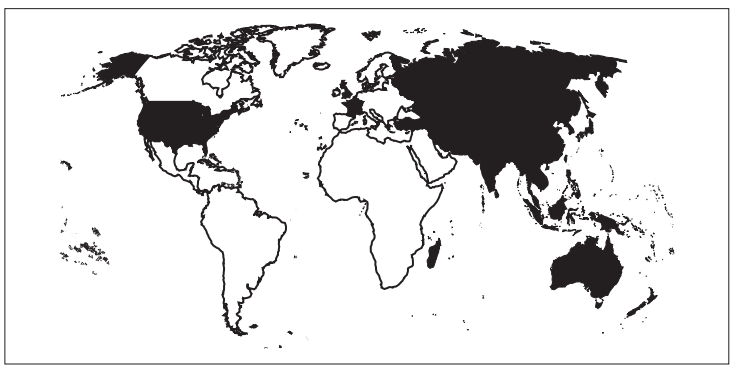

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- Enhanced national capacity for socioeconomic and policy research on sustainable agriculture for poverty reduction and food security
- Enhanced regional coordination and networking to successfully scale up and scale out research findings that have implications for policy design and implementation related to sustainable agriculture and rural development
- Enhanced capacity of policymakers and senior government officials to design and implement policies to achieve rural development, poverty reduction and food security through sustainable agriculture in Asia and the Pacific

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CAPSA-ESCAP
Jalan Merdeka 145, Bogor 16111
Indonesia

Printed in Indonesia
ISBN 978-979-9317-82-7

Cover photos by: Boundeth Southavilay

Cover design by: Fransisca A. Wijaya

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List of Abbreviations

ADB	Asian Development Bank
ADS	Agricultural Development Strategy
AIP	Agricultural Investment Plan
AMP	Agricultural Master Plan
CAS	Centre for Agricultural Statistics
DOPC	Department of Planning and Cooperation
EZ	Economic Zone
ESCAP	Economic and Social Commission for Asia and the Pacific
FDI	Foreign Direct Investment
FRC	Fixed Rotational Cropping
GDP	Gross Domestic Product
IPoA	Istanbul Programme of Action
LCA	Lao Census of Agriculture
LDCs	Least Developed Countries
LFAP	Land and Forest Allocation Program
MAF	Ministry of Agriculture and Forestry
MPI	Ministry of Planning and Investment
NAFRI	National Agriculture and Forestry Research Institute
NEM	New Economic Mechanism
NSEDP	National Socio-Economic and Development Plan
ODA	Official Development Assistance
PPS	Probability Proportional to Size
VDF	Village Development Fund

Foreword

During the 69th session of the United Nations Economic and Social Commission for Asia and the Pacific held in 2013, the Government of Lao People's Democratic Republic (PDR) declared its intent to graduate from the Least Developed Country status by 2020 and the Government introduced a series of reforms through successive national development plans with the objective of transforming its economy largely dependent on agriculture to realize national development objectives. Notwithstanding these reforms, Lao PDR, similar to many other developing economies, continues to experience an imbalance in its economy: the share of agriculture in GDP has declined significantly over the years, but the share of people working in agriculture remains high, locking them into an unproductive sector. This calls for much greater efforts to achieve structural transformation, which will require managing economic growth and transition to realize the convergence of productivity across the agriculture, industry and services sectors simultaneously.

This report is an outcome of a collaborative effort between CAPSA and the Ministry of Agriculture and Forestry of Lao PDR, aimed at understanding the nature of structural transformation taking place in the country and the potential role that agriculture can play to hasten that process. The report finds several elements that could assist in the process. First, structural transformation has come to a standstill in many developing countries for the inability to absorb 'surplus agricultural labour' effectively into industrial and services sectors. The report argues for an agribusiness-led transformation to reinvigorate that process. Second, it makes the case for implementing policies to simultaneously raise agricultural productivity and integrate smallholders with markets as prerequisites for inclusive growth, agribusiness-led transformation to realize the convergence of productivities across the three main sectors – agriculture, industry and services. Third, structural transformation, regardless of its origin, always results in some social groups to lose some entitlements. Designing appropriate responses and strengthening skills to assist those social groups to ensure that they are not fallen below poverty is an imperative. This will require the implementation of safety net programmes including policies and instruments for better managing assets owned by the poor.

I hope that the report will contribute to a healthy dialogue among stakeholders on this vital aspect of development and that it can contribute to implementing a set of policies for realizing inclusive growth and sustainable rural development in Lao PDR and other developing countries.

May 2015

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Acknowledgements

The authors gratefully acknowledge the ideas and suggestions made by the following experts during the preparation of this study: Mr Xyapladeth Choulamany, former Director General, Department of Planning and Cooperation (DOPC), Ministry of Agriculture and Forestry (MAF); Dr. Linkham Daungsavanh, Deputy Director General, National Agricultural and Forestry Research Institute (NAFRI); Ms. Vivanh Souvannamethy, Director, Centre for Agricultural Statistics (CAS), MAF; Dr. Phommy Inthichak, Deputy Director, DOPC, MAF; Mr. Phanthouleth Loungraj, Senior Economics Officer, ADB, Lao PDR Resident Mission; Mr. Chanthaneth Simahano, Deputy Director General, DOPC, MAF; and the participants of the Stakeholder Consultation on Inclusive Growth and Structural Transformation in Lao PDR, held on 29 November 2013 in Vientiane. This study would not have been completed without the contribution of data from the staff of the Centre for Agricultural Statistics, MAF, especially Mr. Sengphachan Khounthikoummane and Mr. Porha Saychounorsoua.

Executive Summary

The Istanbul Programme of Action (IPoA) for LDCs for the Decade 2011-2020 called for commitments to bring about structural transformation in least developed countries (LDCs), fostering accelerated, sustained, inclusive and equitable economic growth and sustainable development to address their long-standing and emerging challenges. The IPoA proposed a three-pronged action programme for agriculture with a view to eradicating poverty and hunger and promoting rural development and gender equality and empowerment of women. It included: (i) strengthening institutions, including cooperatives, to boost smallholder farmer food production, agricultural productivity and sustainable agricultural practices; (ii) encouraging small farmers and pastoralists to change gradually from the production of low-value to high-value products, taking into account specialization, favourable market and infrastructural development conditions, and improved access to financial and risk management instruments; and (iii) making rural markets work better for the rural poor by linking small-scale farmers to markets throughout the food chain, including provisions of price and other relevant information and improving sanitary and phytosanitary services. The need to overcome structural challenges was recognized as an essential part of the IPoA during the Asia-Pacific Regional meeting held in Siem Reap, Cambodia in December 2013. At the 69th Commission Session of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), the Government of the Lao People's Democratic Republic (PDR) declared its intention of graduating from LDC status by 2020. In this context, CAPSA-ESCAP, in collaboration with the Ministry of Agriculture and Forestry of Lao PDR, prepared this report to contribute to the process of policymaking in support of structural transformation and inclusive growth.

The preparation of the report went through an iterative process. It included undertaking: (i) a review of literature on structural transformation and its links to market participation and development policies implemented by the Government of Lao PDR in recent years; (ii) a macro-level data analysis on the current status of structural transformation in Lao PDR in comparison to other countries and its evolution; (iii) an assessment of the degree of structural transformation across provinces by using household-level data available from the Lao Census of agriculture 2010/11 (LCA 2010/11); and (iv) a microeconometric analysis to identify factors that contribute to farm household choices of crops and market participation. The model allows for the possibility of cultivation and market

entry decisions to be interdependent. Models were estimated for rice and other crops separately, differentiated by the degree of income diversification and economic zones.

A review of the literature suggests that structural transformation has been fairly uniform across a large number of countries, but the process has been slow in the developing countries of Asia and the Pacific, primarily due to policy interventions and the inability of other sectors to effectively absorb 'surplus agricultural labour'. Agricultural development, especially, agribusiness-led growth and transformation, could provide a pathway out of the current impasse for countries such as Lao PDR that have the potential for continued agricultural development. Yet, evidence suggests that only a small fraction of farm households in the developing countries of Asia and the Pacific enter markets as sellers of agricultural commodities. Therefore, developing a viable commercial agricultural sector that would also allow farm households with skills and know-how to become agribusiness enterprises is an imperative. Identifying and implementing policies to remove obstacles to increasing agricultural productivity and for farm households to participating in markets must be a cornerstone of structural transformation and inclusive growth in the developing countries of Asia and the Pacific.

A review of agricultural policies implemented in Lao PDR shows that the government has increasingly emphasized expanded industrialization and monetization, expansion of agro-processing industries, development of integrated agricultural production and agroforestry management, all within competitive market and sustainable production norms. Key policies emphasized by the government for developing the agricultural sector include: the facilitation and strengthening of farmer organizations, providing land concessions and developing contract farming to commercialize agriculture. The reforms have produced a certain degree of structural transformation that resulted in the share of agriculture in GDP to decline over the years, mimicking a key stylized fact of structural transformation. However, agricultural labour as a percentage of total employment has declined at a much slower rate, thus widening the income gap between those in agriculture and other sectors. It implies a rise in relative poverty among farm households at the aggregate level. A higher degree of commercialization is generally observed in provinces with higher levels of income diversification. More farmers in those provinces also practice new agricultural production and cropping systems, adopt intensive farming practices, enhanced mechanization and increased monetization.

Regression models were used to test the independence of crop cultivation and marketing decisions and to identify key factors contributing to farmer decisions on crop cultivation and market participation. Evidence suggests a very high degree of inter-

dependency of cultivation and market entry decisions, confirming that policies to enhance agricultural productivity should simultaneously address market entry barriers to facilitate farmers' market participation. The reverse is also true. Merely promoting policies to increase agricultural productivity without facilitating market entry, or vice versa, is unlikely to facilitate the entry of farm households into commodity markets. The results also suggest that the type of commodity is a factor in determining crop selection and market entry decisions by farmers. In addition, these decisions are influenced by ownership of assets (land and cattle), household demography (age and sex of household head and number of family members), availability of agricultural capital and access to agricultural credit and services including crop and veterinary extension services, road connectivity and electricity, agricultural banks (rice and veterinary), and household-led organizations such as cooperatives and trade groups. Farmers use the best combination of marketing and agricultural information channels available. These results confirm that farmers are highly rational in their choice of crops to cultivate and whether and when to participate in markets. Identifying policies and programmes, and implementing these appropriately, could facilitate agricultural commercialization.

A major challenge before Lao PDR and other developing countries in similar situations is how the potential for growth in agriculture could be utilized for realizing structural transformation and inclusive growth. This requires managing economic growth and transition to realize the convergence of productivity across the agriculture, industry and services sectors.

The report recommends interrelated approaches towards that end. Given that close to three fourths of the people in Lao PDR are involved in agriculture, the Government's push to raise agricultural productivity, beginning in 1986, needs to be accelerated through knowledge-intensive agricultural production systems targeting disadvantaged communities and regions. Raising agricultural productivity alone will not deliver the required growth. Efforts to raise agricultural productivity must be accompanied by policies and programmes to make market participation financially gainful for farmers. Policies and programmes towards this end should include: (a) improving rural road connectivity; (b) provision of community-managed market centres to encourage cooperation among farmers to supply commodities in sufficient volume and in required quality to meet consumer demands; (c) introduction of futures contracts between rural communities and key buyers to guarantee fair and stable prices for producers and an uninterrupted supply of food commodities to consumers; (d) development of processing infrastructure at appropriate locations for fruit and other food commodities when these are in excess supply to stabilize farmers' incomes;

(e) enhancing the outreach and accessibility of agricultural finance; and more importantly, introducing or reintroducing farmer education programmes to improve skills in marketing, negotiation, identification of low-cost transport options and processing agricultural products. Introduction of policies of this nature is likely to enhance the benefits of specialization in agricultural production and minimize market participation costs, creating incentives for farmers to increase agricultural productivity and participate in markets to enhance their welfare.

Successful structural transformation requires enhancing capacities in other sectors of the economy such as industries and services to absorb the labour leaving the agricultural sector. Agribusiness-led industrialization is a real possibility for countries such as Lao PDR for realizing structural transformation. The strategy is likely to suit the current stage of development and the skill set of the largely rural population in Lao PDR. Agribusiness-led – industrialization is likely to address the mismatch in skills between what is available and what is required by modern industry in developing countries. Facilitating the establishment of small-scale agribusiness operations targeting specific products at the provincial or regional level can be an appropriate approach. Farming communities also require technologies and know-how along with low-cost agricultural finance and/or venture capital to set up small-scale agribusinesses. The government can be the final guarantor to facilitate appropriate risk-taking by farmers and financial institutions. As a medium-term policy, the government should promote education to develop the sophisticated skills required by modern industry and services to move into the next phase of the transition.

Development and structural transformation will inevitably result in socioeconomic inequalities. This report has identified groups that are disadvantaged under current conditions, which include: farmers in the upland region, women-headed farm families, and communities in remote rural areas. In the interests of economic efficiency and social justice, the Government will have to take a proactive role in minimizing the marginalization of these groups during the process of transformation through the introduction of new, or strengthening the existing programmes, to ensure that their productive assets are not diminished and that they are better prepared for the transition by being equipped with appropriate skills. In extreme circumstances, the Government will have to provide safety nets.

1. Introduction

1.1 Background

The Istanbul Programme of Action (IPoA) for LDCs for the Decade 2011-2020 stated: “An evidence-based appraisal of the implementation of the Brussels programme of Action for the Least Developed Countries for the Decade 2001-2010 confirms that a more strategic, comprehensive, and sustained approach based on ambitious, focused and realistic commitments is required to bring about structural transformation in least developed countries that fosters accelerated, sustained, inclusive and equitable economic growth and sustainable development and helps least developed countries meet long-standing as well as emerging challenges” (United Nations, 2011, p.7). Agriculture, food security and rural development were given high priority in the IPoA, recognizing the crucial role of agriculture in the LDCs in poverty and hunger eradication, rural development, promoting gender equality and women’s empowerment as well as exports. Inadequate investment in crucial infrastructure, scientific and technological development, research and agricultural extension services were recognized as major challenges. The IPoA also took note of the impact of climate change, environmental degradation, desertification, land and soil degradation, extreme weather events, declining water availability and quality, as additional challenges for the LDCs. The ‘actions’ to be undertaken by the LDCs for agricultural development included, among others:

i. Strengthening institutions, including cooperatives, to boost smallholder farmer food production, agricultural productivity and sustainable agriculture;
ii. Encouraging small farmers and pastoralists to change gradually from low- to high-value production, taking into account specialization, favourable market and infrastructure development conditions as well as improved access to financial and risk management; and
iii. Making rural markets work better for the rural poor by linking small-scale farmers to markets throughout the food chain, including through provision of price and other relevant information, and improving sanitary and phytosanitary services.

The Asia-Pacific Regional Meeting on the Implementation of the IPoA held in Siem Reap, Cambodia on 17-19 December 2012, agreed that Asia-Pacific LDCs had made good

progress in implementing the IPoA with national level action as identified in the Road Map, especially mainstreaming the IPoA into national development plans and strategies and promoting social awareness and participation in the implementation of IPoA (United Nations, 2012). The Siem Reap meeting recognized the need for overcoming structural challenges faced by Asia-Pacific LDCs in order to graduate from LDC status within the decade.

At the 69th Commission Session of ESCAP, the Government of Lao PDR declared its intention of graduating from LDC status by 2020. The Government has recognized the primacy of agricultural development for inclusive growth and sustainable development in key development programmes and strategies including the Seventh Five-Year National Socio-Economic Development Plan (NSEDP 2011-15) and the Agricultural Master Plan 2011-2015 (AMP 2011-15). The AMP 2011-15 identified two primary goals: (a) modernization of agricultural production with a focus on smallholder farming; and (b) conservation of upland ecosystems, ensuring food security and improving rural livelihoods. They are particularly relevant for realizing the objective of graduating from LDC status.

This report focuses on the third action proposed by the Government, namely making rural markets work better for the rural poor by linking small-scale farmers to markets. Accordingly, the report assesses factors inducing farmers to engage in markets and their links to agrarian transformation and inclusive growth. It is hoped that this will contribute to the debate on the importance of enhanced market participation of farm households in promoting sustainable development and structural transformation in developing countries.

1.2 Reasons for undertaking the study

Since 1986, the Lao Government's New Economic Mechanism (NEM) has targeted the Promotion of Commodity Production to support the transformation from subsistence to a market-oriented economy by promoting commercialization of agricultural production. Following the introduction of NEM and subsequent policy interventions in the first decade of the 20th century, the agriculture sector in the country has shown considerable dynamism and high growth. An assessment by MAF (1999) opined that NEM resulted in transforming the Mekong corridor into a market-based system of production and that small-scale subsistence farmers had increasingly integrated into national and regional markets.

Despite progress in some areas, the incidence of poverty is still critically high in rural and remote areas (MPI, 2011). The poverty situation in Lao PDR remain similar to that characterized by the 2006 World Bank Issue Paper on rural and agricultural sector (World Bank, 2006), which noted that poverty in the country had a strong spatial dimension. The

remote mountain regions with poor agricultural conditions such as the central-southern highlands and the northern highlands have the highest incidence of poverty. The Mekong corridor and the northern lowlands with good natural conditions for agriculture have lower poverty rates while the Vientiane Plain where farmers are closer to the Vientiane capital territory has the lowest poverty rates.

A background paper[1] by the Lao PDR National Strategy Team found that villages that had diversified into non-agricultural and value-adding activities were better off, which substantiated the view that income diversification is a fundamental force of income growth in Lao PDR. The paper suggested that the key to reducing poverty is to encourage households to specialize in fewer activities and diversify income away from agricultural production, leading some villages and regions to specialize in selected agricultural commodities. It proposed the need to introduce policies to encourage farmers to move away from risk-averse agricultural production systems to a commercialization strategy that inherently has higher risks but offers larger profits. Access to markets was considered the key to promoting such a strategy.

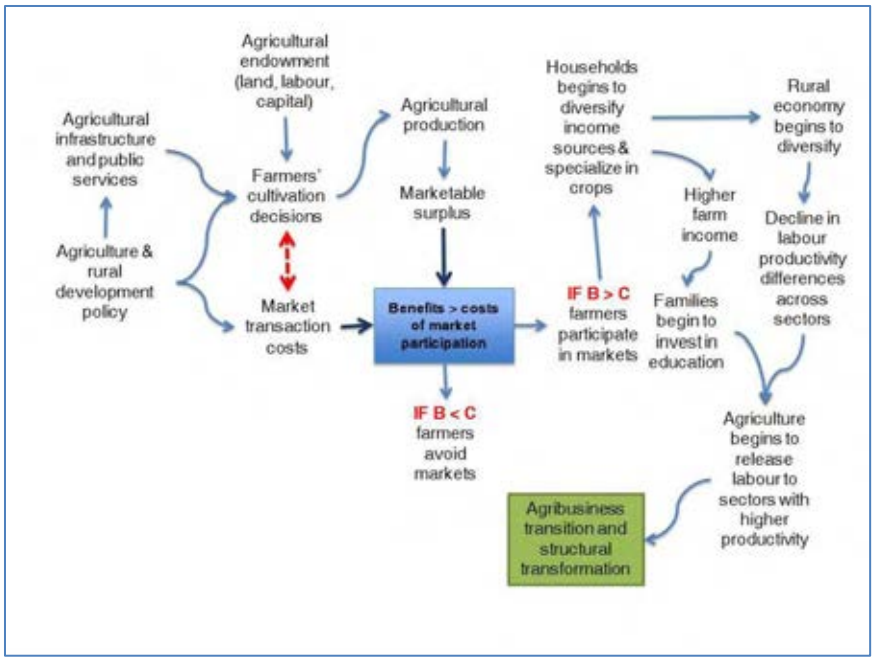
ADB (2013) recognized that Asia's future depends on the way the region manages its structural transformation. This report aims to contribute to this debate through a country-specific case study on the link between market participation of agricultural households, structural transformation and inclusive growth.

1.3 The approach

Commercialization is a key driver of agrarian transformation that can lead to structural transformation of an economy. Agricultural commercialization cannot, therefore, be studied in isolation and must be evaluated within the broad contours of structural transformation including economic, social, institutional and spatial dimension. Developing a structural model to describe the evolution of these factors and their driving forces in a single system is a difficult task. The authors, therefore, approached the issue from a system perspective as described in Figure 1.1. Within this highly complex dynamic system, factors that induce farm households to enter markets are considered the core to structural transformation and development. Based on a literature survey, a coherent explanation is presented to explain why a reduction in market transaction costs is central to structural transformation. The approach presumes the system to move along a development trajectory if the core issue of market transaction costs is addressed effectively.

[1] Agricultural commercialization – A strategic direction for farm families to overcome poverty in Lao PDR.

Figure 1.1 Conceptual framework of the analysis



Source: Authors

1.4 The data

The Lao Census of Agriculture 2010/11 (LCA 2010/11) is the main source of data used in the analysis. The section on structural transformation at aggregate level uses data from other sources.

LCA 2010/11 has collected data at three levels: (i) the village survey, (ii) the household census and (iii) the sample farm household survey[2]. For the analysis, the farm household survey was used as the main anchor, with supplementary information extracted from the village survey and the census. While the census collected farm household information on 1.2 million households in the country, the household survey compiled detailed information on 41,660 farm households across 2,620 villages. The village component collected data on access to public services such as electricity, irrigation, agricultural markets, and transport as well as information on weather, natural disasters and changes in living standards. The household census allowed identification of farm households and recorded information on crops cultivated, livestock, purpose of agricultural

[2] For a complete description of the Lao Census of Agriculture 2010/11, see Lao Census of Agriculture 2010/11 – Highlights, prepared by the Ministry of Agriculture and Forestry (MAF, 2012).

production, and sources of income. The sample farm household questionnaire collected information on land allocation to crops, types of crop cultivated and use of fertilizer and pesticides, ownership and use of household capital equipment, and market participation.

The sample household component used two-stage sampling by selecting villages using the stratified systematic probability proportional to size (PPS) sampling method. The sample of farm households in each sample village is selected through stratified systematic random sampling based on a list of farm households for each village, prepared following the household component of the census.

1.5 Scope and limitations

The main limitation of the data set as far as this analysis is concerned is that it does not include data on sales volumes or values, and household income and expenditure. An attempt to combine data from the survey with the Lao Consumption and Expenditure Survey did not succeed due to difficulties in matching household-level information. However, the LCA 2010/11 data set is rich enough to describe the nature of agriculture, its current state of development, spatial transformation and factors of market participation and structural transformation. The province was used as the unit of analysis, but further disaggregation would make the analysis much richer in its ability to explain structural transformation.

1.6 Organization of report

Section 2 identifies the stylized facts of structural transformation, the role of agriculture and the triggers of farm household participation in markets. This section also explains the mechanics of agrarian transformation that contribute to broad structural transformation in developing countries. Section 3 discusses the nature of structural transformation in Lao PDR, the agricultural policy environment and people's perception of agricultural conditions in the country. Section 4 presents an empirical model and results from a regression model that explains the determinants of farm household decisions on crop cultivation and market participation. Section 5 summarizes the findings.

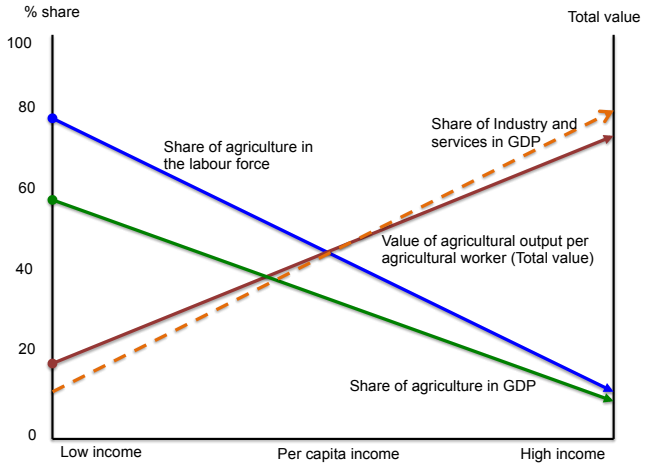
2. Structural Transformation in Developing Countries

2.1 Stylized facts of structural transformation

As documented by Clark (1940), Kuznets (1966), Chenery and Syrquin (1975), Timmer (1988) and Syrquin (2006), from a historical point of view, the rise in per capita incomes across a large group of countries has been fairly uniformly associated with the declining share of agriculture in total output and labour force, and the increasing value of agricultural output per worker accompanied by the rising share of manufacturing and services in output. This involves the replacement of old production processes and institutions with new economic structures and institutions, marked by the shift of labour, capital and other resources to more productive sectors. This leads to sectoral changes in economic composition. Based on historical records of 86 countries, Timmer (2007) concluded that the process was robust with all countries following a variant of basic structural transformation as long as their economies were growing. The share of agricultural employment in total employment, the share of agricultural GDP in total GDP and the difference between these two shares could explain the structural transformation.

A frequently asked question is whether the process of structural transformation is uniform over time, and especially whether non-agricultural sectors in newly emerging countries were able to absorb 'surplus agricultural workers'. This is a key question facing policymakers, especially in countries that managed to industrialize partially but without being able to fully integrate 'surplus' agricultural labour into other sectors. Instead of convergence across sectors in these countries, labour productivities across sectors diverged and agricultural labour productivity was either stagnated or increased at a slower rate, widening the gap over time. This implies that economic growth processes and structural transformation in recent years "has become progressively less successful in integrating low-productive agricultural labour into the rest of the economy" (Timmer, 2007, p. 22). This leads to the question of what policymakers can do to minimize the widening labour productivity gaps to allow the poor and marginalized farmers, 'trapped' in agriculture to realize their full potential, thereby making growth more inclusive.

Figure 2.1 Schematic representation of structural transformation



Source: Modified version of Timmer (2007)

While structural transformation in industrialized countries led to 'surplus agricultural labour' being absorbed by non-agricultural sectors, the Asian region has not been able to do so. This is partly circumstantial, but mostly it is a policy choice. Policy instruments such as agricultural terms of trade have been used in Asia to deliberately 'dampen' the movement of labour out of agriculture (Timmer, 2007). This has been justified on two grounds. First, per capita incomes have increased at faster rates in Asia and, thus, without policy interventions to keep labour in agriculture, the movement of labour out of agriculture would have been too rapid. Second, given that smallholders with meagre resources dominate agriculture in Asia, a rapid movement out of agriculture would have made the movement politically untenable and led to unsustainable urbanization.

Growth in per capita incomes has also been associated with two additional forms of transformation: (i) spatial transition towards increased urbanization, and (ii) institutional transformation from an economy based on informal rules to one based on formal legislation (Brooks, 2012). Spatial transformation is an outcome of growing income and productivity changes inducing rural people to use their resources more efficiently. In the process, some rural households or individuals may move into urban centres, leading to agglomeration of economic activities, which effectively reduces the unit cost of the provision of urban services such as electricity, telephone connectivity, sanitation, education and health care because more people can be served with the same amount of funding for public services. As unit costs decline, greater demand makes it possible for a large number of suppliers to enter

markets, making prices more competitive. Institutional transformation is even more evident and can be manifested in a number of areas including how contracts related to land, labour, credit and marketing arrangements are negotiated and implemented. In remote rural areas, informal arrangements based on tacit understanding take the place of formal contracts in most cases. More formal arrangements begin to emerge with economic growth and market development.

2.2 Role of agriculture in the process of structural transformation

Structural transformation, if spontaneous, is a pathway out of poverty because higher labour productivity and the convergence of agriculture and non-agricultural sectors would allow all to benefit. Because people trapped in low-productive agriculture are known to benefit the most from structural transformation, the process is 'inclusive' in its broadest sense. Several processes are playing a significant role in structural transformation that is relevant for the present study. First, recent advances in agricultural research have hastened the role of agriculture in this process. Advanced knowledge of genetic structures and mechanisms, especially in agricultural biotechnology is likely to push the agricultural productivity frontier dramatically (Naylor and Manning, 2005). This is also likely to contribute to raising the productivity of many secondary crops bypassed by mainstream research, sometimes called 'orphan crops', such as millets, cassava and root crops that provide sustenance to millions (Naylor *et al*., 2004). Social research has offered a much deeper understanding of the determinants of poverty and pathways out of poverty for millions trapped in unproductive agriculture, mostly in marginal lands, in developing countries. Such research has emphasized economic growth as an essential condition for poverty alleviation, but this should not be accompanied by a rapid growth in income inequality (Ravallion and Datt, 1996; Timmer, 2005; World Bank, 2008) and that growth must take place in rural areas (Ravallion, Chen and Sangraula, 2007). Second, vertical integration of agricultural production within larger production and processing systems along with the supermarket revolution has transformed food retail markets and supply chains (Reardon *et al.*, 2003; Reardon and Timmer, 2007) although the strict quality, safety, hygiene and labour standard requirements of supermarkets are a severe constraint to expanding the benefits to a much wider group of farmers, especially smallholders. Third, there is increased demand for food staples such as cereals and vegetable oils, and raw materials, which, if managed effectively, can contribute to revolutionizing agriculture in developing countries. This can make growth more inclusive.

2.3 Triggers and mechanics of transformation in agriculture

This section reviews literature on the nature and role of agriculture in structural transformation in order to understand agrarian transformation, which might lead to develop a coherent theoretical foundation. This is done by slicing the process of transformation into basic building blocks, enabling the separation of fixed factors from policy actions and triggers, and the dynamics of transformation process, if and when such a process begins. Better understanding of triggers and processes of structural transformation can help facilitate making that process faster. The authors have attempted to identify these triggers and processes within the agricultural sector in the initial stages of structural transformation and factors likely to facilitate that transformation. This can assist in unravelling the mechanics of agrarian transformation from pure subsistence to commercial agriculture and finally to a fully functional and integrated market economy where productivity differentials among sectors disappear.

2.3.1 Short-run fixed factors

The authors began by identifying potential fixed factors, or initial conditions that countries are unable to change in the short run. Economic growth and development is inherently linked to factors that can be considered as fixed at any given time for a short or medium term. These can be related to geographical factors such as topography, access to navigable rivers and the sea; natural resources such as land, water, forests, flora and fauna; demographic factors such as population and age structure; and distribution of resources, institutions and culture given social and political structure. These provide the fundamental building blocks for an economy to produce goods and services consumed by its people. The nature of institutions, political structure and culture determine national policies for economic development and their implementation.

2.3.2 Trigger for market production

What are the factors that trigger a farm household to shift from subsistence agriculture to producing for markets and exchanging produce for non-home produced goods? Recent literature has given prominence to reduced transaction costs as a fundamental trigger. The theoretical foundation for the idea comes from the ‘tension’ between benefits of production specialization and the transaction costs of market participation, identified by North (1981) and Wallis and North (1986). Two kinds of costs were seen as inducing/dissuading farm household participation in markets, namely transportation and transaction costs. The former create a price wedge between towns and

the countryside, disadvantaging farmers living at a distance from markets and hindering commercialization (Smith, 1776). Accordingly, "[t]he corn which grows within a mile of the town sells there for the same price with that which comes from twenty mile distance. But the price of the latter must, generally, not only pay the expense of raising it and bringing it to market but afford, too, the ordinary profits of agriculture to the farmers" (Smith, A., Book III Chapter 1). Transaction costs on the other hand, emerge when firms search and gather information, bargain and enforce contracts, keep trade secrets, monitor hired labour and prevent farm thefts (Coase, 1937). According to the theory, firms aim to minimize these transaction costs through internalization. Essentially, an agricultural household is an 'enterprise' that attempts to minimize transaction costs by choosing its optimal production level and buying the rest from the market to keep transaction costs at a minimum. In addition, it seeks to minimize risks arising from the vagaries of the market, environment and seasonality. Thus, operating a farm household is as complex as a modern business enterprise and farm households must consider the costs and benefits of each and every action to survive, not just to make a profit. Depending on the costs and benefits of market participation, a farm household may choose to participate, or stay away from markets. This can explain the existence of various forms of production and marketing arrangements ranging from subsistence to fully integrated markets and all possible arrangements between the two polar cases.[3]

2.3.3 Transformation within the farm household

A significant reduction in transaction costs is likely to lead to a chain reaction within the household, inducing the farm family to reallocate factors of production away from commodities used for self-sufficient production to producing for markets. In the process, the household begins to consume a larger basket of commodities consisting of non-home produced agricultural goods, industrial products and services. The household begins to move away from a strategy of cultivation that allows it to minimize risks to one of specialized production of agricultural products for markets. In the process, the family may choose to reduce the number of plots cultivated and consolidate these into larger units so that new agricultural production techniques can be applied to produce relatively fewer commodities but generate a 'marketable surplus'. At the same time, farmers are likely to diversify from purely crops cultivation to a system comprising a mixture of livestock rearing, processing of agricultural produce and non-farm income-generating activities.

With increasing farm specialization, households begin to use modern agricultural

[3] A mathematical treatment of the issue is presented in Appendix 1.

production techniques such as hybrid varieties, fertilizer and pesticides, and machines. The process is likely to result in further gains in productivity, leading to more specialized farm operations and agricultural processing activities (Wickramasinghe and Weinberger, 2013; Wickramasinghe, 2014). Farm households that are particularly skillful in agriculture begin to invest and move into productive agricultural activities, while those having skills needed by the industrial or services sectors begin to explore alternative livelihoods and consider migrating out of agriculture. The dynamism of the rest of the economy and its capacity to absorb labour leaving agriculture becomes critically important to complete the transformation at this stage.

There is an accompanying increase in the demand for agricultural machinery due to increased specialization of agricultural production along with increased use of skilled labour for certain tasks. Classical economists viewed agriculture as a sector with limited opportunities for the division of labour to take place due to the small size of agricultural markets, the sharp seasonality of production and the inability of agricultural tasks to be subdivided into specialized activities as in industrial processors (Yang *et al*., 2013). Recent research, however, has shown that agricultural labour also moves from less to more specialized tasks (Roumasset and Smith, 1981; Eswaran and Kotwal, 1985; Kikuchi and Hayami, 1999), thus specialization is possible within agriculture. This process is associated with underlying changes in the marginal productivity of regular agricultural activities, managerial tasks, and widening wages of hired and owner-operators (Shaffner, 2001).

This process leads to more fundamental changes within the agrarian economy. The commercialization of agriculture changes the opportunity cost of labour, which affects fertility choice and the composition of family labour (Evenson and Roumasset, 1986) and induces further specialization of labour institutions and human capital accumulation. Modernization and development is also associated with a reduction in the differential between the purchase and sales prices of commodities. This is known to be associated with changes in the opportunity cost of food produced for home consumption, allowing for intensification of production and productivity and greater specialization of agricultural production (Roumasset and Lee, 2007). To facilitate the transition to more market-oriented production, households also begin to use price information for decisions regarding harvesting, processing and marketing. With this change, demand for public and private information channels such as extension services, radio and television, and information and communications technology (ICT) also rises. Farm households begin to use formal financing mechanisms more effectively by participating in village-level funds, microfinance, banks and other financial

intermediaries. Eventually, some farms become agribusiness enterprises and pave the way for an agribusiness transformation.

2.3.4 Transformation within geographical space

The transformation within households generates dynamism in geographical space such as villages, districts and provinces. The transformation becomes manifestly visible when some regions begin to specialize in specific commodities and processing activities. This, in turn, advances the process of streamlining agricultural production and income diversification within households, contributing to a larger output and consumption basket at the aggregate level.

As the transformation progresses, some regions begin to see crop specialization and other changes such as increased average acreage under farm operations along with higher agricultural productivity (Kurosaki, 2003). Some identifiable components of this transformation in geographical space include:

- Reallocation of factors of production, resulting in the decline of differences of labour productivity across the agricultural, industrial and services sectors;
- Production of diversified, higher quality and distinctive agricultural products, supported by the emergence of a strong supplier base and other services, well integrated within the economy; and
- Production of a significant marketable surplus, enabling specific regions to use economies of scale in production and marketing, including through forward contracts.

2.3.5 Transformation outside of agriculture

The industrialized countries went through a distinct agrarian transformation in the initial periods of their development, contributed by several factors. The division of labour as identified by Smith (1776) was perhaps the most fundamental force. He noted that “the greatest improvements in the productive powers of labour….seem to have been the effects of the division of labour” (Book I Chapter 1), and that “it is the power of exchanging that gives rise to the division of labour, so the extent of this division must always be limited by the extent of that power, or, in other words, by the extent of the market.” (Book I, Chapter 3). According to the classical view, a larger market allows greater division of labour as larger markets generate adequate demand for specialized skills and products. Specialization in tasks improves productivity, leading to greater production and supply, effectively enlarging the size of the market.

The second prominent aspect is 'increasing returns to scale' (Young, 1928). Apart from the pursuit of knowledge, economic progress is a result of three fundamental forces: (i) realization of increasing returns through the division of labour and specialization; (ii) the use of machinery in production processes, allowing labour to be used more productively; and (iii) continuous interaction between the market and the division of labour, each supporting the other in an upward spiral. Accordingly, it is the capacity of an economy to utilize increasing returns to scale, not larger operations per se, which determines a country's progress and structural transformation.

The capacity for functional operation of firms, especially purchasing and storing material, transforming it first into semi-finished and then into finished products, storing and selling the output and extending credit to buyers, played a significant role in the emergence of specialized firms and business operations (Stigler, 1951). The decline in the fixed costs of new, intermediate products due to the increased number of final products, intermediate products and transactions (Borland and Yang, 1992; Yang, 2003) also facilitate the specialization and further division of labour.

Fundamental to this change are demand and supply. Growth in agricultural productivity contributes to a general rise in per capita incomes, which, in turn, increases demand for a whole range of commodities, including agricultural, industrial goods, intermediate goods and services. Over time, however, the relative demand for food declines and that for industrial goods and services increases due to differences in the income-elasticity effect. Three additional factors have contributed to a rise in productivity and hence, a shift in aggregate productivity: a rise in capital per worker in agriculture and industry; higher investment in education and skills; and adoption of new production and processing techniques. Productivity growth in the agricultural sector induces 'surplus labour' in agriculture to seek opportunities in the industrial and services sectors, enabling industries to expand production using the availability of a larger pool of human resources.

3. Evolution of Agriculture and Policy Environment in Lao People's Democratic Republic

This section describes the evolution of agriculture in Lao PDR at three levels: (i) agriculture in comparison to other countries; (ii) within-country transformation over the period between 1998-1999 and 2010-2011; and (iii) transformation over geographical space, using the province as the unit of analysis. This chapter also discusses the agricultural policy framework of Lao PDR, using official documents and people's perception of present agricultural conditions.

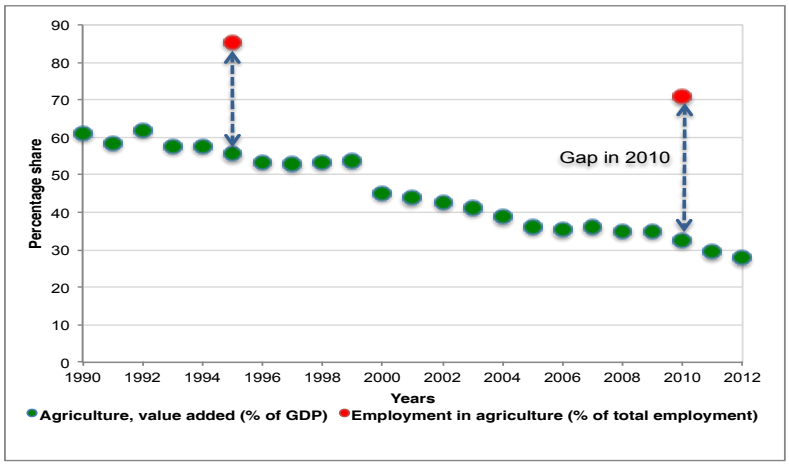
3.1 Evolution of agriculture in Lao PDR

Agriculture dominates a significant proportion of the Lao economy (see Figure 3.1), contributing to around 30 per cent of the GDP and accounting for 70 per cent of total employment. This makes Lao PDR a country with the highest gap between the share of agriculture in GDP and employment in agriculture as a percentage of total employment. Figure 3.1, Panel B shows that Lao PDR is at a stage of low structural transformation in comparison to 72 countries in the world. Between 1995 and 2010, agriculture's contribution to GDP declined from 55 to 32 per cent (23 percentage point decline) but the share of employment declined from over 85 per cent to 71 per cent (14-percentage point decline). This suggests that Lao PDR has experienced not only low growth in agricultural productivity compared to other key sectors, but the gap between farm and non-farm households has deepened. The challenge is, therefore, not just to raise national GDP, but also to increase GDP per capita while implementing policies and programmes to ensure that 'unproductive labour' in agriculture finds opportunities in productive sectors, eventually leading to a convergence of income between the agricultural and non-agricultural sectors.

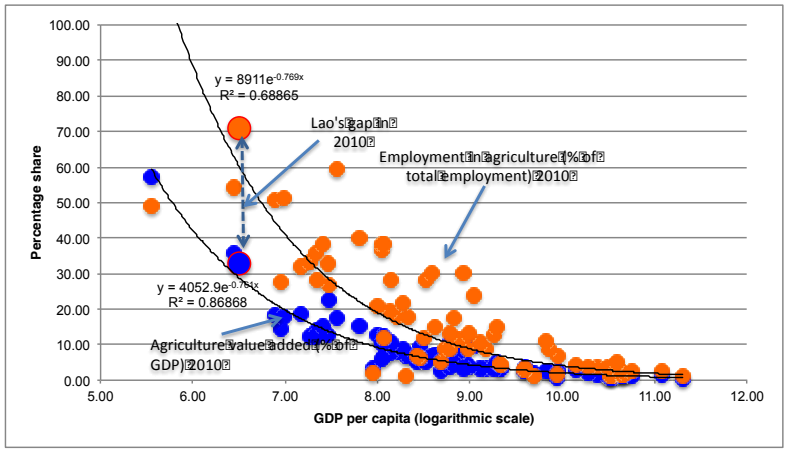
During the 12-year period between 1998-1999 and 2010-2011, the agricultural sector has seen a significant degree of transformation, from one dominated by subsistence farming to becoming more market-oriented. It is observed that the purpose of farming, as indicated by households, has shifted dramatically towards commercial production. For example, while in 1998-1999 only 6 per cent households indicated 'for selling' as the main purpose of farming, but in 2010-2011 30 per cent farming households mentioned that they produce for the market. The proportion of households that sold some portion of their produce had increased from 30 per cent in 1998-1999 to 71 per cent in 2010-2011.

Figure 3.1 Evolution of agriculture in Lao PDR

A: Over time (1990 and 2012)



B: In the spatial context (2010)



Source: Authors, based on World Bank (2014)

During the same period, significant changes are observed in a number of areas that signal a movement towards increased commercialization of agriculture. Land ownership increased and farm households owning less than 1 ha of land declined from 36 to 22 per cent; the proportion of those owning 1-2 ha of land also declined from 36 to 32 per cent, but those with more than 2 ha increased from 27 to 46 per cent. This translated into a rise in the average land ownership from 0.77 to 0.90 ha during the period. Farm households growing vegetables increased marginally from 29 to 31 per cent of total households, while those

cultivating cassava declined from 8 to 4 per cent of total households. During the same period, the area under rubber plantations grew to 40,000 ha (0.3 per cent of total agricultural land), and the total agricultural land area increased from 976,000 to 1,623,000 ha. The area under temporary crops declined marginally but that under permanent crops increased from 8 to 10 per cent of total land area, signalling a shift in crop choice among farm households.

There were also major changes in the use of farm machinery with ownership of two-wheeled tractors increasing from 7 to 34 per cent of all households between 1998-1999 and 2010-2011. Likewise, the hiring of labour by farm households jumped from 26 to 45 per cent of total households and farm households working off-farm increased from 24 to 40 per cent of total households. Agriculture has also become more input-intensive. During the same period, for all agricultural households, input use has increased in chemical fertilizer from 29 to 42 per cent, in organic fertilizer from 34 to 41 per cent, and in pesticides from 11 to 17 per cent.

During the reference period, the number of farm households increased from 668,000 to 783,000, recording a 17 per cent growth. However, the percentage share of farm households in total households declined from 83 to 76 per cent. The total area under agriculture increased from 976,00 ha to 1.62 million hectares, an increase of 647,000 ha; the area under permanent crops doubled to 168,000 ha and under temporary crops increased by about 60 per cent to reach 1.23 million hectares.

In 2010-2011, an estimated 724,000 (71 per cent) farm households cultivated lowland rice in the wet season and accounted for an estimated 75 per cent of agricultural production. Rice production has risen continuously over the last quarter of a century from about 1.5 million tons in 1990 to over 3 million tons in 2010. Crop production has increased significantly since 2005. During the two intervening periods, crop choices have shifted slightly from rice to other crops. For example, while 77 per cent households cultivated rice in 1998-1999, it dropped to 71 per cent in 2010-2011.

Maize, soybean, coffee, cassava, peanut and tea are the other main crops; and roots and tubers, tobacco, sugar cane, legumes and cotton are produced in smaller quantities. The area under maize increased five-fold to 134,500 ha, cultivated by 187,300 farm households during the same period. The jump in maize production from 372,500 tons in 2005 to over a million tons in 2010 can be attributed mainly to productivity growth rather than area expansion. Maize production increased from 30,000 tons in 1995 to 1.2 million tons in 2010 while yield more than doubled from 1.73 to 4.8 tons per hectare.

The rapid expansion in commercial crop production has had an impact on both the local economy and the environment. Maize has not only replaced home gardens, chili and

fruit tree plantations, but also expanded into forest and areas that were kept fallow. Maize cultivation has expanded significantly because of the increased income of farmers, high labour productivity, ease of cultivation, the minimum requirement of technical knowledge for cultivation and low risk and tax concessions offered by the government. In some areas, this has created food shortages and led to the disappearance of traditional livelihoods that, according to some, has contributed to social instability and environmental degradation, especially soil erosion and loss of biodiversity. The demand for maize has been very high, especially from neighbouring countries such as Thailand, Viet Nam and China, primarily for use by the livestock industry. The proximity to markets in neighbouring countries for sales of their produce and purchase of inputs also encouraged farmers, especially in the border provinces, to cultivate maize.

3.2 Emerging agricultural systems

The agrarian transformation has been accompanied by the emergence of four new cropping systems with identifiable salient features (Southavilay, 2013).

Fixed Rotational Cropping (FRC): This is emerging as the dominant non-traditional agricultural production system throughout the northern uplands with the cultivation of numerous cash crops, including maize, cassava, Job's tears, ginger, sesame and beans. The emergence of the FRC is often attributed to the Land and Forest Allocation Program (LFAP) that introduced land zoning and restrictions for accessing fallow lands under traditional systems. This has effectively eliminated fallow periods, which is now identified as a cause for soil erosion and for farm yields to decline over time, further aggravating soil erosion. Fixed rotation has also resulted in higher weed infestation and high incidence of insect and crop diseases, requiring greater use of labour and pesticides.

Modern rice-based farming: This is characterized by the use of high yielding varieties along with mechanized ploughing, chemical fertilizer, insecticides and pesticides. Households with larger land plots tend to use this system more than smallholders, with a higher degree of specialization.

Monoculture cash cropping: This is increasingly being used by farmers in many areas to cultivate maize and banana in place of rice cultivation, and it has also begun to encroach on forest areas. Monoculture is also practised with a relatively high use of hybrid varieties, fertilizer and pesticides, burning of crop residues for land preparation and ploughing on steep slopes, which is believed to aggravate soil degradation and nutrient loss. Thus, the system as a whole is unlikely to yield higher productivity over time.

Industrial plantations: By 2012, rubber plantations had been established in more than 300,000 ha (MAF, 2012). About 75 per cent of the plantations are cultivated under concessional arrangements, especially using fallow lands. However, farmers have encroached natural forest areas, and contributed to food insecurity due to lack of incomes until new plantations generate income.

3.3 Evolution of agriculture in Lao PDR over geographical space

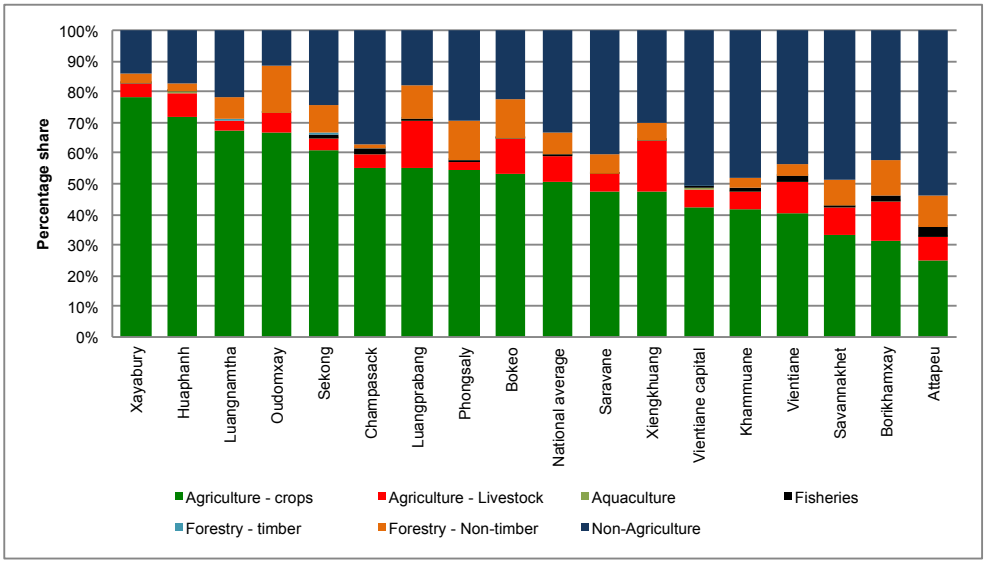
Structural transformation is usually seen as occurring over time, but its characteristics can be observed over geographical space – villages, districts and provinces or larger regions. This is because locations with better market linkages, for example, having access to navigable waterways or having benefited from development interventions, tend to undergo economic transformation faster. The analysis below uses provinces as the unit of analysis.

3.3.1 Agriculture as the main source of income

Figure 3.2 shows the sources of income across the 17 provinces of Lao PDR based on data collected by the LCA 2010/11. It shows that agriculture remains the main source of income for 60 per cent of households at the national level, but varies from 90 per cent in Oudomxay to 46 per cent in Attapeu, with roughly half the provinces above the national average. If only crop cultivation is taken into account without livestock, the national average of households depending on agriculture drops to 50 per cent. Households in some provinces have a very high level of reliance on crop cultivation (both rice and other crops) for income, with livestock contributing very little. Households in Xayabury have the highest dependency on crops with 78 per cent families earning income from crop cultivation. Attapeu is on the other side of the spectrum with only 24 per cent of household income generated from crops. Livestock rearing is the second largest agriculture-related source of income. It is the main livelihood of only 8 per cent of households, followed by non-timber forestry with 7 per cent of households depending on it. Fisheries and aquaculture also contribute marginally to household incomes. The share of agriculture[4] in total household income is significantly lower in some provinces than others, signifying a greater degree of structural transformation.

[4] Agricultural activities include cultivation of crops, livestock rearing, forestry (non-timber), forestry (timber), fisheries and aquaculture.

Figure 3.2 Sources of household income by province



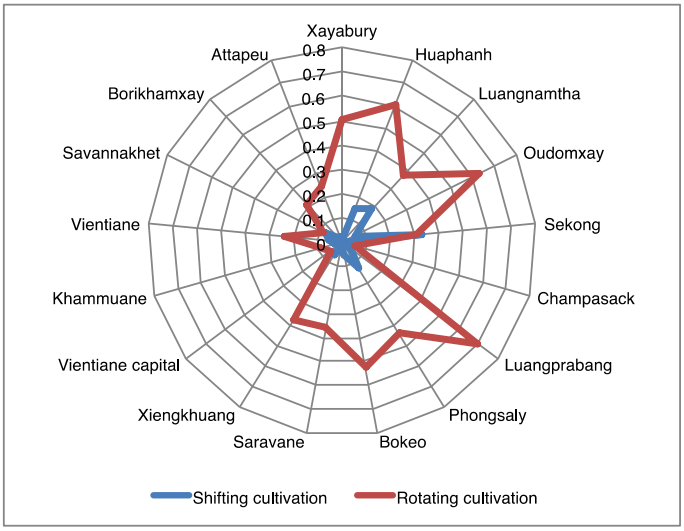
Source: Authors, based on LCA 2010/11

3.3.2 Emergence of modern agricultural practices

Figure 3.3 arranges provinces according to their respective levels of crop diversification as observed earlier, which allows identifying the potential link between agricultural practices and structural transformation across provinces. As can be seen from Figure 3.3, a smaller percentage of households practise shifting cultivation[5] and a larger proportion across several provinces practise rotating cultivation. Although this report does not compare these practices over time across provinces, shifting cultivation is known to have been widespread in many provinces in the past. It is noted that shifting and rotating cultivation practices decline with greater income diversification, with the exceptions of Sekong and Champasack. Over 10 per cent of households practise shifting cultivation in four provinces. It would be particularly useful to examine if the high prevalence of rotation agriculture in some provinces is associated with agricultural intensification, especially increased use of fertilizer and pesticides, and if so, its potential impact on the sustainability of agrarian systems.

[5] Rotating cultivation refers to the planting of a series of different types of crops in the same area in sequence. Shifting cultivation refers to clearing and cultivating a plot of land temporarily, then abandoning it to allow it to revert to its natural state, while the cultivator moves on to another plot.

Figure 3.3 Spread of agricultural practices

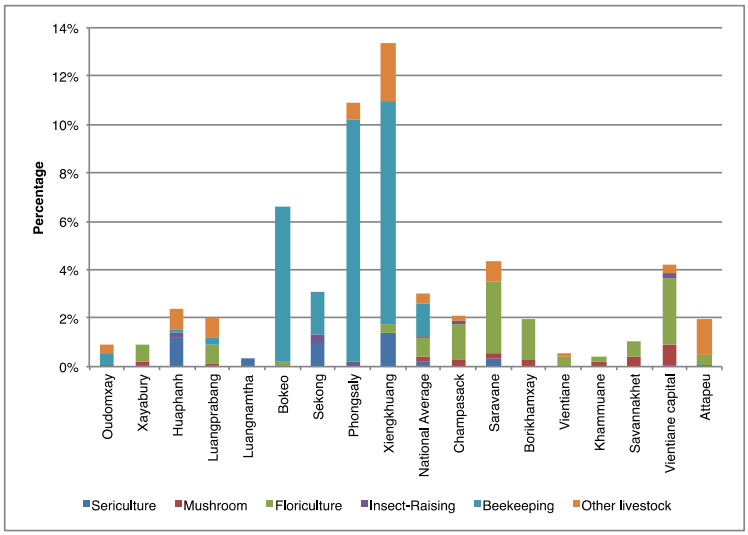


Source: Authors, based on LCA 2010/11

3.3.3 Crop diversification

Households in some provinces are observed having higher rates of crop diversification and producing more value added products (see Figure 3.4). About 3 per cent of agricultural households are engaged in specialized agricultural activities, namely sericulture, mushroom cultivation, insect raising and beekeeping. Beekeeping is practised by a relatively large group of households in Bokeo, Phongsaly and Xiangkhuang. Specialized and high value added activities, such as floriculture and mushroom cultivation are carried out in provinces where crop cultivation and livestock are not the primary source of household income such as Saravane and Vientiane capital. It appears that more farm households are engaged in specialized activities in provinces where agriculture is no longer the main source of income.

Figure 3.4 Specialized agricultural activities



Source: Authors, based on LCA 2010/11

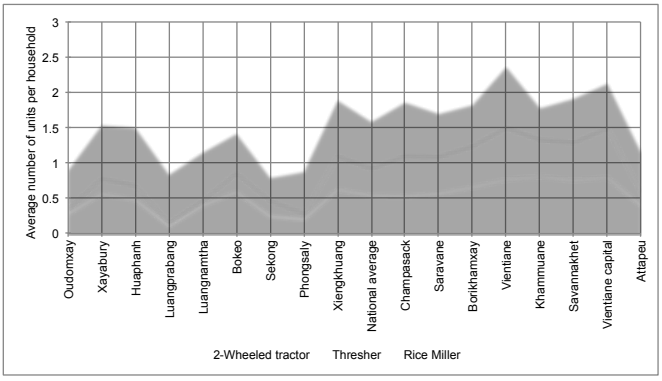
3.3.4 Agricultural mechanization and emergence of intensive agriculture

It is also observed that a relatively higher percentage of households in some provinces make more use of agricultural machinery, fertilizer and pesticides than others. Panel A of Figure 3.5 shows the use of three out of 18 capital equipment items – two-wheeled tractors, threshers and rice millers; Panel B shows the use of machinery, planting devices, and processors; and Panel C shows the use of fertilizer and pesticides. The use of agricultural machinery is relatively high in provinces where a larger share of income is non-agriculture. The use of fertilizer and pesticides is also high in those provinces, although not at the same level as the use of machines in agriculture.

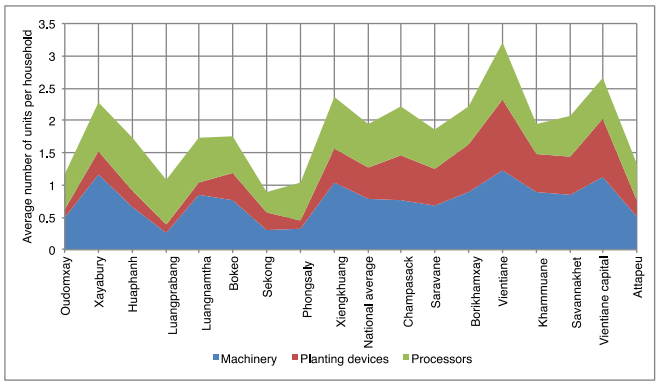
On average, nationwide, 31 and 28 per cent of farm households use organic and chemical fertilizer, respectively, and 18 per cent use pesticide. In comparison, the use of these inputs is around 60 per cent in Attapeu, Vientiane capital, Savannakhet, Khammuane, Sarvane, Champasack and Xienghuang. Although input use is not consistently high across all provinces with a higher degree of income diversification, it is paradoxically where agriculture is no longer the dominant source of income. This may mean that the practice of intensive agriculture is associated with income diversification.

Figure 3.5 Use of agricultural capital and inputs

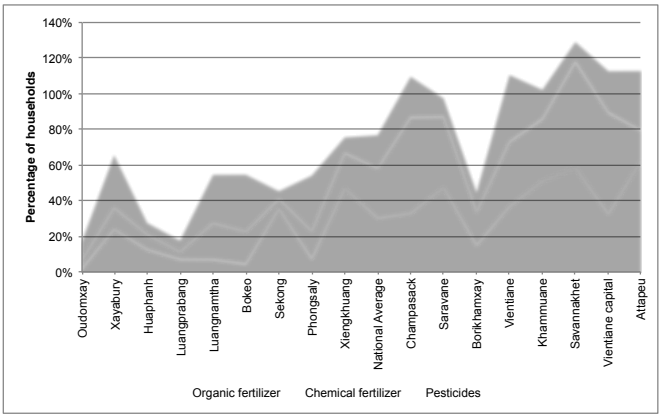
Panel A: Agricultural machinery



Panel B: Machinery, planting devices and processors



Panel C: Fertilizer and pesticides use

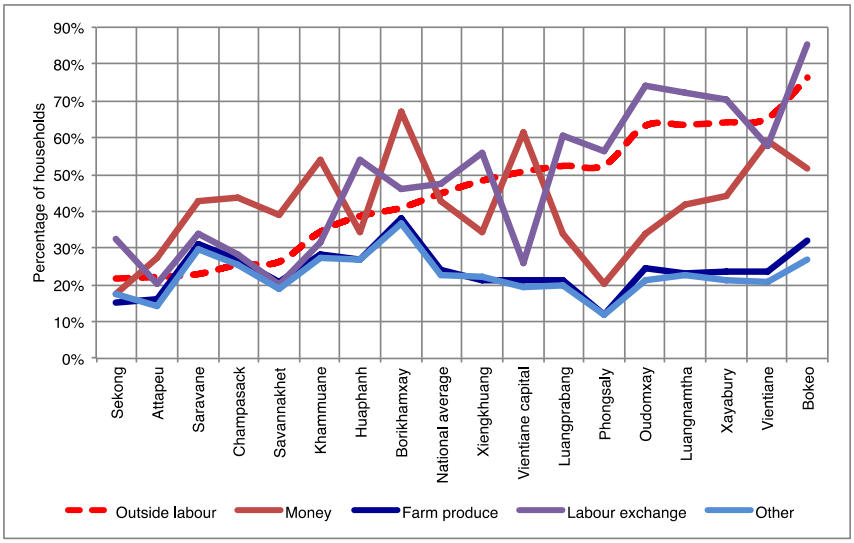


Source: Authors, based on LCA 2010/11

3.3.5 Hired labour use and monetization

Although the use of outside labour by farm households ranges from 20 per cent of households in Sekong to 76 per cent in Bokeo (see Figure 3.6), an identifiable association is not observed between the use of hired labour and the degree of income diversification. By arranging provinces from low to high use of hired labour, we find that use of hired labour has some association with monetization. The use of exchange labour, however, remains high even when hired labour is intensively used.

Figure 3.6 Evolution of labour markets



Source: Authors, based on LCA 2010/11

3.4 Agricultural policy environment

3.4.1 Government agricultural policies

Agricultural development in Lao PDR in recent years has been guided by several key policy documents, including the Political Report to the 9th Party Congress 2010-2015, the NSDEP 2010-2015 and the Agricultural Master Plan 2011-2015 (AMP 2011-2015) (MAF, 2010). The Political Report to the 9th Party Congress introduced in March 2010 marked a departure for agricultural development policy by emphasizing: (a) the need for a new policy direction, leading to increased industrialization and modernization; (b) priority to expansion of agro-processing; and (c) the development of integrated agricultural production and agroforestry management to ensure food security, preservation and rehabilitation of forests,

with the allocation of forest areas to enable villagers to earn a living from forests. Private businesses were encouraged to collaborate with local communities in tree plantation to promote climate change adaptation and mitigation. It was thus a highly forward-looking policy directive. It also promoted foreign direct investment (FDI) in rural development through the provision of agriculture land concessions for cultivating rubber, cassava, eucalyptus and biofuel crops in areas that have been encroached for mining and hydropower development and/or used by rural communities for shifting cultivation.

While the first five NSEDPs emphasized the transformation of agricultural production to meet the national demand for rice, the 6th NSEDP 2006-2010 shifted focus from rice production to the introduction of innovative technologies for the cultivation and processing of high-value crops, and supplying these to domestic and international markets. The NSEDP 2011-2015 aimed to modernize agriculture, improving productivity and product quality through diversification to meet national food security and rural livelihood needs. The policy also paid a particular attention to the sustainability of agricultural systems and forests through sustainable management of natural resources and land.

To achieve the aims of the NSEDP 2011-15, MAF formulated an Agricultural Development Strategy for the period 2011-2020 (ADS 2011-2020). It aimed to preserve biodiversity, essential for the quantity and quality of forests that provide valuable environmental services and benefits to rural communities and enterprises, and conserve upland ecosystems to ensure food security and improve rural livelihoods. The ADS 2011-2020 is the key reference that provides the direction for the government and development partners for supporting the agricultural sector as well as national resources and rural development. The MAF has identified the following four main goals under the ADS 2011-2020: (i) livelihood improvement through agriculture and livestock development; (ii) increased and modernized agricultural production while ensuring the sustainability of production and stabilization of shifting cultivation; (iii) enhanced national capacity to cope with changing climatic conditions; and (iv) sustainable forest management. The AMP 2011-2015 proposed specific interventions to realize the four goals contained in the ADS 2011-2020.

The AMP 2011-2015 proposed activities under eight programmes for realizing its main goals: food security; commodity production and farm organizations; sustainable production patterns, land allocation and rural development; forest development; promotion of irrigation; development of agriculture and forestry infrastructure; agriculture and forestry research extension; and human resource development. The Agricultural Investment Plan

(AIP) 2011-2015 primarily facilitates the implementation of AMP 2011-2015 through private investment, official development assistance (ODA) and foreign direct investment (FDI).

3.4.2 Policies for inducing a new agricultural production system

The three main policies that influenced the emergence of the new agricultural system of commercial crop production include: the promotion of farmer organizations, land concessions and contract farming (Southavilay, 2013).

Farmer organizations: Farmer organizations were promoted as a part of the ADS 2011-2020 and under the 6th of NSEDP to facilitate marketing through strengthened bargaining power of farmers, enhanced economies of scale in production, and marketing and local value-addition. Government policies also encouraged private enterprise, foreign business and traders to invest in agribusiness through farmer groups rather than seeking land concessions. Case studies on farmer organizations in some provinces such as Bokeo suggest these policies have been instrumental in inducing farmers to engage in commercial production (Southavilay, 2013). It is also observed that farmer groups are yet to be fully integrated into the private sector and government programmes, and that farmer organizations face financial difficulties and unable to utilize their bargaining power.

Land concessions: Land concessions refer to arrangements where local and foreign enterprises are granted lease of a large area of land for commercial cash crop production, primarily rubber and eucalyptus. Under the scheme, land parcels of over 1,000 ha have been granted in the Northern provinces (MAF, 2010b). This has, however, resulted in limitations on farmers' ability to use forests as a source of livelihood.

Contract farming: The '2+3 model' is the most widely used approach for contract farming where farmers provide the land and labour to cultivate crops and commercial enterprises invest in land through technology transfer and promoting access to markets. Local authorities play an important role in the facilitation and management of such contracts and concessions (NAFRI, 2007). The involvement of extension agents has ensured the continuity of long-term technical assistance. Local authorities have convinced farmers to participate in contract farming to stabilize shifting cultivation and alleviate poverty. The 'rubber boom' and the rise of maize production are often viewed as outcomes of this policy.

Policy contradictions have, however, been recognized as having negative impact on commercialization and agricultural development. First, the introduction of commercial crops through land concessions in the northern province has affected food security of communities with limited land ownership (Setboonsarng, 2006) and who lost their access to forests (NAFRI, 2007). Second, the commercialization of agriculture has had a negative

impact on the government's overall objective of promoting sustainable forest management and increasing forest cover to 70 per cent of total land area by 2020. Third, meeting the government's rice production target is expected to increase the rice cultivation area by 124,000 hectares, which is likely to limit land for other activities such as reforestation and commercial crop cultivation.

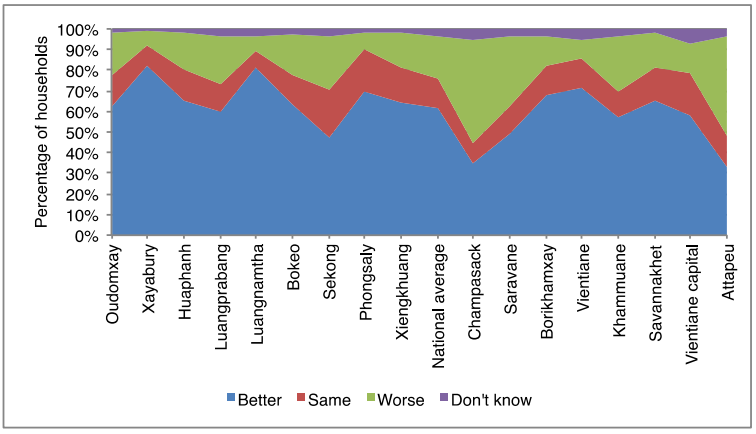
3.5 People's perception of agricultural sector performance

A country may achieve higher growth with a rise in income inequality. Alternatively, growth may be slow, but people may feel that the process has been inclusive and income distribution is fair. People's perception of economic performance is an important indicator of inclusiveness. The sample household survey assessed household perception of agricultural conditions in the preceding 12 months and 3 years compared to the situation 10 years ago. Provincial level results are summarized in Figure 3.7 and data provide insights on farm households' perception of the inclusiveness of the growth process. At the national level, 60 per cent of households indicated that agricultural conditions in the last 12 months were better than 10 years ago, 14 per cent felt there was no change and 20 per cent thought the situation had worsened. When comparing agricultural conditions in the last 3 years to those 10 years ago, 62, 16 and 15 per cent of households, respectively, felt these had improved, not changed or worsened.

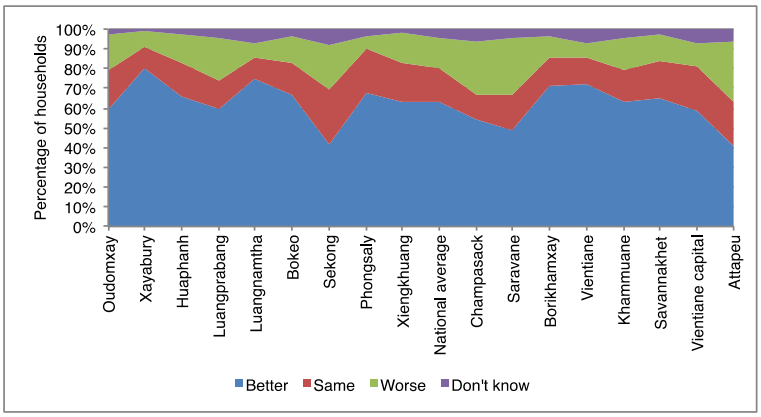
When provinces are ranked by the level of dependency on agriculture for income, it is found that households in provinces with high agricultural dependency, for example Xayabury and Luannamtha, think that agricultural conditions have improved over the last 10 years. But the majority of agricultural households in provinces where dependency on agriculture is low tend to think the conditions have not improved or in some cases, such as in Attapeu, worsened. The initial conditions and the progress in agriculture in respective provinces appear to have contributed to this result.

Figure 3.7 Farmers' perception of agricultural conditions

Panel A: During the last 12 months



Panel B: During the last 3 years



Source: Authors, based on LCA 2010/11

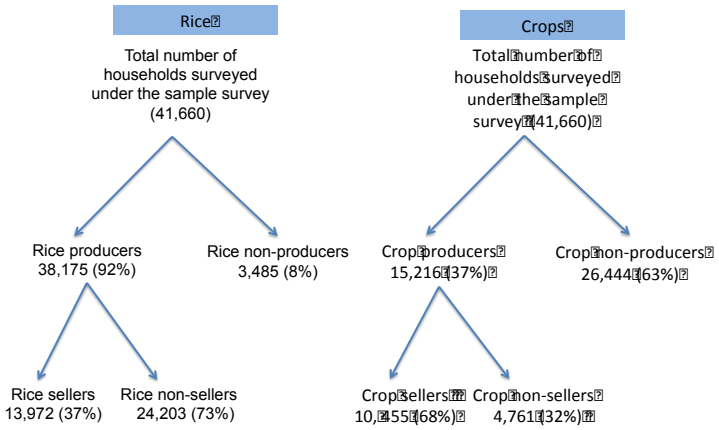
4. Determinants of Farmers' Cultivation and Market Entry Choices

This section first analyses land allocation and crop choices of farm households in order to develop a broader understanding of the agricultural landscape in Lao PDR, followed by a discussion on econometric estimates that describe farmers' cultivation and market entry choices.

4.1 Farmers' crop choices

Data show that 92 per cent of households cultivate rice, and of these 37 per cent sell rice, but 37 per cent households cultivate other crops and 68 per cent of them sell other crops (see Figure 4.1). What this means is that rice and other crops are markedly different commodities in terms of cultivation and market participation.

Figure 4.1 Farmers' cultivation and sales choices



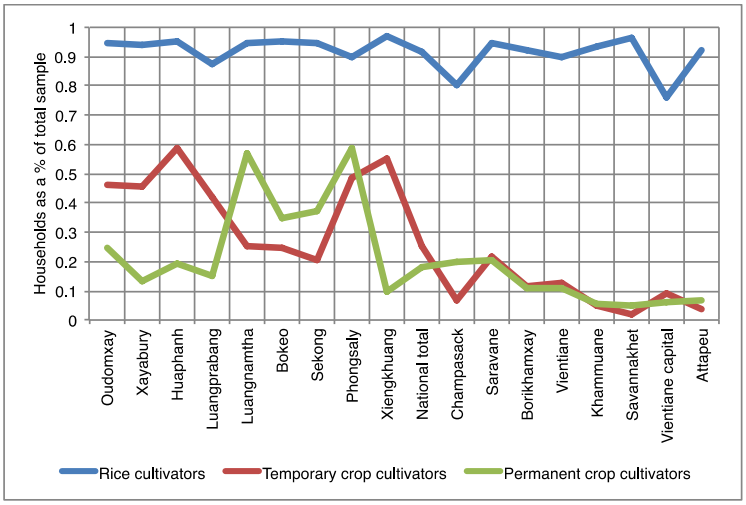
Source: Authors, based on LCA 2010/11

Figure 4.2 shows the proportion of households that cultivate rice, temporary crops and permanent crops during the wet season, and those selling rice and other crops, all as a percentage of the total sample. As before, provinces are ordered according to the level of income diversification. It can be observed that the proportion of farm families cultivating rice is high across all provinces, but the proportion of households cultivating temporary crops and permanent crops during the wet season is lower in provinces where there is a high

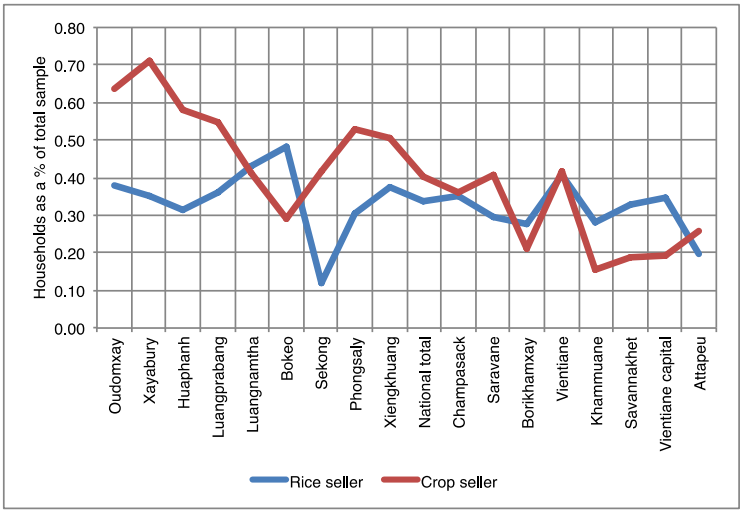
degree of income diversification. Similarly, the proportion of households selling rice and other crops is low in provinces where there is higher income diversification. Rice appears to be a special commodity in Lao PDR, where households cultivate rice regardless of their source of income. Other crops, however, are cultivated and traded primarily to earn income.

Figure 4.2 Proportion of households in cultivation and sales

A: Cultivators



B: Sellers



Source: Authors, based on LCA 2010/11

The way farmers allocate their land among crops is a reliable indicator of crop preferences. Out of all household-operated lands in the wet season, 51 per cent of land is allocated to rice, 10 per cent to other temporary crops such as roots and tubers, legumes, vegetables, oil crops, sugar and fodder; and 9 per cent to permanent crops such as fruits and nuts. Uncultivated lands are either left fallow or used for grazing, forests and other purposes.

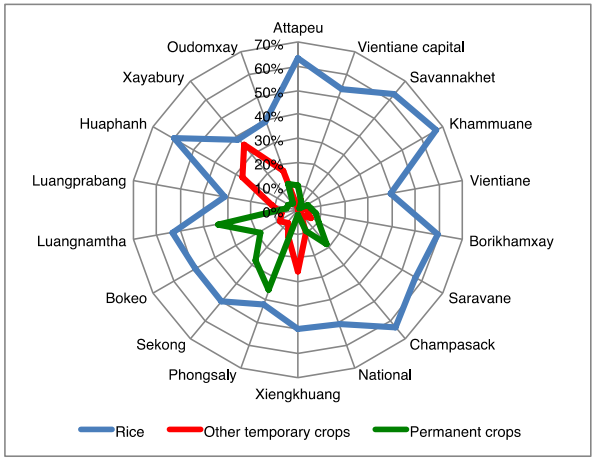
Rice is the preferred crop cultivated during the wet season; during the dry season, however, rice cultivation drops to a very low level but other crops are cultivated more or less at the same levels that other crops are cultivated during the dry season. During the wet season, 91 per cent of households in the country cultivate rice, but only 10 per cent cultivate it in the dry season. About 30 per cent of farm households cultivate other crops in the wet season and 11 per cent in the dry season. Non-rice crops cultivated by farm households include: vegetables (13 per cent), oil crops (5 per cent), roots and tubers (4 per cent), and legumes, sugar and fodder (nearly 1 per cent). Of the total sample, 11 per cent households cultivated cash crops while 6 per cent households cultivated fruits and less than 1 per cent nut farming and horticulture.

The distribution of rice cultivation across provinces suggests a paradoxical outcome with a relatively higher proportion of farm households tending to cultivate rice in provinces with higher income diversification (see Figure 4.3). For example, over 60 per cent of household land is allocated for rice in Attapeu, Savannakhet and Khammuane, but in provinces such as Phongsaly and Luangprabang, this share drops to 30 per cent. The reduction in the proportion of households cultivating rice in the dry season compared to the wet season is 80 percentage points, but for other crops, this reduction is only 20 percentage points.

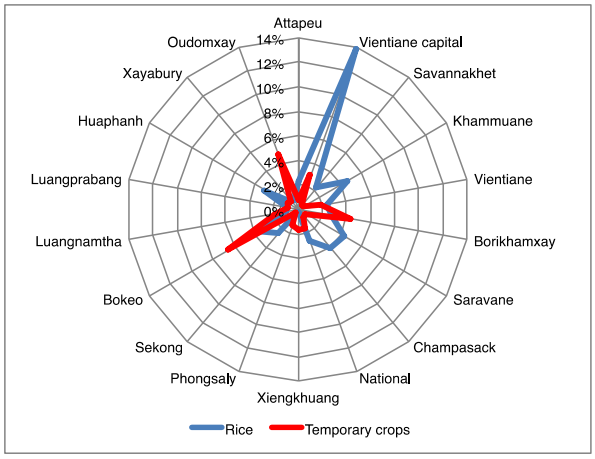
This general pattern is different, however, in Vientiane capital and some other provinces such as Xayabury, Xienghuang, Phongsaly and Luangnamtha where other crops continue to be cultivated by a relatively higher percentage of farmers.

Figure 4.3 Farmers' land allocation

A: Wet season temporary and permanent crops



B: Dry season temporary crops



Source: Authors, based on LCA 2010/11

4.2 The empirical model and the results

A structural model was constructed where market entry and cultivation choices are considered interdependent to identify farmers' crop cultivation and market entry decision[6]. Information on whether a farm household sold its produce is available for rice, other crops and livestock only at aggregate level, and that too, was limited to whether households sold them or not, but not sales values or volumes. Thus, the analysis was restricted to binary

[6] See Appendix 2 for a detailed description of the model structure used in the report.

outcome models. In addition to the rice and other crop models using the overall data set, two additional models were estimated for rice and other crops: (i) by aggregating provinces into three categories based on the level of income diversification; and (ii) by environmental zones – lowland, upland and plateau[7]. Altogether, 15 models, each on sales and production, were estimated. Their results are presented in Appendix 2. The model was estimated using *treatreg* in STATA, which specifically allows estimating models with binary endogenous variables.

Several groups of variables were used in the models as independent variables: household demographic characteristics, land and capital owned by farm households, access to inputs and input markets, production risks, village marketing infrastructure and marketing channels, public agricultural services such as extension and information services, and access to finance. Household characteristics include the gender and age of the household head (HH) and the number of adults in the family. Household assets include land owned by the family, number of land parcels, land area with irrigation and improvements, number of cattle and agricultural equipment owned. Based on research elsewhere, it is assumed that farm households tend to use mechanized equipment as commercialization progresses. To account for this possibility, agricultural equipment was classified into machinery (tractors), planting equipment and processing equipment. These three categories are expected to serve as an approximation for the orientation towards mechanization, which is expected to increase with structural transformation. Agricultural reforms in Lao PDR have emphasized the development of the marketing infrastructure and the strengthening of marketing channels. Given this focus, the models specifically considered the available marketing infrastructure and channels. A number of variables were considered to gauge the

[7] Lao PDR consists of three primary agroecological zones: lowland, upland and plateau. The lowland comprises the floodplains of the Mekong River and its tributaries and covers about 20 per cent of the land area. The region generally has a tropical wet and dry climate, receiving highly seasonal rainfall, ranging from 1,300 to 1,700 mm, mostly from May to September, with a dry and warm spell in April. The area is mostly used for rain-fed rice cultivation but also considered suitable for crop varieties given the favourable soil conditions. There is a distinct crop calendar similar to wet cropping systems in Asia with integrated crop-livestock cultivation. The highlands are the mountainous lands ranging in altitude between 1,100 and 3,000 m above sea level and located mostly in the north and a narrow land strip bordering Viet Nam in the south. Farmers still practice slash-and-burn agriculture but the system is no longer considered sustainable due to the growing population and government restrictions on clearing new forest land for cultivation. Rice and maize are the main upland crops, combined with roots and tubers. Poor roads and communications limit market access for agricultural produce. This has kept farming close to subsistence levels with little to no agricultural surplus produced by farm households. The plateau lies between the lowland and upland, located between 800 m and 1,300 m above sea level. The vegetation mostly consists of savannah forests and grasslands. Coffee is cultivated in the area, but most agriculture is slash-and-burn. Cattle are a source of cash income while other livestock such as poultry are mainly used for family consumption. The cropping systems in the three main agro-ecological regions imply a high prevalence of cultivation and market participation of farm households in the lowland region but relatively less in the upland and plateau.

impact of marketing infrastructure including whether the village has a permanent market, shops/services, food store, trade group and cooperative society. Also included were marketing channels used by farmers, such as sale through contract farming, directly to companies, directly to traders in the village, directly to traders in other villages, in the village market and in other ways. To determine whether access to information and communications technology were significant in explaining market entry, the paper uses a dummy for price information. Whether the household has access to all-season roads was used as an approximation to gauge the transaction cost environment.

4.2.1 Linkages between cultivation and market entry decisions

The model was constructed on the premise that cultivation and market participation decisions are endogenous. If this is the case, *rho*, (i.e. correlation coefficient between the random errors of the two equations) should be expected to be statistically significant. It is found that the estimated *rho* values are significant at the 0.01 probability across all models, with the exception of one model. Therefore, the null hypothesis $H_0: \rho = 0$ at the 0.01 probability is rejected, which implies that the unmeasured factors that make farm households more likely to cultivate a selected commodity, also make the household more likely to enter markets as sellers, conditional on factors considered in the model. In other words, farm cultivation and sales decisions are interrelated.

The implication of this finding is that public policies to facilitate farmer market participation should also aim to enhance agricultural productivity because farmers can participate in markets only if they can produce a marketable surplus. Merely promoting agricultural productivity without facilitating access to markets, or solely facilitating market entry without facilitating agricultural productivity is not sufficient. Policies should simultaneously enhance productivity and market entry. Policies must also address critical constraints within a given development, agroecological and socio-political context to enable farm households to make optimal production and sales decisions, given their special circumstances such as land ownership, family size, skills and the costs and benefits of market participation.

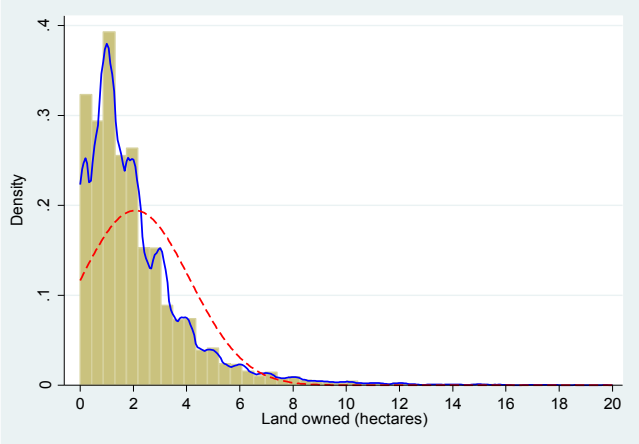
4.2.2 Access to land

The estimated models for rice and other crops confirm that land owned, land irrigated (in cultivation model) and the number of cattle owned (in both cultivation and market entry models) is significant at the 0.01 probability. Land ownership is widespread in

Lao PDR with 93 per cent of households owning land. The average landholding[8] is 2.2 ha. However, the national and provincial averages hide significant differences in land ownership (see Figure 4.4). However, a large proportion of households identified limited access to land as a key constraint to agricultural production. The cumulative density function shows that 60 per cent of households own less than 2 ha of land, which is the standard definition of a smallholder. The issue needs further analysis given that econometric estimates suggest that land is not significant in model but households indicating the opposite. It is noted that 8 per cent of households rented land for agricultural purposes and that the average rented size was 1.6 ha. Approximately 1 per cent of rented land is under share contracts with an average parcel size of 1.1 ha[9].

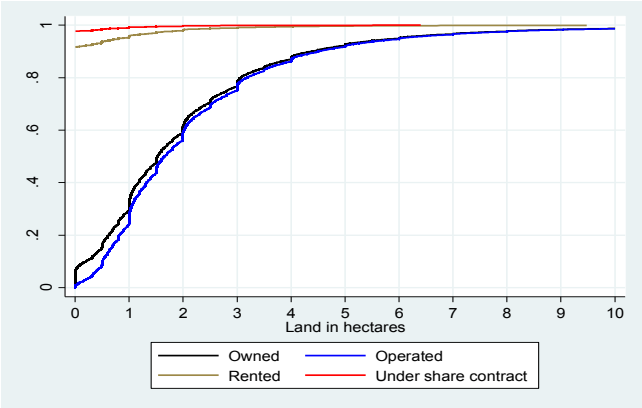
Figure 4.4 Land accessibility

Panel A: Histogram of land ownership



[8] Households not owning land are excluded in the calculation of the average landholding size.
[9] It is observed that the average area of land under share contract is more than the area of land operated by households. This is due to not taking into account households not renting or under share contract, in estimating the average. For example, the total land operated in Luangnamtha is 3,095 ha, distributed among 1,488 households (average = 2.08) but 63 ha are held under share contract among 23 households (average = 2.76).

Panel B: Cumulative density functions



Source: Authors, based on LCA 2010/11

It is also found that the extent of land ownership is significant at the 0.01 probability in both rice and other crops in stage-2 and stage-3 of income diversification in models disaggregated by the level of income diversification, whereas it is significant for other crops only in stage-1. This means that farmers with more land tend to cultivate more commercial crops even when farmers with limited access to land may not be interested in cultivating for the market. In other words, having more land is likely to induce farm households to become commercialized even when the region may be at an early stage of development. Similarly, access to irrigated land is significant for rice cultivation at all stages of development, but for other crops, it plays a role only in stage-1 of income diversification. It may be that farm households find ways to irrigate when farmers find opportunities in crop cultivation and market sales, regardless of the level of income diversification.

In models disaggregated by the economic zone (lowland, upland and plateau), land ownership is significant at the 0.01 probability in the lowland and the plateau, but in the upland it is significant only at the 0.05 level. For other crops, access to land is significant at the 0.01 probability in all three economic zones. Access to irrigated land is significant in rice at the 0.01 probability in all three economic zones, but in other crops, it is significant at the same level only in the lowland and the plateau. This means that farmers in the upland region are constrained significantly by lack of access to land with irrigation facilities to engage in productive agriculture and participate in markets.

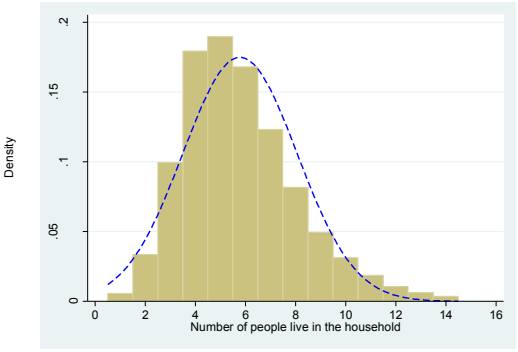
4.2.3 Household demography and labour markets

Among the demographic variables considered, the number of adults in the household is significant for market entry and cultivation at the 0.01 probability in both rice and other crops; the age of the household head is significant at the same level of probability only in market entry models; and the gender of the household head is significant at the same probability, only for rice market sales. Thus, the number of adults in the family can be considered a key variable in determining cultivation and market entry in Lao PDR, while the age of the household head is critical for market sales of rice and other crops. Whether the household head is a male plays a role in cultivation for market sales of rice and other crops.

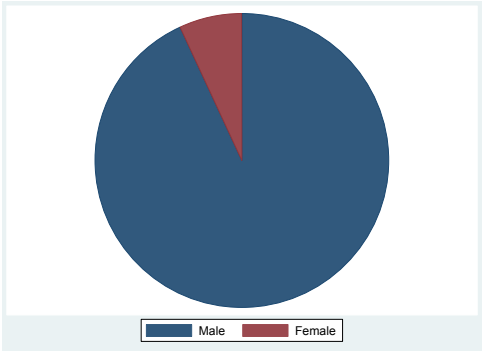
Lao PDR does not seem to have experienced a significantly higher degree of demographic transition and market development to move away from a high reliance on family labour for agriculture. The age and other characteristics of the household head are known to affect farming decisions and choice of agricultural inputs such as seeds, fertilizer and pesticides as well as technology and machinery, access to credit and marketing of the produce. Data show the average household head to be aged 45 years with a standard deviation of 12 years. It appears that there is a link between age and the gender dimension of development. The average age of the head of household rises to 51 years with a standard deviation of 13 years if only women-headed households are considered (see panel B in Figure 4.5). If only men-headed households are considered, the average age drops. This means that households headed by women tend to belong to a generally higher age cohort, which is a disadvantage in agriculture. Women are also usually disadvantaged when it comes to asset ownership. Taking the two factors together, it can be deduced that women-headed households are more disadvantaged. This is reflected in regression models through the fact that men-headed households engage more in crop cultivation and marketing than women-headed households. Thus, programmes targeting women-headed households can be justified on grounds of economic efficiency and social justice. Otherwise, children in women-headed households are also likely to be denied adequate access to basic social services.

Figure 4.5 Household demography

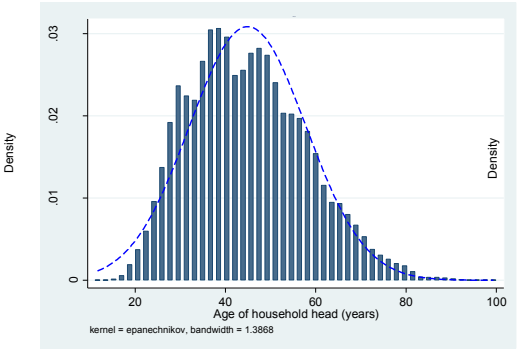
Panel A: Number of people in the household



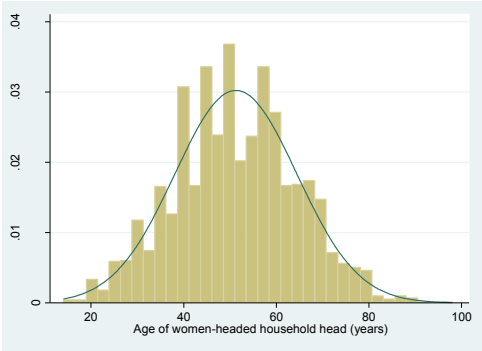
Panel B: Gender composition of household head



Panel C: Age distribution of household head



Panel D: Age distribution of women-headed households



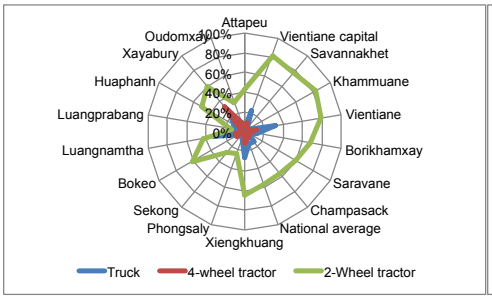
Source: Authors, based on LCA 2010/11

4.2.4 Access to agricultural machinery and equipment

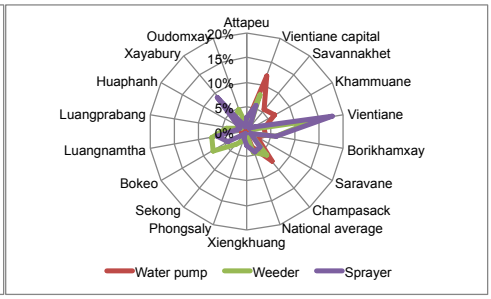
LCA 2010/11 recognized the use of four types of agriculture-related capital: land preparation equipment such as tractors; plant protection equipment such as water pumps and weeders; harvesting machines; and processing equipment. The importance of access to agricultural machinery and equipment, rather than actual ownership, was tested because whether the household has the capacity to use agricultural machinery and equipment is the most critical factor in agricultural production. They entered the model through the cultivation choice models and assumed that they indirectly influence market entry. It is found that all three types of capital equipment are significant at the 0.01 probability in both rice and other crop models.

Figure 4.6 Use of agricultural capital by province

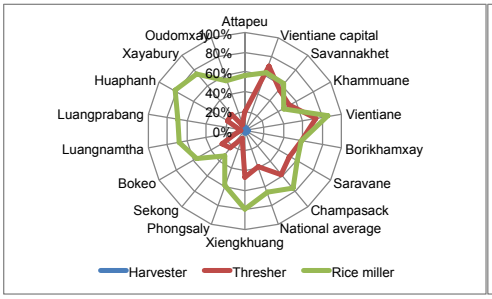
A: Land preparation equipment



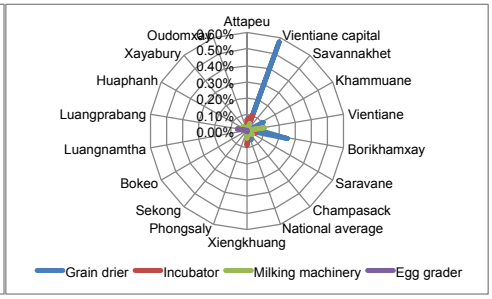
B: Plant protection equipment



C: Harvesting and bulk processing



D: Processing equipment



Source: Authors, based on LCA 2010/11

The models disaggregated by income levels show mixed results. In particular, tractors or processing equipment are not significant at higher levels of income diversification. In the models disaggregated by economic zone, the use of capital equipment is significant in all the models except planting and processing equipment in the upland and plateau models. The authors think, however, that this is not because of the intensive use of capital equipment by households in crop cultivation, but rather due to the fact that households using capital equipment intensively for rice cultivation also happen to cultivate for markets.

4.2.5 Access to agricultural finance

Access to low-cost agricultural credit can be a powerful influence on agricultural development, encouraging farmers to invest in new production technology and pre- and post-harvest loss reduction, establish marketing mechanisms or add value to agricultural produce. Farmers are more likely to approach financial institutions if they have the capacity to manage formal financial arrangements. The influence of rural finance on inclusive growth,

structural transformation and poverty alleviation depends on the availability of rural financial instruments that are accessible to rural farm households as well as their efficient use.

Regression results confirm that access to credit is a significant factor in market sales of rice and other crops. This finding is consistent with the ground conditions, especially in the context of rice being the preferred consumption commodity and other crops having a high commercial value. While farmers cultivate rice regardless of their credit status, producing a marketable surplus in other crops requires greater use of market-purchased inputs and services that, in turn, needs access to credit. Access to Village Development Funds (VDFs) is significant at the 0.01 probability level in both rice and other crop models. This is supported by LCA 2010/11 data showing 53 per cent of villages with some access to credit. VDFs were the most widespread financial instrument, accessible to 39 per cent of villages; public banks were used by 22 per cent, microfinance by 4 per cent and domestic private banks by 1 per cent of villages. Foreign banks and other financial institutions were used by less than 1 per cent of villages.

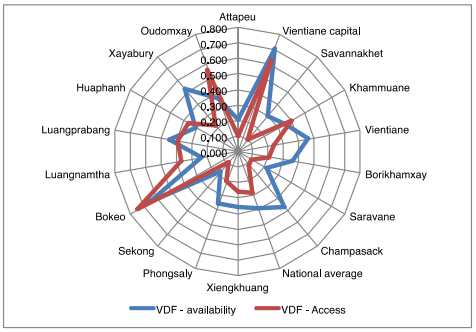
In models disaggregated by income diversification, access to credit is significant at the 0.01 probability in rice market entry at higher levels of income diversification (stage-2 and stage-3). This suggests that credit is an important determinant for market entry, but not for rice cultivation when income sources are diversified. In other crops, access to credit is significant for cultivation in all three stages, but only at the first two stages of market entry. Similar results are found with regard to the availability of VDFs for rice and other crops as well as at higher income diversification levels.

The authors find a marked difference between the outreach and accessibility of agricultural financial instruments in Lao PDR. Figure 4.7 shows the 'availability' of and 'accessibility' to VDFs and public banks at the provincial level. As before, the provinces are ordered according to the degree of household income diversification. It is noted that VDFs have the widest outreach, so are with a correspondingly high access of farm households to credit. On the other hand, there is a widespread network of public banks, but only a small proportion of farmers access them. The outreach of public banks and farmers' access to these are also not linked across provinces as in the case of VDFs. Thus, it may be worthwhile reviewing the policy framework on agricultural financing instruments and their outreach strategy. Farmers have identified microfinance as another source of credit, but it is limited to 4 per cent of villages with a relatively higher outreach in provinces such as Attapeu (15 per cent), Xayabury (18 per cent) and Luannamtha (16 per cent). Access to microcredit is also limited to 2 per cent of all farm households.

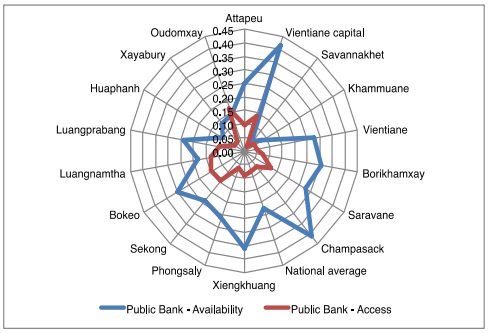
In models disaggregated by economic zone, access to credit was found to be significant at the 0.01 probability for rice sales in the lowland and plateau, but not in the upland. For other crops, access to credit is significant for cultivation across all economic zones, but for market entry, availability of credit is significant only in the lowland at the 0.01 probability level, and in the upland at the 0.05 level of significance.

Figure 4.7 Availability and accessibility to financial instruments

A: Village Development Fund



B: Public Bank



Source: Authors, based on LCA 2010/11

4.2.6 Outreach of agricultural services

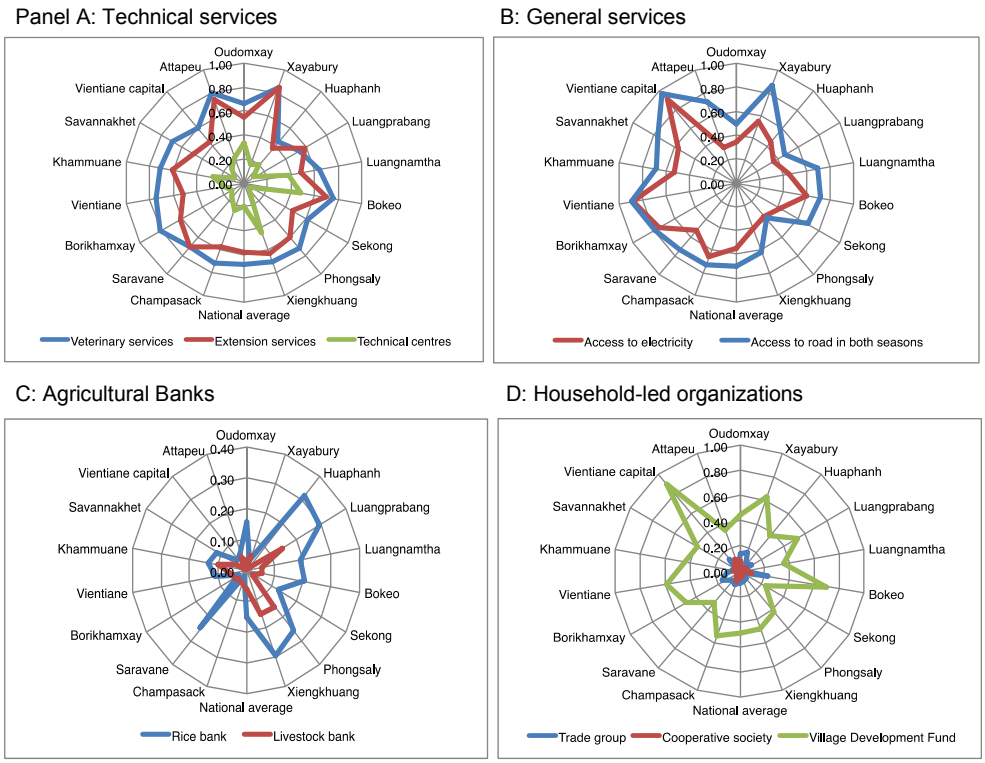
Based on the survey data, agricultural and publicly provided services that benefit agricultural households can be classified into: (i) technical services such as veterinary services, extension services and technical centres; (ii) general public services such as electricity and roads; (iii) agricultural banks including rice banks and veterinary banks; and (iv) household-led organizations such as cooperatives and trade groups. Extension services, access to roads, cooperative societies and trade groups are included in the regression models.

Access to extension services is assumed to influence market entry through cultivation. It is found that access to extension services is significant at the 0.01 probability in several regression models including other crop cultivation in the overall model; other crop cultivation at stage three of income diversification; rice cultivation in the upland and plateau; and other crop cultivation in the lowland and upland. The government policy appears to be to provide such services as widely as possible across the country (see Figure 4.7). Veterinary and extension services are also widely used across Lao PDR, covering 69 per cent and 58 per cent farm households, respectively. Access to roads in both seasons is available for 70 per cent of households while 55 per cent of households on average have access to electricity with considerable variation across provinces. For example, over 90 per

cent of farm households have access to roads and electricity in Vientiane capital whereas less than 40 per cent have access in places like Phongsaly.

Approximately 15 per cent of households in Lao PDR use rice banks. Under this initiative, the community maintains rice stocks in the village, initially supplied from the community surplus or by external agencies. Villagers can borrow rice from the bank and repay during their next harvest. This addresses seasonal food insecurity faced by poorer households, and the method is considered cheaper than borrowing from moneylenders to purchase food during the lean period.

Figure 4.8 Outreach of agricultural services



Source: Authors, based on LCA 2010/11

4.2.7 Usage of price and production information and channels

The use of price information was found to be significant at the 0.01 probability for market entry for both rice and other crops, and cultivation of other crops in the overall models. This confirms that households use price information to decide what to cultivate and

whether to sell in the market regardless of whether it is rice, mostly produced for home consumption, and other crops.

In disaggregated models, the use of price information is significant for market entry for both rice and other crops at all levels of income diversification, but not for cultivation decisions across different income levels or economic zones. The limitations in the use of price could also be due to difficulties in accessing information across different locations.

The analysis on the availability of information at provincial level found that households use two main channels for obtaining information, namely state organizations and media along with private channels. Television is used as a source of agricultural information by 49 per cent of households, followed by radio, state organizations, extension services and newspapers. Despite wide availability of media and state organizations, 54 per cent of households obtained information from other farmers and 24 per cent from input suppliers.

4.2.8 Village marketing infrastructure and channels

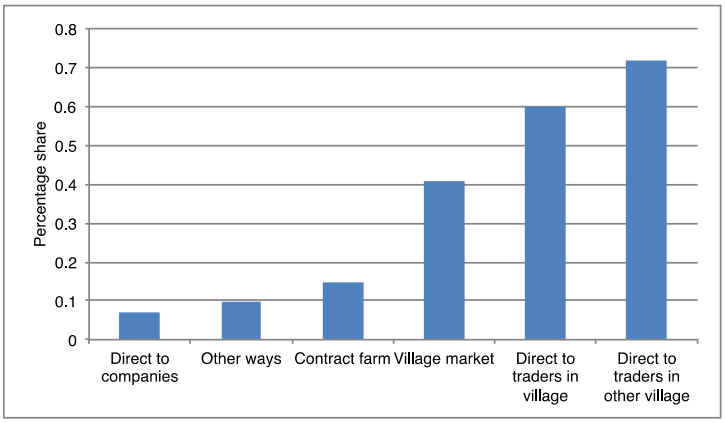
The usefulness of marketing infrastructure and channels in promoting market entry, especially in a high transaction cost environment, is well recognized. Economic theory suggests that farmers choose their marketing channels based on economies of scale. In the absence of measurable indicators of transaction costs, marketing channels can provide insights on the transaction cost environment facing farm households. Accordingly, a number of indicators representing marketing channels and infrastructure were used in the models.

Accessibility to roads in both seasons is a key determinant of market access and significant at the 0.01 probability for rice production and other crop market entry at the national level. Farm households with better access to roads are more likely to sell in markets. This is also confirmed when cultivation and market entry are analysed using disaggregated data. The only exception is stage-2 of income diversification and the lowlands, where accessibility to roads was not found to be significant.

The estimated models show that a number of marketing channels significantly affect production and sales decisions in both rice and other crops. The availability of marketing channels significantly affects production and sale decisions of other crops than for rice, which may be due to the fact that other crops require greater marketing effort than rice. We find that contract farming, direct sale to companies, selling to traders in other villages, selling in the village market and other channels are all highly significant in the case of other crops, but for rice, only contract farming, direct sale to traders in own village and other villages are significant. Direct observation of marketing channels also confirm these results.

As Figure 4.9 shows, selling directly to traders in own village or other villages are the main marketing channels. Contract farming is practised by 15 per cent of farmers and direct sales to companies by 7 per cent of farm households. Between 1 to 5 per cent of households engage in contract farming across different provinces, with none reported in three provinces.

Figure 4.9 Channels of agricultural marketing



Source: Authors, based on LCA 2010/11

Several marketing channels were found to be significant in explaining market entry for other crops. Selling to traders and through contract farming are the key marketing channels for selling rice. In the models disaggregated by income diversification and economic zones, contract farming was found to be significant for market entry of other crops across the three stages of income diversification and the upland and plateau. For rice, however, contract farming becomes less significant as agricultural income declines, but other channels such as direct sales to companies become more prominent. A slight increase in sales to traders in their own villages as a marketing channel was observed at higher levels of income diversification, which may be due to the emergence of a trading class within the village as economies diversify.

The existence of sales outlets becomes significant for rice sales, but it is less so for other crops. Having a permanent market in the village has a significant impact on farmers' production and market sale of rice and is significant only for market entry decisions for other crops. Existence of cooperative societies, on the other hand, significantly affects cultivation decisions of both rice and other crops and rice market entry at the 0.05 level of probability.

5. Summary and Findings

The Istanbul Programme of Action (IPoA) for LDCs for the decade 2011-2020 called for a commitment to structural transformation in LDCs for accelerated, sustained, inclusive and equitable economic growth to address emerging and long-standing challenges (United Nations, 2011). Agriculture, food security and rural development are high in the IPoA agenda, with agriculture recognized as playing a crucial role in eradicating poverty and hunger, promoting rural development, gender equality and empowerment of women. IPoA proposed a three-pronged action programme for agricultural development to achieve these goals that included: (i) strengthening institutions, including cooperatives, to boost smallholder farmer food production, agricultural productivity and sustainable agricultural practices; (ii) encouraging small farmers and pastoralists to change gradually from production of low-value to high-value produce, taking into account specialization, favourable market and infrastructure conditions and improved access to financial and risk management; and (iii) making rural markets work better for the rural poor by linking small-scale farmers to markets throughout the food chain, including the provision of price and relevant information, and improving sanitary and phytosanitary services. The need to overcome structural challenges was recognized as an essential part of this programme during the Asia-Pacific Regional meeting on the implementation of the IPoA, held in Siem Reap, Cambodia (United Nations, 2012).

Through successive national and sectoral plans, Lao PDR has implemented several programmes, primarily targeting the agricultural sector, aiming to realize the goal of graduating from LDC status by 2020. Programmes and projects to modernize agricultural production with a focus on smallholder farming and improving rural food security and livelihoods have been implemented over several decades. While these policy reforms have created dynamism in the agricultural sector and in some regions, subsistence and semi-subsistence agricultural practices continue to dominate the sector. This report aimed to understand the nature of structural transformation in agriculture in Lao PDR and the extent to which growth processes have been inclusive and to identify critical factors contributing to structural transformation. It is hoped that the report will contribute to the broader debate on the nature and determinants of inclusive growth and structural transformation in developing countries.

Structural transformation is a process where economies realize higher labour productivity and productivity convergence across key sectors, allowing everyone to benefit from economic growth and development. In this sense, structural transformation is an inclusive process of growth and development. This is manifested through a sectoral transition where the share of agriculture declines in total economic output and the labour force, accompanied by a rise in the share of manufacturing and services. In the process, old production processes and institutions give way to newer institutions, and resources move from low- to high-productive sectors. Structural transformation is also associated with a spatial and demographic transformation. LCA 2010/11 data suggest that the majority of farm households feel that agricultural conditions improved compared to 10 years ago. Interestingly, households feel that agricultural conditions are better in provinces where they earn higher income from agriculture than in provinces where households have diversified sources of income.

Agriculture is increasingly recognized as a sector with much potential to contribute to poverty alleviation and structural transformation. Recent advances have enhanced the potential role of agriculture in the process through: (i) advances in knowledge of genetic structures and mechanisms, especially in agricultural biotechnology and its capacity to push the agricultural productivity frontier; (ii) the supermarket revolution which has transformed food retail supply chains; and (iii) a deeper understanding of the determinants of poverty and pathways out of poverty – economic growth with a fair distribution of income. Within this process, understanding what motivates a subsistence farmer to produce for markets, the dynamics of the process of transformation, and the determinants of that process will help in the design of policies to facilitate agricultural growth without creating distortions and bottlenecks for farmers.

A review of literature in the paper led to the identification of critical elements in this process. First, certain fixed factors cannot be changed in the short- to medium-term. These include natural capital (land, water, flora and fauna, climate and topography), the nature and distribution of resources among people, institutions and culture, and political structure. Second, a trigger for a movement towards market participation and exchange could come from reduced transaction costs enhancing the potential benefits of market exchange and increasing the capacity for consumption. It was noted that varying degrees of transaction costs could explain the existence of pure subsistence and fully integrated markets, and all the intermediate production and marketing arrangements within the two polar cases. Third, once there is a powerful trigger for market participation, a chain reaction induces the

household to reallocate resources from low- to high-productive activities, moving towards production for markets and exchange for non-home produced commodities. This transition is manifested in several observable changes including changes in crop choices, the use of machinery and equipment, use of hired labour, use of price information and more advanced contractual arrangements such as contract farming and forward contracts. Fourth, when a critical mass of households has undergone this transition, the entire region becomes more dynamic, facilitating and hastening the transition. Fifth, to complete the transition to a full-fledged economic transformation, there must be faster productive growth in other sectors to absorb agricultural 'surplus labour'. Agribusiness development has been found to contribute to this transition significantly in Asian countries.

Lao PDR offers an excellent case study of agrarian transformation for several reasons. Several national plans over the years have targeted the agricultural sector in the country, including successive NSEDPs, national agricultural and forestry development and investment plans, all guided by the reports of the Party Congress. In recent years, these policies have emphasized new policy directions, leading to increased industrialization and monetization, expansion of agro-processing industries, developing integrated agricultural production and agroforestry management, all within competitive market and sustainable production norms. The Government has also supported farmer organizations, through land concessions and the development of contract farming with a view to commercialize agriculture. Lao PDR has developed an increasingly progressive agricultural policy framework that has contributed to creating a dynamic agricultural sector. Against this background, the study aimed to identify further action that the Government of Lao PDR could take to maximize the contribution of agriculture to the national economy, facilitating inclusive growth and structural transformation.

Lao PDR has undergone a considerable degree of agricultural transformation. Between 1995 and 2010, the sector's contribution to national economy declined from over 55 per cent to 32 per cent. An area of concern is the slow movement of labour out of agriculture, with the sector's share in total employment declining from 85 to 71 per cent over the same period. The gap between the two has widened. This implies a reduction in the per capita agricultural income of those in the agricultural sector and hence, widening income disparity between workers in agriculture and the industrial and services sectors. Compared to more industrialized countries, Lao PDR still needs to undergo a considerable degree of transformation to reach the convergence of productivity across sectors enabling those 'trapped' in unproductive agriculture to move out and realize broad-based and inclusive growth.

Based on data from the agricultural censuses of 1998/99 and 2010/11, it is observed that the agricultural sector in Lao PDR has undergone a significant degree of transformation towards commercialization, which is manifested in a number of ways. First, the number of farm households as a proportion of the total number of households declined from 83 to 71 per cent in the two intervening years. Second, farm households cultivating crops mainly for the market increased from 6 to 30 per cent of total farm households, and those who actually sell increased from 30 per cent to 71 per cent. Third, there was a decline in the number of households owning small land parcels but an increase in households owning more than 2 ha, resulting in a rise in average land ownership from 0.77 to 0.90 ha. Fourth, Lao agrarian transformation has been accompanied by changes in agricultural cropping patterns. Fixed Rotational Cropping (FRC) emerged as the dominant non-traditional agricultural production system in the northern uplands, a development often attributed to the Land and Forest Allocation Program (LFAP) that introduced land zoning and access to traditional lands that restricted the shifting agricultural practice. This has, however, also resulted in soil erosion, weed infestation and insect and crop diseases, requiring the use of higher amount of labour and pesticides. The area under permanent crops, especially rubber, increased from 40,000 to 1,623,000 ha while that under temporary crops declined marginally. Farmers have begun monoculture cash cropping, mainly maize and banana, which has led to increased use of fertilizer, pesticides and other inputs. Fifth, there has been an increase in input-intensive rice farming, which included the use of mechanized ploughing, high yielding varieties and chemical fertilizer, pesticides and insecticides. For example, from 1998-199 to 2010-2011, the ownership of two-wheeled tractors increased from 7 per cent to 34 per cent; the use of fertilizer from 29 to 42 per cent; pesticides from 11 to 17 per cent; and hired labour from 26 to 45 per cent.

Agricultural transformation, analyzed using the province as the unit of analysis, shows a considerable degree of transformation across the country. First, the share of agriculture in household income varies from 90 per cent in Oudomxay to 46 per cent in Attapeu. On average, 50 per cent of household income comes from crops while livestock and forestry contribute about 20 per cent. Second, input-intensive agricultural practices such as mechanization and the use of high yielding varieties, chemical fertilizer, insecticides and pesticides have emerged in some provinces while traditional agricultural practices such as shifting agriculture have lost importance in some provinces, and rotational cultivation has increased in others. It was observed that rising share of diversification of income is associated with a declining practice of both these agricultural practices. Third, households

are observed to diversify away from traditional crops towards more market-oriented and value added products. In places where farm income has diversified, farmers engage in more specialized agriculture such as mushroom cultivation, floriculture and beekeeping. Fourth, agricultural mechanization is observed in some provinces, with a tendency to increase the level of mechanization with greater diversification of farm household income. Fifth, agriculture has become more monetized, but some traditional practices such as exchange labour continue to be used along with higher monetary transactions. For example, the growing use of hired labour was associated with the increased use of different payment methods, including money and farm produce, but labour exchanges continue to be practised despite greater degree of monetization.

It is observed that farmers cultivate rice and other crops with very different objectives. Rice appears to be cultivated mostly for home consumption, whereas a larger proportion of households cultivate other crops for selling in the market. Based on sample data, it is noted that 92 per cent of farmers cultivate rice, but only 37 per cent of them sell rice. On the other hand only 37 per cent of farm households cultivate other crops, but 68 per cent of those who cultivate enter market as sellers. Moreover, cultivation and market entry decisions of rice and other crops are significantly different. In case of rice, the proportion of households who cultivate and enter markets as sellers tend to be somewhat constant across different levels of income diversification. It is, however, different in case of other crops. We find that fewer households cultivate other crops at higher levels of income diversification, but the proportion of sellers does not decline. This finding is in line with the stylized facts structural transformation.

Using a structural equation model with two endogenous variables, we investigated the determinants of crop cultivation and market entry decisions. The regression estimates suggest that cultivation and market entry decisions are interdependent, not independent. The key implication of this finding is that public policies to facilitate market participation by farmers should also address farmers' market entry barriers. Merely promoting policies to increase agricultural productivity without facilitating market entry, or vice versa, is unlikely to yield tangible results.

Several variables were found to affect farmers' crop cultivation and market entry decisions. First, household assets, especially access to land and cattle, affect cultivation and market entry decisions; ownership of more land induces farmers to enter into commercial production even at lower levels of income diversification – an approximation for structural transformation. Second, household demographics, namely the number of family members, age and gender of the household head, affect farm decisions on cultivation and

market entry, but its impact varies at different stages of income diversification and also on the type of commodity under consideration. The average age of female household heads is slightly higher than that of male household heads; and being a male appears to be an advantage in commercially oriented farm operations. The combined effect of the skewed age distribution among female-headed households and the likelihood of them owning fewer assets may have a negative overall impact on the poverty levels of female-headed households. A movement towards monetization of labour markets in accordance with structural transformation is noted, but the change is too slow to be recognized by an analysis of spatial data. Third, the use of agricultural capital as well as a greater degree of mechanization is observed with rising commercialization. Fourth, access to agricultural credit is a key determinant of market entry, but its impact varies across rice and other crops. In the case of other crops, a positive association between access to credit and market entry is observed. In the case of rice, however, the availability of credit does not significantly affect cultivation and market entry decisions. As for VDFs, they are available widely across the provinces and that farmers rely on them intensively. This is not the case with more formal financial institutions such as public banks, which, despite being widespread, are accessed only by a small percentage of farm households. Fifth, the Government of Lao PDR provides a range of agricultural services including extension services (crop and veterinary services), general public services (rural roads and electricity), agricultural banks (rice and veterinary), and contributes to organizing cooperatives and trade groups. Regression results suggest that selected set of services significantly affect farmer market entry for both rice and other crops. It appears that the government has selected extension services judiciously to match the requirements of different regions. Access to roads that can be used in both seasons was found to be a significant determinant of market entry for other crops. Sixth, farmers receive price and product information from a variety of channels. Despite widespread availability of information channels, farmers-to-farmers and input suppliers-to-farmers are used more intensively. Seventh, farmers use a variety of marketing channels, ranging from selling at village markets, selling to traders and companies, and selling through contract farming. It is difficult to generalize the use of marketing channels by farmers, but it appears they use many channels to suit their conditions, especially selling more commercialized crops.

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Appendices

Appendix 1. Gains from specialization and costs to market participation: Mathematical treatment

This can be best described by resorting to a simple optimization model of an agrarian household. Following standard economic theory, consider a household that maximizes utility (U) by choosing levels of goods consumed (c), produced (q), bought (b) and sold (s) subject to the income constraint, production technology, the resource constraint and the non-tradable availability constraint (Omamo, 2007; Duncan, *et al*., 2007). The household utility maximization problem can be written as: $Max\ U(c_i, z)$ Subject to the cash constraint: $\sum_{i=1}^{N}(p_i c_i + t_i b_i) = \sum_{i=1}^{N} p_i(q_i + e_i) - t_i s_i$, the resource balance constraint: $q_i + e_i + b_i - s_i - c_i \geq 0$, the production function: $F(Q, Z) \geq 0$, and the non-tradable availability constraint $A = \sum_i^N A_i$. In the set of equations, variables are defined as follows: prices (p_i) and transaction costs (t_i) are given, e are endowments, and F represents the household's production technology determined by privately-held resources such as land, labour, livestock and machinery, and publicly provided services such as irrigation extension services, market information services, all represented by Z. Households face transaction costs when participating in markets, which are often idiosyncratic to the household and depend on the level of education, technical knowledge, gender, age, etc. By rearranging the cash constraint in terms of benefits and costs to market participation, one can write: $\sum_{i}^{N} t_i(b_i + s_i) = \sum_{i=1}^{N} p_i(q_i - c_i + e_i)$. The left side of this shows costs of participating in markets for traded goods while the right side shows the total sum of revenue net of consumption plus endowments evaluated at the market price.

The equality of the equation implies that, for given consumption and endowment, an increase in the unit transaction cost (t_i) will induce households to reduce the quantity traded and increase the range of commodities produced within the farm to compensate for lost consumption opportunities. Conversely, a reduction in unit transaction costs is likely to stimulate commodity specialization and market exchange. Gains from specialization and costs to market participation can thus explain the existence of an array of production and consumption arrangements. Smallholders select whether to engage in production for markets and hence some degree of specialization, in exchange for purchasing non-home produced goods. This opens up for the existence of all possible levels of home production and market participation between pure subsistence and complete market participation.

Households that find the benefits of specialization outweighing the costs of market participation, participate in markets, and others avoid them completely or partially. This implies that any policy instrument that significantly reduces the transaction costs of market participation is likely to trigger market production by agrarian households who exchange their income for non-home produced commodities, finally ending in complete specialization and market participation.

This framework explains the choice of levels of market production and participation without the need to evoke risk preferences or even the powerful argument of missing markets and services [insurance (Bromley and Chavas, 1989), food markets (de Janvry, *et al*., 1991; Fafchamps, 1993), credit markets (Eswaran and Kotwal, 1985; Rosenzweig and Wolpin, 1993), and household-specific market failures (Kurosaki, 2003)] a factor of considerable influence on agricultural production.

Appendix 2. Structure of the empirical model

Given the nature of the data available from the survey, we employ a binary choice model where the outcome variable, y, takes one of two values:

$$y = \begin{Bmatrix} 1 \ with\ probability\ p \\ 0\ with\ probability\ 1-p \end{Bmatrix}$$

This allows us to use binary outcome models such as Logit, Probit, linear probability and log-log models that can be used to model p as a function of regressors $\mathcal{X}$, without loss of generality.

Whether a farm household decides to cultivate a commodity and to enter the market as a seller are not independent decisions, but depend on the family's assessment of the cost of market participation and possible welfare gains in terms of consumption through market exchange – the tension between specialization and transaction costs discussed above. Thus, we model market entry and production as a structural equation model where market entry S_i is the dependent variable in the structural equation and binary decision on cultivating commodity *i*, Q_i, is an endogenous regressor. The two endogenous variables are modelled as linear in exogenous variables $\mathcal{X}_{1\mathrm{i}}$ and $\mathcal{X}_{2\mathrm{i}}$. Thus, the model is,

$$S_i = \beta Q_i + \mathcal{X}_{1i}'\gamma + \mathcal{u}_i$$

$$Q_i = \mathcal{X}_{1i}'\theta_1 + \mathcal{X}_{2i}'\theta_2 + \mathcal{v}_i$$

where I = 1,….,N; $\mathcal{X}_1$ is a K1 x 1 vector of exogenous regressors, and $\mathcal{X}_2$ is a K2 x 1 vector of additional instrumental variables that affect production decisions but may not affect sales decisions directly but through production. Following standard assumptions, we assume that $(\mathrm{u_i}, \mathcal{v}_\mathrm{i})$ are normally jointly distributed, i.e., $(u_i, \mathcal{v}_i) \sim N(0, \Sigma)$, where (σ_{ij}). Given that coefficients are only identified up to a scale factor, scale normalization implies that $\sigma_{11} = 1$. This implies that $\mathcal{u}_\mathrm{i}|\mathcal{v}_\mathrm{i} = \rho\mathcal{v}_\mathrm{i} + \epsilon_\mathrm{i}$, where $\mathrm{E}(\varepsilon_\mathrm{i}|\mathcal{v}_\mathrm{i}) = 0$. Therefore, a test of the null hypothesis of exogeneity of production Q_i is equal to test of H_0: $\rho = 0$, because then $\mathrm{u_i}, \mathcal{v}_\mathrm{i}$ are independent.

The primary focus of this research was on commodities. Hence, only rice and other crops were considered. Several variables were assumed to directly affect farm household decisions on crop choices but not having a direct, impact on decisions to enter markets. These include: land owned by the household, irrigated land, whether the farm household used outside labour, whether the farm used shifting or rotating cultivation, the use of agricultural capital and equipment, use of fertilizer and pesticides, access to an input store in the village and extension services. As per the model specified above, these variables

represent X_2, and hence, are included in determining a household's cultivation decision but not its decision on market entry.

Appendix 3. Summary statistics

Variable	Mean	Std. Dev.	Min	Max
1=household sold rice	0.34	0.47	0	1
1=household sold crops	0.40	0.49	0	1
1=Farmers in village sell through contract farming	0.15	0.35	0	1
1=Farmers in village sell directly to companies	0.07	0.26	0	1
1=Farmers in village sell directly to traders in village	0.60	0.49	0	1
1=Farmers in village sell directly to traders in other village	0.72	0.45	0	1
1=Farmers in village sell in village market	0.41	0.49	0	1
1=Farmers in village has other ways to sell	0.10	0.29	0	1
1=Household head is male	0.93	0.26	0	1
Age of household head (years)	44.88	12.97	0	120
Adult members in the households (number)	5.85	2.45	0	28
1=Household received credit	0.14	0.35	0	1
1=Village experienced drought in every 1-2 years	0.67	0.47	0	1
1=Village experienced pest attack in every 1-2 years	0.64	0.48	0	1
1=Village has road accessible in both seasons	0.70	0.46	0	1
1=Village has a permanent market	0.20	0.76	0	1
1=Village has shops / services	0.72	0.45	0	1
1=Village has a food store	0.60	0.49	0	1
1=Village has a trade group	0.10	0.30	0	1
1=Village has a cooperative society	0.05	0.22	0	1
1=Village has Development Fund	0.49	0.50	0	1
Number of channels household received agriculture information	2.63	1.42	0	8
Cattle owned by the household (number)	2.19	4.62	0	150
1=Village has paid employment opportunities	0.78	0.41	0	1
Land owned by the household (hectares)	2.07	2.05	0	20
Irrigated land owned by the household (hectares	0.39	0.81	0	20
1=Household used outside labour for cultivation	0.45	0.50	0	1
1=Household practises shifting cultivation	0.06	0.24	0	1
1=Household practises rotating cultivation	0.33	0.47	0	1
Number of agricultural equipment owned (e.g. hand tractors)	0.78	0.70	0	3
Number of planting equipment owned	0.50	0.65	0	6
Number of processing equipment owned	0.67	0.48	0	6
1=Household used organic fertilizer	0.31	0.46	0	1
1=Household used chemical fertilizer	0.28	0.45	0	1
1=Household used pesticides	0.09	0.29	0	1
1=Village has agriculture and machinery store	0.09	0.28	0	1

1=Village has input store	0.09	0.29	0	1
1=Household received extension services	0.58	0.49	0	1

Source: Authors based on the Lao Census of Agriculture 2010/11

Appendix 3 – Table1. Overall model - rice and other crops

Variables	Overall model			
	Rice		Other crops	
	Sale	Cultivation	Sale	Cultivation
1=Farmers in village sell through contract farming	0.0302***	-0.00874	0.113***	0.561***
	(0.0066)	(0.0328)	(0.0075)	(0.0194)
1=Farmers in village sell directly to companies	0.0157*	-0.348***	-0.0046	0.344***
	(0.0090)	(0.0351)	(0.0088)	(0.0260)
1=Farmers in village sell directly to traders in village	0.0724***	-0.0140	0.0646***	0.0201
	(0.0049)	(0.0240)	(0.0048)	(0.0148)
1=Farmers in village sell directly to traders in other village	0.0967***	0.0491*	0.0613***	0.0740***
	(0.0053)	(0.0251)	(0.0051)	(0.0159)
1=Farmers in village sell in village market	0.0019	-0.118***	0.0137***	-0.0542***
	(0.0049)	(0.0230)	(0.0048)	(0.0148)
1=Farmers in village has other ways to sell	-0.0108	-0.0500	-0.0171**	-0.0787***
	(0.0077)	(0.0352)	(0.0074)	(0.0236)
1=Household head is male	0.0234***	-0.0041	0.0149*	0.262***
	(0.0090)	(0.0387)	(0.0088)	(0.0289)
Age of household head (years)	0.00157***	-0.00165*	0.000979***	0.00
	(0.0002)	(0.0009)	(0.0002)	(0.0005)
Adult members in the households (number)	-0.00764***	0.0707***	-0.00283***	0.00779***
	(0.0010)	(0.0052)	(0.0009)	(0.0028)
1=Household received credit	0.0414***	-0.0418	0.0232***	0.219***
	(0.0066)	(0.0321)	(0.0066)	(0.0191)
1=Village experienced drought in every 1-2 years	-0.0354***	0.223***	0.0266***	-0.0650***
	(0.0052)	(0.0242)	(0.0050)	(0.0154)
1=Village experienced pest attack in every 1-2 years	-0.0166***	0.137***	0.0057	-0.0409***
	(0.0052)	(0.0244)	(0.0050)	(0.0153)
1=Village has road accessible in both seasons	-0.00564	-0.260***	0.0326***	-0.0214
	(0.0054)	(0.0288)	(0.0052)	(0.0161)
1=Village has a permanent market	-0.0275***	-0.0852***	-0.0177***	-0.0114
	(0.0031)	(0.0129)	(0.0030)	(0.0102)
1=Village has shops / services	0.0121	-0.170***	-0.0025	0.0036
	(0.0079)	(0.0396)	(0.0076)	(0.0234)
1=Village has a food store	0.0329***	-0.0495	-0.0067	-0.0720***
	(0.0072)	(0.0343)	(0.0070)	(0.0215)
1=Village has a trade group	0.0183**	-0.168***	-0.0041	0.0455**
	(0.0078)	(0.0347)	(0.0075)	(0.0230)
1=Village has a cooperative society	0.0229**	-0.137***	-0.0148	0.0895***
	(0.0104)	(0.0432)	(0.0100)	(0.0306)
1=the Village Development Fund is available	0.0272***	-0.189***	0.0225***	-0.0670***
	(0.0047)	(0.0226)	(0.0046)	(0.0140)

1=Household received price information	0.0224***	-0.0137*	0.0259***	0.0330***
	(0.0016)	(0.0081)	(0.0016)	(0.0051)
Cattle owned by the household (number)	0.00728***	-0.00934***	0.000902*	-0.00318**
	(0.0005)	(0.0022)	(0.0005)	(0.0015)
1=Village has paid employment opportunities	0.0464***	-0.197***	0.0489***	-0.198***
	(0.0059)	(0.0315)	(0.0059)	(0.0178)
Land owned by the household (hectares)		0.0285***		0.0896***
		(0.0062)		(0.0034)
Irrigated land owned by the household (hectares)		0.205***		0.0760***
		(0.0180)		(0.0084)
1=Household used outside labour for cultivation		0.293***		0.206***
		(0.0242)		(0.0143)
1=Household practises shifting cultivation		1.554***		0.223***
		(0.0880)		(0.0285)
1=Household practises rotating cultivation		1.112***		0.363***
		(0.0309)		(0.0163)
1=Household used tractors		0.462***		0.0951***
		(0.0197)		(0.0116)
1=household used planting equipment		0.141***		-0.144***
		(0.0206)		(0.0124)
1=Household used processing equipment		0.532***		-0.0610***
		(0.0229)		(0.0150)
1=Household used organic fertilizer		0.501***		-0.221***
		(0.0267)		(0.0164)
1=Household used chemical fertilizer		0.342***		-0.370***
		(0.0288)		(0.0187)
1=Household used pesticides		-0.234***		0.214***
		(0.0383)		(0.0247)
1=Village has agriculture and machinery store		0.0099		-0.126***
		(0.0407)		(0.0303)
1=Village has input store		-0.200***		-0.0360
		(0.0384)		(0.0295)
1=Household received extension services		-0.0342		0.0611***
		(0.0234)		(0.0145)
Rice cultivation in wet season	0.597***		0.623***	
	-0.0164		(0.0161)	
Constant	-0.493***	0.281***	-0.124***	-0.866***
	-0.0205	-0.0737	(0.0153)	(0.0475)
Rho	-0.182***		-0.134***	
	-0.00944		(0.0101)	
Observations	41,583	41,583	41,583	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 3 – Table 2. Disaggregated regression model of rice (provinces classified by income diversification)

Variables	Provinces classified by level of income generated from agriculture					
	More than 80%		Between 60 - 80%		Less than 40%	
	Rice market entry	Rice cultivation	Rice market entry	Rice cultivation	Rice market entry	Rice cultivation
1=Farmers in village sell through contract farming	-0.0347***	0.179***	0.105***	-0.0987*	0.0265**	0.0571
	(0.0108)	(0.0582)	(0.0127)	(0.0590)	(0.0131)	(0.0684)
1=Farmers in village sell directly to companies	-0.0312	0.0157	-0.0256*	-0.543***	0.0381**	-0.175**
	(0.0218)	(0.0894)	(0.0135)	(0.0529)	(0.0151)	(0.0681)
1=Farmers in village sell directly to traders in village	0.0448***	0.0349	0.0612***	0.128***	0.0913***	-0.104***
	(0.0102)	(0.0510)	(0.0085)	(0.0433)	(0.0079)	(0.0401)
1=Farmers in village sell directly to traders in other village	0.0482***	0.120**	0.0796***	-0.0114	0.103***	0.0661
	(0.0115)	(0.0570)	(0.0090)	(0.0445)	(0.0082)	(0.0405)
1=Farmers in village sell in village market	0.0071	-0.167***	-0.0023	-0.152***	-0.0147**	-0.123***
	(0.0103)	(0.0495)	(0.0084)	(0.0414)	(0.0074)	(0.0370)
1=Farmers in village has other ways to sell	0.0346*	-0.154*	-0.0181	-0.134**	-0.0245**	0.124**
	(0.0205)	(0.0889)	(0.0125)	(0.0618)	(0.0110)	(0.0546)
1=Household head is male	0.0364	0.0619	0.0339**	0.0551	0.0211*	0.0045
	(0.0239)	(0.1010)	(0.0156)	(0.0707)	(0.0121)	(0.0550)
Age of household head (years)	0.0001	-0.0007	0.00195***	0.00404***	0.00194***	-0.00654***
	(0.0004)	(0.0018)	(0.0003)	(0.0015)	(0.0003)	(0.0013)
Adult members in the households (number)	0.0028	0.106***	-0.00993***	0.0500***	-0.0120***	0.0700***
	(0.0020)	(0.0117)	(0.0016)	(0.0087)	(0.0015)	(0.0082)
1=Household received credit	0.0017	-0.0698	0.0368***	0.0105	0.0683***	-0.0359
	(0.0121)	(0.0601)	(0.0107)	(0.0567)	(0.0113)	(0.0560)
1=Village experienced drought in every 1-2 years	-0.0434***	-0.0766	-0.0397***	0.296***	-0.0209***	0.311***
	(0.0108)	(0.0541)	(0.0093)	(0.0466)	(0.0080)	(0.0388)
1=Village experienced pest attack in every 1-2 years	-0.0196*	0.284***	0.0133	-0.0994**	-0.0328***	0.216***
	(0.0107)	(0.0520)	(0.0091)	(0.0466)	(0.0078)	(0.0379)
1=Village has road accessible in both seasons	-0.0842***	-0.351***	-0.00227	-0.265***	0.0873***	-0.162***
	(0.0099)	(0.0568)	(0.0087)	(0.0484)	(0.0097)	(0.0515)
1=Village has a permanent market	-0.0351***	0.0028	-0.0305***	-0.101***	-0.0203***	-0.103***
	(0.0066)	(0.0311)	(0.0056)	(0.0268)	(0.0046)	(0.0184)
1=Village has shops/services	0.0327**	-0.0484	-0.0038	-0.269***	-0.0191	-0.0712
	(0.0147)	(0.0786)	(0.0139)	(0.0705)	(0.0131)	(0.0672)
1=Village has a food store	-0.0089	-0.178***	0.0733***	0.0220	0.0575***	-0.0465
	(0.0134)	(0.0672)	(0.0133)	(0.0630)	(0.0112)	(0.0570)
1=Village has a trade group	0.0487***	-0.221***	0.0104	-0.284***	0.0031	-0.138**
	(0.0143)	(0.0671)	(0.0135)	(0.0600)	(0.0134)	(0.0626)
1=Village has a cooperative society	0.0053	0.188*	0.0122	-0.150**	0.0353**	-0.203***
	(0.0204)	(0.1060)	(0.0172)	(0.0761)	(0.0171)	(0.0695)
1=Village Development Fund is available	0.0134	-0.122**	0.0324***	-0.106***	0.0251***	-0.315***
	(0.0094)	(0.0475)	(0.0080)	(0.0406)	(0.0074)	(0.0376)

1=Household received price information	0.0186***	0.0282*	0.0328***	0.0143	0.0193***	-0.0555***
	(0.0031)	(0.0165)	(0.0028)	(0.0147)	(0.0027)	(0.0134)
Cattle owned by the household (number)	0.00296**	-0.0058	0.00771***	-0.0101**	0.00859***	-0.0167***
	(0.0012)	(0.0050)	(0.0009)	(0.0041)	(0.0007)	(0.0031)
1=Village has paid employment opportunities	-0.0050	-0.239***	0.0703***	-0.330***	0.0790***	-0.109**
	(0.0109)	(0.0627)	(0.0097)	(0.0570)	(0.0105)	(0.0524)
Land owned by the household (hectares)		-0.0125		-0.0449***		0.117***
		(0.0131)		(0.0109)		(0.0112)
Irrigated land owned by the household (hectares)		0.276***		0.422***		0.0874***
		(0.0389)		(0.0403)		(0.0249)
1=Household used outside labour for cultivation		0.371***		0.368***		0.302***
		(0.0477)		(0.0441)		(0.0413)
1=Household practises shifting cultivation		5.0920		1.778***		1.169***
		(81.9200)		(0.1300)		(0.1360)
1=Household practises rotating cultivation		1.151***		1.432***		0.964***
		(0.0518)		(0.0575)		(0.0674)
1=Household used tractors		0.507***		0.318***		0.519***
		(0.0371)		(0.0354)		(0.0341)
1=household used planting equipment		-0.0240		0.109***		0.260***
		(0.0454)		(0.0375)		(0.0339)
1=Household used processing equipment		0.375***		0.873***		0.377***
		(0.0462)		(0.0430)		(0.0387)
1=Household used organic fertilizer		0.298***		0.421***		0.536***
		(0.0710)		(0.0486)		(0.0386)
1=Household used chemical fertilizer		0.162*		0.521***		0.207***
		(0.0956)		(0.0535)		(0.0409)
1=Household used pesticides		-0.185*		-0.209***		-0.236***
		(0.0994)		(0.0668)		(0.0570)
1=Village has agriculture and machinery store		-0.344***		0.0043		0.0171
		(0.1000)		(0.0847)		(0.0567)
1=Village has input store		-0.0725		-0.1330		-0.290***
		(0.0960)		(0.0829)		(0.0520)
1=Household received extension services		0.0523		-0.0995**		-0.0437
		(0.0495)		(0.0424)		(0.0373)
Rho	-0.111***		-0.181***		-0.220***	
	-0.0203		-0.0152		-0.0138	
Observations	11,137	11,137	14,064	14,064	16,382	16,382

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 3 – Table 3. Disaggregated regression model of other crops (provinces classified by income diversification)

Variables	Provinces classified by level of income generated from agriculture					
	More than 80%		Between 60 - 80%		Less than 40%	
	Crop market entry	Crop cultivation	Crop market entry	Crop cultivation	Crop market entry	Crop cultivation
1=Farmers in village sell through contract farming	0.0263**	0.439***	0.105***	0.540***	0.133***	0.223***
	(0.0128)	(0.0319)	(0.0134)	(0.0401)	(0.0126)	(0.0440)
1=Farmers in village sell directly to companies	-0.0471**	0.207***	0.0933***	0.405***	0.00304	0.199***
	(0.0228)	(0.0612)	(0.0135)	(0.0411)	(0.0140)	(0.0510)
1=Farmers in village sell directly to traders in village	0.0123	-0.0527*	0.0414***	-0.0505**	0.0890***	-0.0486
	(0.0107)	(0.0289)	(0.0084)	(0.0255)	(0.0072)	(0.0302)
1=Farmers in village sell directly to traders in other village	0.0556***	-0.117***	0.0820***	0.0709***	0.0431***	0.141***
	(0.0122)	(0.0332)	(0.0089)	(0.0269)	(0.0076)	(0.0317)
1=Farmers in village sell in village market	-0.0394***	-0.0488*	0.0655***	-0.0799***	0.0094	0.123***
	(0.0107)	(0.0289)	(0.0084)	(0.0257)	(0.0068)	(0.0289)
1=Farmers in village has other ways to sell	-0.0567***	0.142**	0.0237*	-0.124***	-0.0190*	-0.0269
	(0.0215)	(0.0579)	(0.0124)	(0.0387)	(0.0101)	(0.0422)
1=Household head is male	-0.0030	0.164**	-0.0102	0.140***	0.0224**	0.232***
	(0.0253)	(0.0672)	(0.0155)	(0.0479)	(0.0113)	(0.0521)
Age of household head (years)	0.00112***	0.00206**	0.00141***	0.00614***	-0.0001	0.00326***
	(0.0004)	(0.0010)	(0.0003)	(0.0009)	(0.0003)	(0.0011)
Adult members in the households (number)	-0.00909***	0.0160***	-0.0009	-0.0061	0.0004	0.0226***
	(0.0021)	(0.0056)	(0.0015)	(0.0047)	(0.0014)	(0.0055)
1=Household received credit	0.0543***	0.126***	0.0303***	0.207***	-0.0007	0.107***
	(0.0130)	(0.0347)	(0.0110)	(0.0329)	(0.0105)	(0.0403)
1=Village experienced drought in every 1-2 years	-0.0298***	0.123***	0.0151	-0.238***	0.0202***	-0.213***
	(0.0114)	(0.0307)	(0.0097)	(0.0277)	(0.0075)	(0.0295)
1=Village experienced pest attack in every 1-2 years	0.0369***	0.0708**	-0.0315***	-0.215***	-0.0113	-0.0414
	(0.0112)	(0.0302)	(0.0091)	(0.0274)	(0.0071)	(0.0289)
1=Village has road accessible in both seasons	0.0523***	0.137***	-0.0136	0.0453*	0.0651***	-0.191***
	(0.0106)	(0.0286)	(0.0086)	(0.0266)	(0.0091)	(0.0364)
1=Village has a permanent market	-0.0091	-0.0450**	-0.0186***	-0.0100	-0.0172***	-0.0768***
	(0.0070)	(0.0214)	(0.0054)	(0.0192)	(0.0042)	(0.0181)
1=Village has shops/services	0.0266*	0.0282	-0.0313**	0.129***	-0.0279**	0.0203
	(0.0155)	(0.0417)	(0.0137)	(0.0422)	(0.0120)	(0.0509)
1=Village has a food store	-0.0343**	-0.108***	0.0181	-0.135***	0.0006	0.0616
	(0.0142)	(0.0384)	(0.0132)	(0.0401)	(0.0103)	(0.0437)
1=Village has a trade group	0.0052	-0.0086	-0.0081	0.0280	-0.0035	0.0914*
	(0.0150)	(0.0410)	(0.0133)	(0.0410)	(0.0123)	(0.0470)
1=Village has a cooperative society	-0.0062	0.245***	-0.0426**	0.0458	0.0201	-0.0299
	(0.0215)	(0.0585)	(0.0170)	(0.0532)	(0.0157)	(0.0657)
1=Village Development Fund is available	0.0440***	-0.0529**	0.0303***	-0.0848***	-0.0060	0.0019
	(0.0099)	(0.0267)	(0.0080)	(0.0243)	(0.0068)	(0.0282)
1=Household received price information	0.0289***	-0.0221**	0.0283***	0.0546***	0.0213***	-0.0349***
	(0.0032)	(0.0092)	(0.0028)	(0.0089)	(0.0025)	(0.0108)
Cattle owned by the household (number)	-0.00527***	0.0110***	0.00355***	0.00736***	0.00210***	0.0013
	(0.0012)	(0.0037)	(0.0009)	(0.0027)	(0.0006)	(0.0024)

1=Village has paid employment opportunities	0.0474***	-0.156***	0.0091	-0.0300	0.0755***	-0.299***
	(0.0115)	(0.0317)	(0.0096)	(0.0296)	(0.0100)	(0.0389)
Land owned by the household (hectares)		0.149***		0.177***		0.0752***
		(0.0076)		(0.0077)		(0.0054)
Irrigated land owned by the household (hectares)		0.0194		0.307***		0.0347***
		(0.0211)		(0.0208)		(0.0125)
1=Household used outside labour for cultivation		0.0714***		0.171***		0.0860***
		(0.0271)		(0.0246)		(0.0300)
1=Household practises shifting cultivation		-0.143**		0.155***		0.341***
		(0.0573)		(0.0443)		(0.0590)
1=Household practises rotating cultivation		0.0247		0.220***		0.448***
		(0.0305)		(0.0289)		(0.0358)
1=Household used tractors		0.250***		0.0906***		0.0234
		(0.0215)		(0.0209)		(0.0239)
1=household used planting equipment		0.0837***		-0.235***		0.172***
		(0.0271)		(0.0247)		(0.0216)
1=Household used processing equipment		-0.111***		-0.235***		-0.0533*
		(0.0283)		(0.0265)		(0.0317)
1=Household used organic fertilizer		-0.0379		-0.143***		-0.138***
		(0.0415)		(0.0280)		(0.0289)
1=Household used chemical fertilizer		0.194***		-0.482***		-0.199***
		(0.0563)		(0.0324)		(0.0317)
1=Household used pesticides		0.191***		0.175***		0.104**
		(0.0640)		(0.0418)		(0.0419)
1=Village has agriculture and machinery store		0.0299		-0.0218		-0.207***
		(0.0708)		(0.0579)		(0.0485)
1=Village has input store		-0.304***		-0.137**		0.307***
		(0.0697)		(0.0591)		(0.0442)
1=Household received extension services		-0.0038		0.0182		0.0830***
		(0.0281)		(0.0253)		(0.0282)
Rice cultivation in wet season	0.919***		0.346***		0.650***	
	-0.0356		-0.0226		-0.0383	
Constant	-0.0973***	-0.656***	-0.000564	-0.039	-0.109***	-1.616***
	-0.0362	-0.0987	-0.0286	-0.0802	-0.0215	-0.0925
Lambda (rho*sigma)	-0.335***		0.0108		-0.166***	
	-0.0223		-0.0145		-0.0212	
Observations	11,137		14,064		16,382	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 3 – Table 4. Disaggregated regression model of rice (provinces classified by economic zone)

Variables	Households classified by economic zone					
	Lowland		Upland		Plateau	
	Rice sale	Rice cultivation	Rice sale	Rice cultivation	Rice sale	Rice cultivation
1=Farmers in village sell through contract farming	0.014	-0.00568	0.0565***	-0.0309	0.0612***	-0.0184
	(0.0119)	(0.0530)	(0.0112)	(0.0715)	(0.0117)	(0.0591)
1=Farmers in village sell directly to companies	0.0448***	-0.0936*	-0.00465	-0.427***	-0.0188	-0.537***
	(0.0131)	(0.0551)	(0.0204)	(0.0862)	(0.0163)	(0.0628)
1=Farmers in village sell directly to traders in village	0.0781***	-0.0777**	0.119***	-0.0475	0.0040	0.187***
	(0.0077)	(0.0351)	(0.0086)	(0.0547)	(0.0100)	(0.0475)
1=Farmers in village sell directly to traders in other village	0.0820***	0.0498	0.126***	0.0983*	0.0998***	0.0702
	(0.0081)	(0.0359)	(0.0091)	(0.0577)	(0.0112)	(0.0521)
1=Farmers in village sell in village market	-0.0151**	-0.154***	0.0207**	-0.131**	-0.0125	-0.134***
	(0.0072)	(0.0325)	(0.0092)	(0.0542)	(0.0099)	(0.0471)
1=Farmers in village has other ways to sell	-0.0093	0.0066	-0.0530***	0.0634	-0.0008	-0.255***
	(0.0107)	(0.0484)	(0.0148)	(0.0955)	(0.0173)	(0.0723)
1=Household head is male	0.0370***	-0.0217	0.0180	0.1630	0.0656***	-0.0276
	(0.0115)	(0.0497)	(0.0210)	(0.1080)	(0.0203)	(0.0846)
Age of household head (years)	0.00212***	-0.00485***	0.000585*	0.00367*	0.0003	0.0007
	(0.0003)	(0.0012)	(0.0003)	(0.0020)	(0.0004)	(0.0017)
Adult members in the households (number)	-0.0135***	0.0656***	0.0007	0.0791***	-0.00667***	0.0823***
	(0.0016)	(0.0074)	(0.0016)	(0.0112)	(0.0020)	(0.0108)
1=Household received credit	0.0839***	-0.0573	0.0180	0.0351	0.0382***	-0.0039
	(0.0110)	(0.0487)	(0.0112)	(0.0714)	(0.0118)	(0.0590)
1=Village experienced drought in every 1-2 years	0.0027	0.331***	-0.0707***	-0.0164	-0.0673***	0.269***
	(0.0086)	(0.0362)	(0.0086)	(0.0558)	(0.0106)	(0.0487)
1=Village experienced pest attack in every 1-2 years	-0.0280***	0.225***	0.0012	0.160***	-0.0038	-0.0538
	(0.0082)	(0.0350)	(0.0088)	(0.0555)	(0.0106)	(0.0505)
1=Village has road accessible in both seasons	-0.0051	-0.0703	-0.0628***	-0.317***	0.0400***	-0.281***
	(0.0097)	(0.0452)	(0.0084)	(0.0560)	(0.0107)	(0.0584)
1=Village has a permanent market	-0.0278***	-0.0921***	-0.0292***	-0.178***	-0.0248***	-0.0968***
	(0.0043)	(0.0174)	(0.0072)	(0.0336)	(0.0059)	(0.0275)
1=Village has shops/services	-0.0286**	-0.276***	0.0457***	-0.0827	-0.0070	-0.0232
	(0.0133)	(0.0618)	(0.0125)	(0.0755)	(0.0166)	(0.0828)
1=Village has a food store	0.0619***	-0.0055	-0.0224*	0.0535	0.0426***	-0.191**
	(0.0111)	(0.0492)	(0.0122)	(0.0727)	(0.0153)	(0.0744)
1=Village has a trade group	0.0319**	-0.0890*	-0.0027	-0.297***	0.0276**	-0.0721
	(0.0125)	(0.0540)	(0.0153)	(0.0792)	(0.0137)	(0.0624)
1=Village has a cooperative society	0.0382**	-0.116*	-0.0536**	0.0870	0.0498***	-0.1100
	(0.0154)	(0.0626)	(0.0220)	(0.1300)	(0.0187)	(0.0805)
1=Village Development Fund is available	0.0311***	-0.246***	0.0225***	-0.125**	0.0244***	-0.114**
	(0.0073)	(0.0329)	(0.0084)	(0.0522)	(0.0094)	(0.0458)
1=Household received price information	0.0294***	-0.0068	0.0151***	0.0054	0.0212***	-0.0538***
	(0.0026)	(0.0120)	(0.0028)	(0.0175)	(0.0033)	(0.0169)
Cattle owned by the household (number)	0.00903***	-0.0140***	0.00305***	-0.0126**	0.00890***	0.0054
	(0.0007)	(0.0029)	(0.0009)	(0.0049)	(0.0010)	(0.0054)

1=Village has paid employment opportunities	0.0323***	0.0338	0.0206**	-0.161***	0.0514***	-0.340***
	(0.0123)	(0.0509)	(0.0086)	(0.0590)	(0.0119)	(0.0644)
Land owned by the household (hectares)		0.0820***		-0.0321**		-0.0345***
		(0.0090)		(0.0136)		(0.0128)
Irrigated land owned by the household (hectares)		0.0867***		0.383***		0.387***
		(0.0225)		(0.0538)		(0.0380)
1=Household used outside labour for cultivation		0.340***		0.246***		0.380***
		(0.0357)		(0.0544)		(0.0478)
1=Household practises shifting cultivation		0.415***		1.818***		2.051***
		(0.1530)		(0.1560)		(0.2270)
1=Household practises rotating cultivation		0.645***		1.265***		1.269***
		(0.0621)		(0.0561)		(0.0553)
1=Household used tractors		0.555***		0.525***		0.398***
		(0.0289)		(0.0487)		(0.0348)
1=household used planting equipment		0.204***		0.115**		0.0555
		(0.0299)		(0.0512)		(0.0371)
1=Household used processing equipment		0.505***		0.308***		0.612***
		(0.0342)		(0.0519)		(0.0445)
1=Household used organic fertilizer		0.575***		0.246***		0.492***
		(0.0347)		(0.0772)		(0.0563)
1=Household used chemical fertilizer		0.283***		0.0510		0.363***
		(0.0360)		(0.0963)		(0.0712)
1=Household used pesticides		-0.235***		-0.189*		-0.184**
		(0.0483)		(0.1080)		(0.0849)
1=Village has agriculture and machinery store		-0.0601		-0.1120		0.446***
		(0.0504)		(0.1220)		(0.1040)
1=Village has input store		-0.188***		-0.0773		-0.432***
		(0.0473)		(0.1260)		(0.0999)
1=Household received extension services		-0.0479		-0.195***		0.147***
		(0.0336)		(0.0529)		(0.0474)
Rice cultivation in wet season	0.628***		0.499***		0.557***	
	-0.0219		-0.0401		-0.0281	
Constant	-0.500***	0.00387	-0.377***	0.229	-0.459***	0.00538
	-0.0303	-0.112	-0.0453	-0.164	-0.039	-0.153
Lambda (rho*sigma)	-0.200***		-0.151***		-0.169***	
	-0.0130		-0.0216		-0.0170	
Observations	17,844		13,566		9,966	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 3 – Table 5. Disaggregated regression model of other crops (provinces classified by economic zone)

Variables	Households classified by economic zone					
	Lowland		Upland		Plateau	
	Crop sales	Crop cultivation	Crop sales	Crop cultivation	Crop sales	Crop cultivation
1=Farmers in village sell through contract farming	0.103***	0.542***	0.117***	0.490***	0.0824***	0.555***
	(0.0119)	(0.0355)	(0.0141)	(0.0344)	(0.0142)	(0.0364)
1=Farmers in village sell directly to companies	-0.0263**	0.166***	-0.0275	0.529***	0.0174	0.388***
	(0.0116)	(0.0411)	(0.0223)	(0.0593)	(0.0173)	(0.0489)
1=Farmers in village sell directly to traders in village	0.0452***	0.178***	0.0925***	-0.153***	0.0459***	0.0871***
	(0.0069)	(0.0269)	(0.0094)	(0.0252)	(0.0103)	(0.0296)
1=Farmers in village sell directly to traders in other village	0.0452***	0.0422	0.0787***	0.136***	0.0680***	-0.136***
	(0.0071)	(0.0280)	(0.0102)	(0.0267)	(0.0115)	(0.0334)
1=Farmers in village sell in village market	0.0200***	0.0447*	-0.0078	-0.106***	0.0301***	0.0347
	(0.0064)	(0.0251)	(0.0101)	(0.0267)	(0.0101)	(0.0297)
1=Farmers in village has other ways to sell	0.0192**	-0.0958**	-0.0577***	0.0622	-0.0449**	-0.0269
	(0.0094)	(0.0378)	(0.0159)	(0.0432)	(0.0177)	(0.0518)
1=Household head is male	0.0129	0.326***	-0.0003	0.0730	0.0247	0.0705
	(0.0103)	(0.0442)	(0.0227)	(0.0617)	(0.0209)	(0.0602)
Age of household head (years)	0.00102***	-0.0006	0.00121***	0.0009	0.000888**	0.00256**
	(0.0002)	(0.0010)	(0.0003)	(0.0009)	(0.0004)	(0.0011)
Adult members in the households (number)	0.0015	0.0017	-0.00581***	0.0105**	-0.00570***	-0.0022
	(0.0014)	(0.0054)	(0.0017)	(0.0045)	(0.0020)	(0.0059)
1=Household received credit	0.0333***	0.264***	0.0271**	0.185***	-0.0039	0.128***
	(0.0100)	(0.0344)	(0.0127)	(0.0328)	(0.0124)	(0.0355)
1=Village experienced drought in every 1-2 years	0.0458***	-0.156***	0.0140	0.0804***	-0.0011	-0.0040
	(0.0076)	(0.0282)	(0.0094)	(0.0250)	(0.0107)	(0.0312)
1=Village experienced pest attack in every 1-2 years	0.0151**	-0.121***	-0.0168*	-0.0655**	0.0000	0.0886***
	(0.0071)	(0.0271)	(0.0095)	(0.0255)	(0.0109)	(0.0315)
1=Village has road accessible in both seasons	-0.0000396	0.0321	0.0452***	-0.0206	0.0413***	0.0436
	(0.0085)	(0.0339)	(0.0090)	(0.0248)	(0.0110)	(0.0323)
1=Village has a permanent market	-0.0192***	-0.0623***	-0.0106	-0.0509**	-0.0115*	0.0133
	(0.0038)	(0.0158)	(0.0076)	(0.0221)	(0.0061)	(0.0190)
1=Village has shops/services	-0.0435***	0.0788*	0.0087	0.0312	-0.0003	0.0578
	(0.0117)	(0.0471)	(0.0134)	(0.0362)	(0.0171)	(0.0493)
1=Village has a food store	0.0129	0.0212	-0.0018	-0.0861**	-0.0115	-0.0701
	(0.0098)	(0.0389)	(0.0133)	(0.0356)	(0.0158)	(0.0456)
1=Village has a trade group	0.0251**	0.0231	-0.0235	0.129***	-0.0099	-0.228***
	(0.0110)	(0.0394)	(0.0165)	(0.0452)	(0.0144)	(0.0409)
1=Village has a cooperative society	-0.0265*	-0.0538	0.0154	0.140**	-0.0237	0.207***
	(0.0136)	(0.0511)	(0.0238)	(0.0646)	(0.0193)	(0.0564)
1=Village Development Fund is available	0.0010	-0.0317	0.0453***	-0.0039	0.0344***	-0.149***
	(0.0064)	(0.0247)	(0.0090)	(0.0243)	(0.0099)	(0.0279)
1=Household received price information	0.0196***	0.0635***	0.0321***	0.0104	0.0190***	0.0165
	(0.0023)	(0.0090)	(0.0030)	(0.0085)	(0.0034)	(0.0102)
Cattle owned by the household	0.00253***	-0.0136***	-0.0009	0.0025	0.0002	-0.0008

(number)	(0.0006)	(0.0025)	(0.0010)	(0.0028)	(0.0011)	(0.0032)
1=Village has paid employment opportunities	-0.0015	-0.0703*	0.0483***	-0.108***	0.0855***	-0.104***
	(0.0108)	(0.0421)	(0.0093)	(0.0259)	(0.0122)	(0.0359)
Land owned by the household (hectares)		0.0817***		0.128***		0.144***
		(0.0052)		(0.0068)		(0.0083)
Irrigated land owned by the household (hectares)		0.0332***		0.0333*		0.180***
		(0.0118)		(0.0201)		(0.0200)
1=Household used outside labour for cultivation		0.250***		0.0561**		0.111***
		(0.0255)		(0.0246)		(0.0290)
1=Household practises shifting cultivation		0.0095		-0.182***		0.282***
		(0.1040)		(0.0377)		(0.0661)
1=Household practises rotating cultivation		0.631***		-0.0151		0.100***
		(0.0374)		(0.0275)		(0.0301)
1=Household used tractors		0.175***		-0.0616***		0.0907***
		(0.0207)		(0.0213)		(0.0210)
1=household used planting equipment		-0.0670***		-0.143***		-0.213***
		(0.0207)		(0.0231)		(0.0238)
1=Household used processing equipment		-0.122***		0.0525**		-0.115***
		(0.0281)		(0.0247)		(0.0297)
1=Household used organic fertilizer		-0.315***		-0.127***		-0.0628*
		(0.0257)		(0.0357)		(0.0328)
1=Household used chemical fertilizer		-0.321***		-0.130**		0.0669*
		(0.0272)		(0.0523)		(0.0395)
1=Household used pesticides		0.196***		0.266***		0.163***
		(0.0349)		(0.0572)		(0.0526)
1=Village has agriculture and machinery store		-0.0464		-0.129*		-0.318***
		(0.0415)		(0.0693)		(0.0663)
1=Village has input store		0.0575		0.0365		-0.0267
		(0.0389)		(0.0801)		(0.0673)
1=Household received extension services		0.0933***		0.0629***		-0.0525*
		(0.0262)		(0.0240)		(0.0294)
Rice cultivation in wet season	0.586***		0.660***		0.763***	
	-0.0252		-0.0408		-0.0351	
Constant	-0.0377*	-1.684***	-0.154***	-0.490***	-0.148***	-0.540***
	-0.0224	-0.0911	-0.0321	-0.084	-0.0345	-0.0971
Lambda (rho*sigma)	-0.0745***		-0.230***		-0.209***	
	-0.0148		-0.0256		-0.0221	
Observations	17,844	17,844	13,566	13,566	9,966	9,966

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1