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2015

Chapter 4 - The contribution of multi-purpose farming to the food security of small-scale farmers: An agro-economic analysis in the lowland Mekong alluvial plain

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Suggested citation: Tong, C. and Diepart, J.-C. (2015) The contribution of multi-purpose farming to the food security of small-scale farmers: An agro-economic analysis in the lowland Mekong alluvial plain. in Diepart, J.-C., (ed.) *Learning for resilience: Insights from Cambodia's rural communities,* Phnom Penh: The Learning Institute. pp. 79-100.

CHAPTER 4

The contribution of multi-purpose farming to the food security of small-scale farmers: An agro-economic analysis in the lowland Mekong alluvial plain

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ABSTRACT

Agricultural development models are the focus of intense debate in the Cambodian policy-making arenas. A model inspired by the 'Green Revolution', which promotes industrialization of rice cropping systems and is mainly dependent on external inputs, is usually contrasted with multi-purpose farming (MPF) in which rice cropping is integrated with other production to maximize their interactions and complementarities. The purpose of this research is to present some economic arguments based on the experience in promoting MPF of CEDAC (Centre d'Etude et de Dévelopement Agricole Cambodgien, also known as the Cambodian Center for Study and Development in Agriculture).

We develop a comparative analysis between conventional rice cropping systems and MPF to analyze the production economics and the overall patterns of household labor diversification. Focusing primarily on rainy-season rice production, we attribute significant advantage to MPF against non-MPF practices. These differences are perceptible in higher rice yield, lower cash-paid costs, and higher value-added per hectare. However, these differences become less significant when multi-purpose farming is only partially implemented, i.e. if some elements of the system are missing. MPF provides employment opportunities that represent a reliable alternative to job migration. Under MPF, family labor is used more on-farm than is the case with non-MPF farms and is more homogenously distributed throughout the year.

However, we identify barriers that curb the scaling-up of this innovation, which include limited access to information, anticipated lack of labor, lack of capacity or technical skills, lack of up-front capital to make the initial investment in land conversion to MPF, and land plot sizes that are too small to be converted to this model. We also discuss the opportunities to create markets for products of differentiated quality produced under multi-purpose farming.

Key words: *multi-purpose farming, agriculture, food security, agro-ecology*

INTRODUCTION

Despite a significant reduction in poverty over the past 20 years, food insecurity remains widespread in Cambodia. According to the FAO's indicators (2002), from 1990-1992 to 2011-2013 the prevalence of undernourishment[1] in the total population dropped from 39.4 percent to 15.4 percent. But in a context of demographic growth, the number of people who are undernourished remained high in 2013 (2.2 million people) (FAO 2014). In a recent World Bank poverty assessment, despite a huge drop in poverty between 2004 and 2011 (from 52.3 percent to 20.5 percent), there has been a lack of progress in combatting child malnutrition: the percentage of children who, between 2005 and 2010, could be described as `wasted' actually increased from 8 to 11 (World Bank 2013). In Cambodia, the paradox represented by food insecurity is well-recognized (Royal Government of Cambodia 2014); it is a rural problem affecting a farming population whose primary occupation is to produce food for self-consumption.

In the context of high agricultural prices, there is an increasing consensus that agricultural development is particularly effective in reducing hunger and malnutrition (FAO et al. 2012). To reduce poverty, action should be focused where the poor live and on the endowments of the poor (World Bank 2013). But the challenges facing small-scale farmers are immense: they need to increase food production for a growing rural population, address the increase and diversification of food demand from the urban population which is growing at an even faster rate than its rural counterpart (National Institute of Statistics 2009), and generate surplus for export.

Some institutional circumstances make these tasks challenging: national investment for small-scale agricultural development remains low (World Bank 2013); agricultural land holdings have become heavily fragmented in the context of high demographic pressure on land (Royal Government of Cambodia 2008); and the domestic food price index remains volatile (FAO 2014). Scarcity of labor as people transfer from agriculture to secondary and tertiary sectors through rural-to-urban migration, raises production costs (Diepart et al. 2014).

In order to address these challenges, two contrasting models of agricultural development are being promoted in Cambodia. The first is a 'Green Revolution' model which promotes industrialization of rice cropping systems through use of high-yielding rice varieties (and their required chemical and other inputs) developed abroad. It also promotes increased rice production for export and the development of irrigation infrastructure for early season or dry season cultivation (Royal Government of Cambodia 2005, Royal Government of Cambodia 2010). This model implies rice production intensification and very often results in a very limited degree of crop diversification. The second system is multi-purpose farming (MPF) which is an alternative model for sustainable agriculture. In MPF, rice cropping

[1] Undernourishment is measured as the proportion of the population below the minimum level of dietary energy consumption. That is, the MDG indicator number 1.9, which uses the distribution of dietary energy consumption on per person per day as a base

is integrated with other products and production activities and processes (livestock, aquaculture, orchards, forage, annual crops, and so on) to maximize their interactions and complementarities (Agri-Sud 2010). It includes several types of agro-ecological practices and resource-conserving technologies that can be used to improve the stocks and use of natural capital, for example, integrated pest management, conservation tillage, livestock integration, water harvesting, aquaculture and agroforestry (Pretty 2006).

There are several significant differences between these two models of agricultural development models. First, there is a clear distinction between the societal aspects of each. Integrated farming systems and agro-ecology are knowledge-intensive and are based upon dialogue between farmers and their supporters. Agro-ecology is a source of emancipation for farmers: instead of receiving advice, they become development co-actors (De Schutter 2010) and are not just implementers of a productivity-enhancing modernization scheme as tends to be the case with the `Green Revolution' model. Second, there is a clear environment management divide between both models. Unlike rice mono-cropping, which relies on chemical fertilizers and pesticides, MPF recognizes and uses the complexity of the agro-ecosystem. It mimics nature in that production activities integrate into food production processes such biological and ecological processes as nutrient cycling, nitrogen fixation, soil regeneration, predation and parasitism (Pretty 2006). The system builds on positive interactions and nutrient transfers between crop and livestock sub-systems. In the context of environmental changes, MPF can be climate-smart, as it may provide protection against drought, flood, and storm hazards that is better and more integrated (Lipper et al. 2010). Third, the economic logic of the two models is notably different. MPF operations draw on recycled by-products and locally-made bio-pesticides and organic fertilizers and rely less on costly chemical products that can cause harm to the environment. If yield is maintained, lower costs that are related to the reduced use of off-farm chemical inputs may keep the production cost low with a net positive effect on profitability and overall farm income.

The purpose of this research is to shed light on these economic arguments, which are the subject of intense debate among agro-economists and policy-makers. We examine cases of multi-purpose farms supported by CEDAC, focusing on the economic advantages and constraints of MPF against conventional rice field systems. A comparative approach is used to analyze the costs incurred by both and the consequent values created during the operation of a multi-purpose farm. We also compare the overall patterns of household labor diversification, and the structure of total family income. Based on this analysis, the rationality of the MPF system is assessed, along with its appropriateness and the potential for scaling it up.

CEDAC APPROACH TOWARDS MULTI-PURPOSE FARMING

After introducing the System of Rice Intensification (SRI) to Cambodia in 2000, CEDAC started supporting farmers to experiment with the conversion of their rice fields into diversified farming systems. Experiments included digging canals, building surrounding dikes, planting 'living fences' of multi-purpose trees, digging small ponds to improve water storage and accessibility, and growing additional crops on the dikes, upper fields and in the rice fields as inter-crops. What was then called the System of Intensification and Diversification (SID) evolved into an improved integrated farming system that CEDAC now refers to as Multi-Purpose Farming (MPF). This combines rice production with the growing of fruit trees, perennial crops, vegetables and seasonal crops, as well as animal husbandry and aquaculture. Since 2001, the initiative has encouraged more than 400 farmers across Cambodia (in CEDAC target areas) to convert their small plots of land to multi-purpose farms. Other NGOs like Partnership for Development of Kampuchea (PADEK) and Catholic Relief Services (CRS) have also promoted integrated farming and, all together, the innovation has been adopted by approximately 2,400 farmers.

MPF is an agricultural innovation that aims to enhance the production capacity of small-scale farmers as well as the quality and diversify of their food intake. The model rests on the assumption that better soil management and diversification in farming activities will result in increased yield and diversified food production, thus contributing to improved family income and nutrition.

The conversion of rice fields into an MPF system requires an important change in land use (Figure 1). A fully functional, multi-purpose farm comprises several sub-systems. Farmers retain about 60 percent of their land area for rice cultivation. The rice plot is surrounded by a deep canal to store water and allow for efficient mobilization of water resources, to limit irrigation expenses (work time and water quantity used) or to serve as drainage when there is too much water (water logging) in the farm. The canal and rice field are surrounded by a dike that helps to keep fish and soil nutrients within the farm area and that also prevents minor flooding. The rest of the farm is divided into two or three areas: a pond serving for aquaculture production, and an upper area for seasonal crops and vegetables, for fruit trees, and for livestock rearing. Sediments from the pond and canal are collected annually. This, and manure from animal raising, is recycled as fertilizer, either directly or combined with crop residues to produce compost (making nutritional elements more easily available to plants and limiting the risk of propagating weeds, pests, and disease organisms contained in the manure and straw). Multi-purpose trees (often leguminous, which are effective as nitrogen fixers) planted on the dike as a living fence, limit damage from wind or animal grazing and reduce soil erosion. Living fences function as hedgerows, and are favorable to crops through providing shade, and increasing the presence of natural enemies to pests (diversity). These living fences also reduce the leaching of mineral elements from the farm to outside areas, provide biomass resources for use on the farm, and create ecological habitats conducive to maintaining agro-ecological diversity.

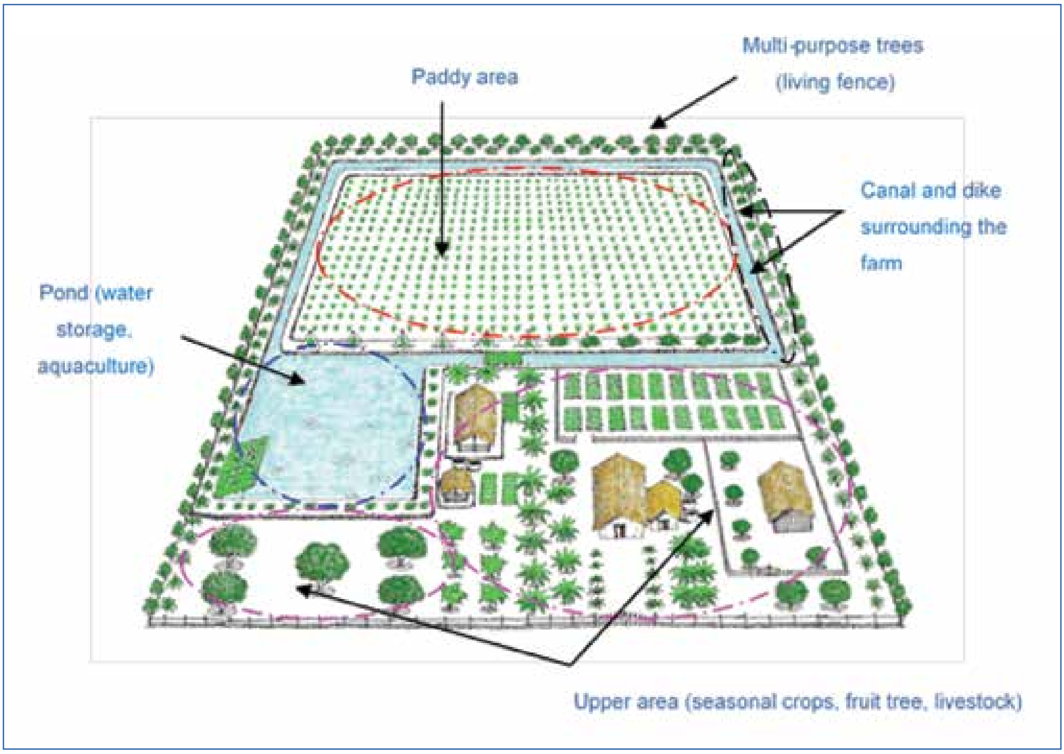

Figure 1: *General design of a Multi-Purpose Farm (Lim 2007)*

In the rice area, CEDAC promotes the System of Rice Intensification (SRI). This involves integrated agro-ecological farming practices designed to provide optimal growing conditions to individual rice plants to maximize tillering (Lim 2007). SRI practices involve raising seedlings in non-waterlogging nurseries, then gently transplanting single, young (8-15 days old) seedlings using wide plant spacing, and providing intermittent irrigation to avoid permanent flooding during the vegetative growth phase. Compost is used instead of chemical fertilizer, and intensive manual or mechanical weed control avoids the need for herbicides (Uphoff et al. 2002). Previous research has shown that the potential for SRI is high for resource-poor farmers (Dobermann 2004) in areas close to the homestead where the transfer of organic fertilizers is easily achieved (Anthofer 2004).

Preliminary research conducted by Lim (2007) indicated that the MPF system is suitable for areas of between 0.2 and 0.6 ha, with the water surface representing 15 percent of the area, the rice field 60 percent and the upper area for seasonal crops, fruit trees and livestock representing 25 percent. The up-front investment costs (in cash) necessary to convert 0.5 ha of rice field into an MPF system is approximately USD 830. This covers the cost of renting the machine to dig the pond and surrounding canal (USD 1 for each cubic meter of soil). Additional labor for soil digging is usually provided in-kind by the family, and represents approximately USD 600 for 0.5 ha (USD 2 for each cubic meter of soil).

The perception of the farmers on the contribution an MPF system can make to household food security is very positive. Earlier surveys showed that farmers who had adopted this system observed increased food supply - thus reducing their expenditure on food - and greater income from the sale of surplus produce. In terms of nutrition, they reported that their farms were able to produce a greater variety of food for consumption and that this had improved the health of family members (Lim 2007, Pean 2004).

METHODOLOGY

Study area and action-research process

The research was conducted in Takeo province located in the Mekong alluvial plain (Figure 2) in south-central Cambodia. The selection of Takeo is based on the following criteria: high incidence of poverty and food insecurity; livelihoods are subsistence-rice based; households possess small landholdings; and CEDAC is currently involved in supporting multi-purpose farming in this region.

This province is a rain-fed lowland area, highly prone to drought, and is located about 78 km from Phnom Penh. Around 93 percent of the total 186,247 families living there produce rice and most of them grow one crop a year. The average agricultural land area is one hectare per household, and 57 percent of households have less than one hectare of rice land (NCDD 2010). The average rice yield is 1.74 tonnes per hectare and about 40 percent of farmers are unable to produce enough rice for family consumption. The production of vegetables and other crops, as well as animal husbandry, are the secondary farming activities after rice. Limited irrigation is one of the main constraints for farmers wishing to increase agricultural production (CEDAC 2010).

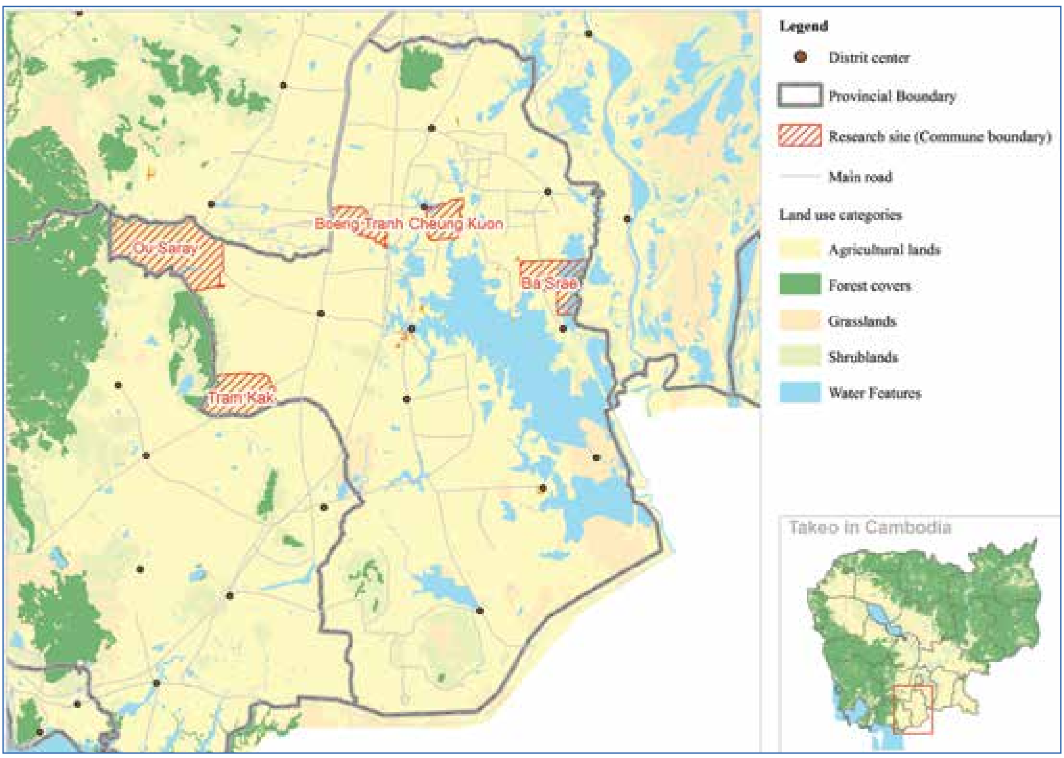

Figure 2: *Overall land use in Takeo province and the study area*

The action-research included two distinct steps: a diagnostic and then a monitoring phase.

Diagnosis and classification of multi-purpose farms

The diagnostic phase was conducted to understand the specific agro-ecological context and the type of multi-purpose farming activities in which households were engaged. The preliminary phase was also used as a forum to review past experiences in implementing multi-purpose farming in each village, to present the action-research project, and to probe the capacities and willingness of households to engage in a detailed survey of their farming systems. Two participatory rural appraisal (PRA) tools were used: focus group discussions with community representatives; and semi-structured interviews with selected households. This phase was carried out in January and February 2012 with 66 sample households selected from four villages, using the purposive sampling techniques for MPF farmers and simple random sampling for non-MPF farmers. Two of the villages studied already featured examples of MPF, and two others did not. The sample households represented three groups: MPF farmers and non-MPF farmers in the same village where MPF was already practiced, and non-MPF farmers from other villages. The sample size was determined with a confidence interval of 90 percent using the Yamane Taro formula (Israel 1992).

An important output of this diagnostic phase was the classification of farming systems into three groups according to the degree to which the MPF system had been adopted; this distinction was important in calculating rainy season rice production:

1. 'MPF complete' farms were those that had:
    - paddy fields fully converted into MPF with the existence of all sub-systems (Figure 1)
    - canal and dike (some had a completed dike surrounding the whole farm, some only on one or two edges of the farm)
    - seasonal crops/vegetables all year round as they benefited from better access to water sources for irrigating their crops via the pond and canal. More flexible water management also allowed for intermittent irrigation (alternating between dry and wet soil conditions) which is an important aspect in the System of Rice Intensification (SRI)
    - farmers who had been engaged in the system for a long time with significant coaching and mentoring from CEDAC.
2. 'MPF incomplete' farms were those that had:
    - farming systems comprising a limited number of MPF activities, usually a pond, seasonal crops/vegetables, small livestock or fish rearing, and rice production. No canal or dike. These farmers mainly focused on livestock production (in particular poultry rearing) or vegetables for market
    - farmers who, although they had received support from CEDAC, had a more recent experience in agro-ecology: they were in a process of transition from conventional rice farming to fully integrated multi-purpose systems.

3. Non-MPF farmers were those that were:
    - mostly engaged in conventional rice cropping systems, although some of them had received agro-ecology training from CEDAC covering subjects such as SRI. They were also involved to varying degrees in several farming activities (rice, livestock, fish rearing and non-rice crops), but these sub-systems were running in parallel and were not integrated as is the case in MPF.

Information from the diagnostic phase formed the basis for household selection for the next (monitoring) phase. Households were selected in five communes in two districts located in very similar agro-ecological environments. The selection of households followed an *ad hoc* procedure. First, there was purposive selection of households involved in MPF. In total 26 MPF farmers were selected (eight from 'MPF complete' farms, and 18 from ones that were `MPF incomplete'). Then, in order to make the most robust comparison possible, an equivalent number of households (n=26) were selected who were not involved in MPF but in mono-cropping farming. The sample size was limited as the comprehensive recording and monitoring work required a lot of resources. The total sample is presented in Table 1.

Table 1: *Key characteristics of sample households (HH)*

	Number of HH	Agricultural land area (ha)			Rice intensification index[2]
		Total	Upper land	Rice field	
MPF complete	8	0.85	0.12	0.73	1.17
MPF incomplete	18	1.09	0.11	0.98	1.15
Non MPF	26	0.99	0.01	0.98	1.07
Total sample	52	1.01	0.6	0.94	1.11

Monitoring multi-purpose farms

The monitoring phase was implemented over the course of one year and was based on a record of all production activities (products and expenses), labor use and level of consumption in respect of each household. The participating farmers were asked to record the relevant data in a daily datasheet format in a logbook. Once a month (from May 2012 to April 2013), the research team visited to copy the farmers' data record and/or ask for more information/clarification if any data was missing or unclear. To enable the process of data recording and collection to be conducted thoroughly and accurately, the team gave farmers extensive training in record keeping through a monthly workshop. This time-consuming effort paid off, and we are confident that accurate data was collected from the farm households. Furthermore, most of the households had participated in CEDAC's projects and training for many years and had a keen interest in discovering their actual household income and expenses.

[2] The rice intensification index is a specific measure of rice intensification derived from the ratio between the total rice cultivated area (ha) and total usable rice land area (ha)

Analytical framework

The comparison of performance between multi-purpose and non-multi-purpose farming systems is based on production processes, household labor management and income generation.

A number of production indicators were used to evaluate and compare the productivity, efficiency and profitability of the two systems. While the primary focus was on land productivity, indicators were also developed to take into account the return on labor in both systems.

Value of production and value-added

The analytical approach was centered on the notion of value-added, which represents the wealth created during the production process (Dufumier 1996). The value-added equals the gross value of the production (in-kind and in-cash) minus the cost values of production inputs called consumables i.e. that are entirely consumed during the production process (fertilizers, pesticides, renting of equipment, seeds, and so on) (Figure 3). The value-added serves to pay for the services supplied during the production process: the external labor; the payment of interest rates to credit institutions; and taxes paid to the state or landowners. After deduction of these external services, the balance is the income left to the family engaged in the production process.

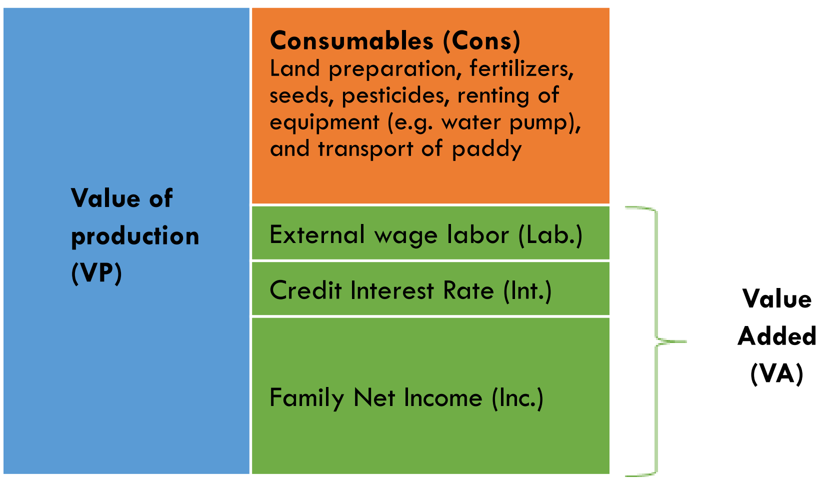

***Figure 3:** Structure of key indicators in the agro-economic analysis*

Productivity indicators

Indicators of productivity are derived from the value of the product for both direct consumption and for sale. Land and labor productivities indicate the production per unit of land (kilograms per hectare) and labor (kilograms per each man.day), respectively. The rice intensification index is a specific measure of rice intensification derived from the ratio between the total rice cultivated area (hectares) and the total usable rice land area (hectares). The costs calculated per unit of land (USD/ha) indicate the level of intensification while cost per unit of product (USD/kg) is the so-called unit cost price. This quantifies how much it costs to produce one kilogram of product (e.g. rice).

Research limitations

The initial aim was for the sample size to comprise 52 housheolds (26 MPF farmers and 26 non-MPF farmers) to allow for a consistent statistical comparison. As our research project developed, however, we realised that it was necessary to split the group of MFP farmers into two categories - complete- and incomplete-MPF. Indeed, multi-purpose farming is at full potential only when farmers are selecting and undertaking all necessary investments. If one element of the system is missing, the complementarity within the farming system is disrupted. We had, therefore, to take these major differences in production systems into account and, as a consequence, the basis for comparison is not as solid as initially intended.

The absence of household social-economic classification - to reflect the importance of non-farm employment and wages in the production system - was another limitation. It could be argued that non-farm and off-farm activities are factors that can affect the capacity of households to undertake innovations and improve their farming systems, such as engagement in MPF.

THE EFFICIENCY OF MULTI-PURPOSE FARMING SYSTEMS

In order to assess and compare the efficiency of multi-purpose farming against conventional rice cropping, we examined the production of rainy season rice - a key component of all farming systems in Takeo - and compared the degrees of productivity and efficiency between both production systems. We then widened the scope of the assessment between MPF farmers and non-MPF farmers by addressing the overall family labor management in the different household production sub-systems (farming, non-farm and wage labor) and scrutinized the resulting family income level and structure.

Rainy season rice production

Statistically significant differences were found in rainy season rice yield (Table 2) between complete MPF farms (3,153 kg per hectare) and non-MPF farms (2,357 kg per hectare) ($p = 0.02$). The rainy season rice yield of incomplete multi-purpose farms fell between these two categories (2,755 kg per hectare) but the difference with the other two is not statistically significant. In order to make sense of these differences, the factors that determine yield were also examined. These included rice varieties, water management, intensity of labor use and the use of inputs including chemical or organic fertilizers.

Farmers involved in rainy season rice production under the three different farming systems use mostly the same rice varieties in very similar proportions. Farmers grow jasmine rice (known as *romdoul*), mainly for sale, in areas ranging from 0.20 to 0.50 hectares, and a local variety (*chhma prom*) for family consumption. Both varieties have the same growing period and similar potential yield. As indicated in Table 2, the intensity of labor use as well as labor productivity for rainy season agriculture do not differ significantly between the three types of farming systems. As far as the costs of production are concerned, cash-paid costs of production (consumable inputs) are less important for multi-purpose farmers (Table 2) but these differences are not statistically significant. Figure 4 shows that incomplete-MPF farmers use fertilizer in the same proportion as non-MPF farmers; our research further revealed that incomplete-MPF farmers are also engaged in SRI cultivation techniques but they do not fully follow the SRI principles and rather specialize in livestock production (chicken, pig and fish rearing). The structure of cash-paid costs (Figure 4) reveals that the expenses of the multi-purpose farmers are lower for all items (water management, manure, fertilizers, soil preparation and seeds).

SECTION B

Table 2: *Indicators for rainy season rice production*

Indicator		**Complete Multi-Purpose Farm**		**Incomplete Multi-Purpose Farm**		**Non Multi-Purpose Farm**	
Yield	*Kg/ha*	3,153		2,755		2,357	
Family labor use	*Man.days/ha*	76		73		81	
Labor productivity	*Kg/man.day*	54		57		52	
Costs of production (consumables inputs)	*USD/ha*	30		84		66	
Unit cost price	*USD/kg*	0.0105		0.034		0.0305	
Value Added	*USD/ha*	985	(100%)	781	(100%)	621	(100%)
Including external labor	*USD/ha*	54	(5%)	118	(15%)	57	(9%)
Including payment of interest	*USD/ha*	56	(6%)	13	(2%)	13	(2%)
Including family income	*USD/ha*	875	(89%)	650	(83%)	551	(89%)

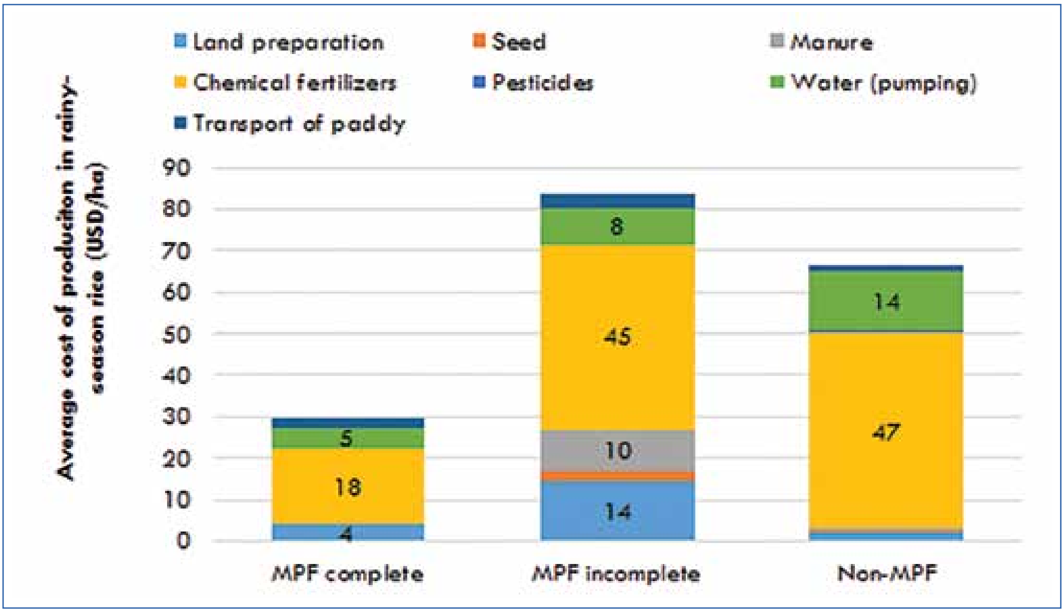

Figure 4: *Level and structure of production costs in rainy season rice (per hectare)*

In a context where there are no major differences in soil quality between the sites, these results suggest that complete MPF allows for much better management of soil fertility through the recycling of organic matter from other farming sub-systems such as livestock manure, cover crops grown in the dry season, leaves from trees/crops, and waste water from fish ponds. These practices, in association with the System of Rice Intensification (SRI), enable farmers to obtain significant productivity gains.

As Table 2 shows, the unit cost, which measures yield against the cost of production, is low for complete-MPF farmers suggesting that they are at a competitive advantage in rain-fed rice production compared with their non-MPF counterparts. The value-added per hectare sum, which describes the wealth created per hectare during the production process, is significantly higher for complete-MPF farmers (USD 985 per hectare) than for non-MPF farmers (USD 621 per hectare) ($p = 0.002$). While 5 percent of that value goes to pay external labor on complete-MPF farms, this value is much higher for incomplete- and non-MPF farmers (15 and 9 percent, respectively). As Figure 5 shows, the share of the value-added that goes on payment of interest is higher for complete-MPF farmers as a result of the up-front investment needed to transform the system. The resulting family income per hectare is significantly higher for complete-MPF farmers (USD 875 per hectare) compared with non-MPF farmers (USD 551 per hectare) ($p = 0.006$) but not significantly different for incomplete-MPF farmers (USD 650 per hectare).

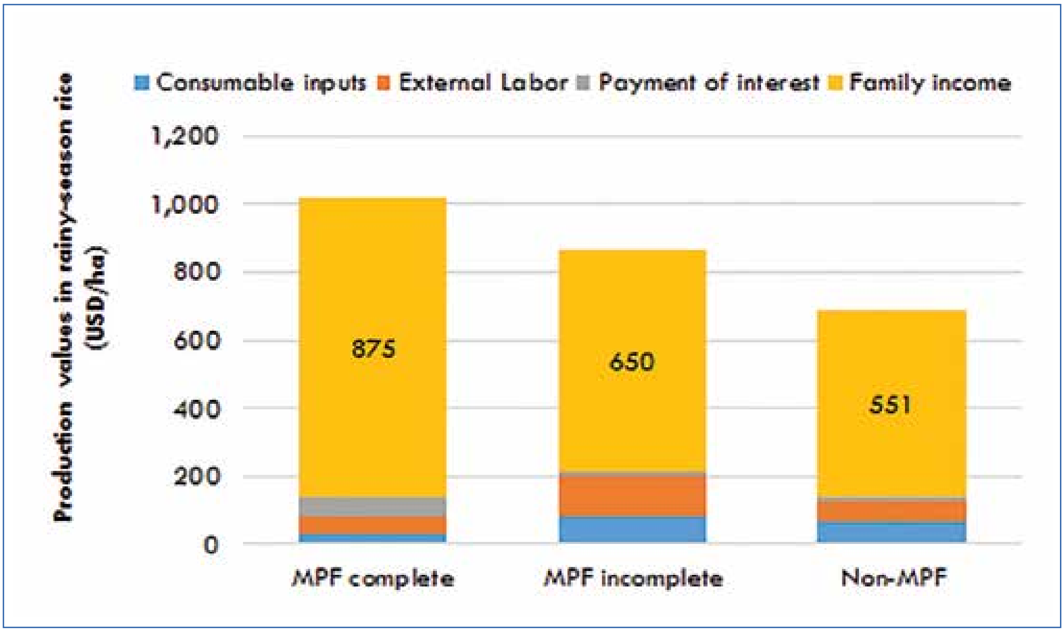

Figure 5: Distribution of production values in rainy season rice production

These results strongly suggest that wet season rice production under a complete-MPF model makes a lot of economic sense. Significant gains in productivity attributed to better labor, and water and soil fertility management, combined with lower level cash costs of production resulting from recycling of sub-products within the farm, increase production, making it more efficient and profitable. However, our data shows that these gains in productivity and profit margin are not significant for incomplete-MPF farmers. This suggests that in order to realize the full potential of multi-purpose farming, farmers need coaching and mentoring support so that they can follow the MPF principles more precisely.

Labor management

Family labor is engaged not only in farm activities; off-farm wage labor and non-farm work are frequently central elements in the income diversification portfolio of households. Takeo province, along with the other provinces in the Mekong delta, is known for high job migration rates especially among young people (Diepart et al. 2014). A wider picture of family labor management is thus necessary to assess multi-purpose farming in the overall context of livelihood diversification. The data allows us to group livelihood activities into three categories:

- Farming, which comprises self-employed activities such as rice production, livestock husbandry, fishing and upland crop production
- Non-farming, which includes self-employment, for example in small shops or in handicraft production, and
- Salaried jobs and wage labor, which include agricultural or non-agricultural wage labor sometimes involving migration (Figure 6).

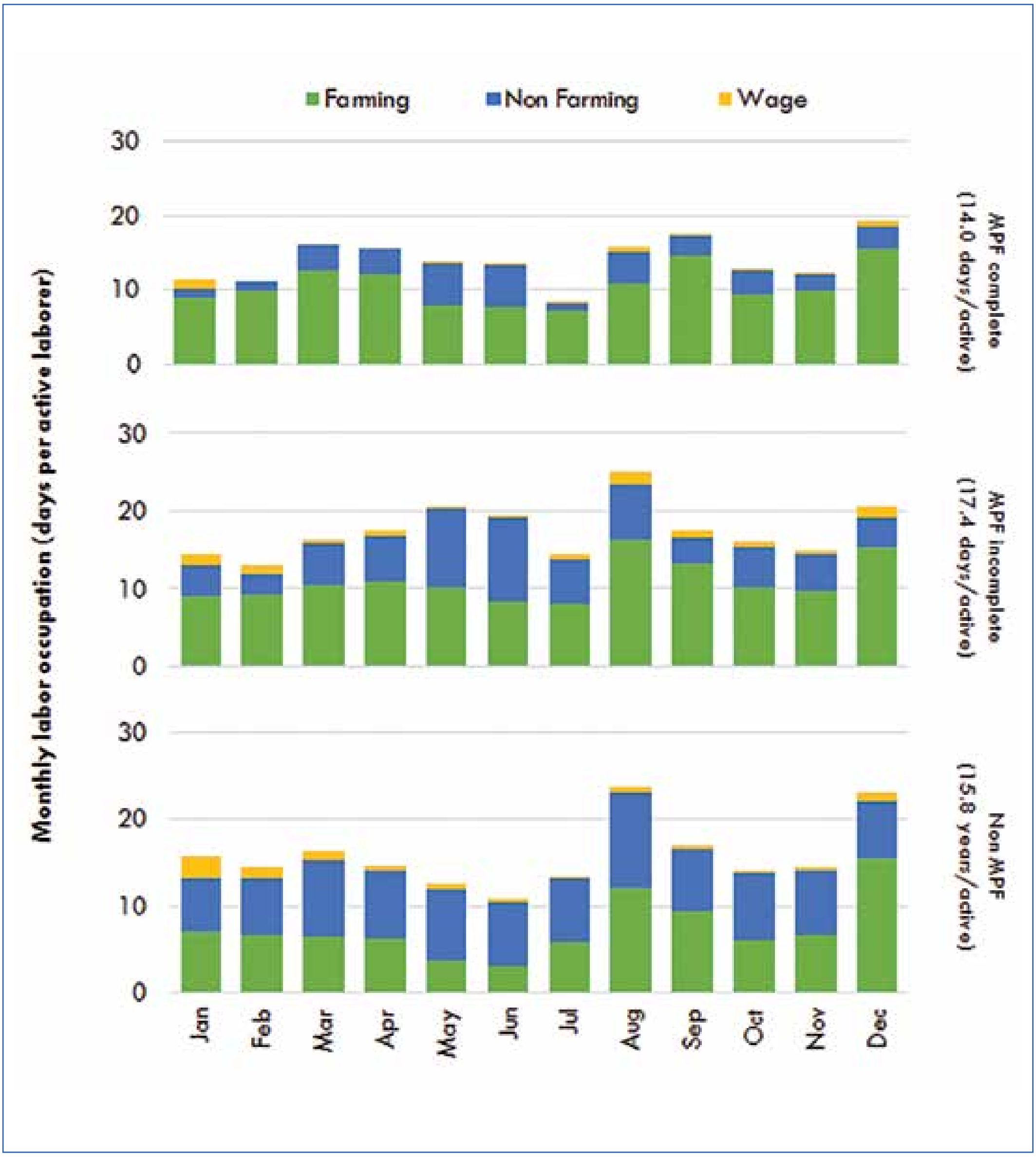

Figure 6: *Monthly distribution of labor*

Important observations can be drawn from Figure 6. First, it can be seen that the number of active working days tends to be lower for complete-MPF farmers (14.0 days/active/month) than for incomplete-MPF farmers (17.4 days/active/month) or non-MPF farmers (15.8 days/active/month). Furthermore, the share of labor devoted to farming activities is much higher for complete-MPF farmers (75 percent) against 63 percent and 47 percent for incomplete-MPF and non-MPF farmers, respectively.

A particularly important contribution of multi-purpose farming is that labor occupation in farming activities is significant in the dry season (especially on livestock or upper crop cultivation), a period when family labor is traditionally under-utilized or allocated to non-farm activities and very often to migration. Therefore, by providing productive employment at the farm level, multi-purpose farming also contributes to reducing migration. Another advantage of a multi-purpose farming system is that it allows for fuller employment and a more regular use of labor throughout the year (Figure 6).

Household income

These differences in labor management patterns also influence income structure. Incomes were computed separately for all livelihood activities and then averaged and aggregated into a hypothetical average family income. Incomes from farming activities covered those derived from rice, other crops and livestock (including aquaculture). Non-farm incomes included revenues from all self-employed and salaried activities, while agriculture or non-agricultural wage labor was accounted for in a separate category. The so-called 'external income' comprised all types of income generated outside (by family members or not) and transferred to the family through remittances or gifts.

The average annual income of complete-MPF households is significantly higher than that of non-MPF families (USD 1,155 per active laborer against USD 944) but slightly smaller than incomplete-MPF households. This is the result of the fact that households in our sample specialized in livestock production, and this does not necessarily reflect the situation of other incomplete-MPF households in the country.

Figure 7 indicates the differential in total income per active laborer (i.e. income attributed to household members who were capable of active labor). It can be seen that complete-MPF farmers gain in income generated by farming activities (rice and other crop production, and animal raising): these represent 64 percent of total income in the case of complete-MPF households, against 61 percent for incomplete-MPF and 45 percent for non-MPF households.

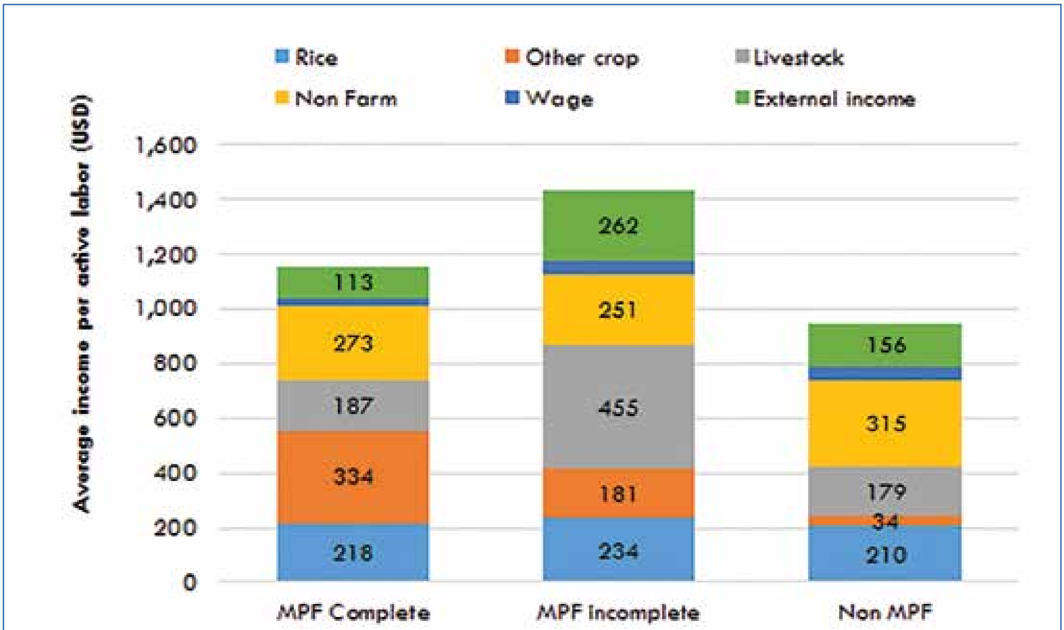

Figure 7: *Average family income per active laborer*

A corollary of this gain in agricultural income and diversification is the reduction of risk associated with specialization in mono-cropping. And in the context of environmental change, these risks have become higher as increased occurrence of flood or drought can have rapid and substantially negative effects on rice production and can jeopardize the family economy through indebtedness or survival migration.

However, Figure 7 indicates that income derived from wage, non-farm activities and external sources is not fundamentally different among the three types of household. This suggests that multi-purpose farming, even if it consolidates farm activities, assets and income, does not constrain livelihood diversification to solely farm activities. Non-farming activities remain accessible and even an important part of the income portfolio. This is an important observation to be interpreted in the wider perspective of agrarian transition and the transfer of labor from agriculture to the industrial and service sectors that is taking place in Cambodia. Despite the strong push from the government to accelerate this transition (Diepart et al. 2014), there is a growing consensus about the limited capacity of the industrial and services sectors to absorb labor from agriculture and to offer quality jobs to people who quit agriculture (Murshid and Phim 2007, World Bank 2013). In this context of non-linear and incomplete transition, multi-purpose farming helps to consolidate a farming sector in ways that reduce risks of failed transition.

PROMOTING MULTI-PURPOSE FAMING SYSTEMS

Understanding the factors that constrain the uptake of MPF is key. It is the basis on which policy makers and practitioners need to work to ensure the scaling-up of this innovation.

First of all, the survey reveals that a large proportion of households (82 percent) living close to MPF farmers have actually never heard about it. It seems that information and knowledge about this agricultural innovation are still very compartmentalized. Therefore, there is a need to break these barriers in order to promote it. In addition to this information gap, an important proportion of households (54 percent) do not want to engage in MPF and have definite reasons for that choice (Figure 8).

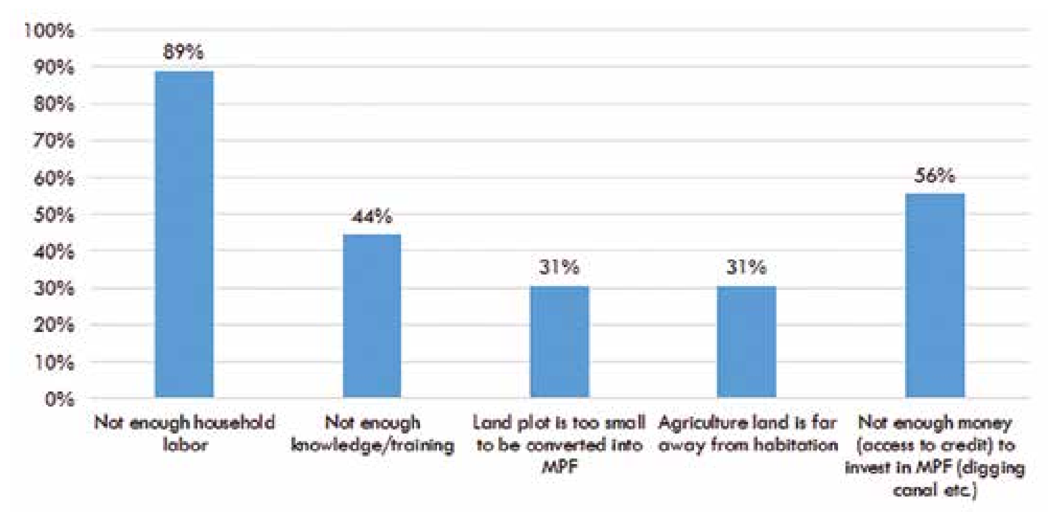

Figure 8: *Reasons for not adopting MPF*

Among those households not willing to engage in multi-purpose farming, 89 percent anticipate lack of labor as a key constraint. Our results suggest, however, that MPF does not necessarily make a more intensive use of labor but rather changes the labor employment patterns. Based on our results, we would argue that the key underlying question here has not so much to do with the amount of time and labor needed to conduct farming, but more with the interest on the part of the household, especially the young, to engage professionally in agriculture. But the development of multi-purpose farming is not so narrowly limited to farming as it brings a wide range of economic opportunities to create diversified services upstream and downstream of production itself, e.g. agro-processing, packaging, marketing, and so on. Capacity development and vocational training could be promoted along these lines to stimulate new vocations that would support this model of agriculture, especially among rural youth and young graduate students from faculties of agriculture.

A substantial 44 percent of households consider that a lack of capacity is a constraint that impedes them in engaging in multi-purpose farming. To address this, farm schools that facilitate farmer-to-farmer knowledge transfer should be promoted. For it to be fully successful, a co-learning approach between innovative farmers, and field practitioners and supporters is required. The model needs to undergo place-specific trials and experimentation, and to evolve within specific social-ecological contexts. Experience shows that the system works if there is adequate support and if farmers are able to experiment and innovate based on their own observation and analysis.

Another significant constraint (56 percent of households) is the lack of up-front capital to make the initial investment in land conversion to multiple-purpose farming. Credit is generally available in the area but at a high interest rate (e.g. 2.5 percent per month). This is arguably a key element to consider. The generalization of MPF is possible if adequate and affordable credit is made available to farmers or if there is sufficient public investment to equip farms with canals and small-scale irrigation systems (for instance through commune or district funds). This could also be achieved via a redirection of funds from mega-irrigation projects towards small (family) scale irrigation. Community/farmer-led savings groups currently exist in many rural villages and can provide access to financial capital.

For 31 percent of the households, the land plot size is considered too small to be converted into MPF. In reality, the degree of application of MPF is somewhat limited because the lands of small-scale farmers are parceled out in small plots scattered outside the household and even outside the village boundaries. Indeed, there are few instances of farms exhibiting the ideal layout as depicted in Figure 1.

But to push multi-purpose farming forward there is a need for a strong enabling policy framework that recognizes and promotes the approach as a credible component of sustainable agricultural development. The institutionalization of multi-purpose farming can be advanced through the creation of a market for products of differentiated quality produced under multi-purpose farming (eco-label, green products, and so on). Innovative marketing is needed to raise awareness among consumers and to stimulate their interest and demand for better quality products. New forms of partnerships between producers and consumers need to be developed through alternative agro-food networks (Kremen et al. 2012). One of these alternatives is the so-called 'community-supported agriculture', a partnership of mutual commitment between a farm and a community of supporters that provides a direct link between the production and consumption of food. Supporters usually cover a farm's yearly operating budget by purchasing a share of the season's harvest and in some cases they assist with the farm work. In return, the farm provides, to the best of its ability, a healthy supply of seasonal fresh produce (Hinrichs 2000).

A RESILIENT MODEL OF AGRICULTURE: CONCLUDING REMARKS

This chapter has presented multi-purpose farming as a resilient form of agriculture: for a start, it has demonstrated that this model makes strong economic sense. Compared with the conventional mono-cropping rice-based farming system, it shows significant gains in land productivity, efficiency and profitability for rainy season rice production. It helps consolidate the role and importance of farming in household economics both in terms of labor employment and income formation. It is a source of resilience in that it i) limits the dependence of farmers on international agricultural inputs and commodity markets, ii) provides them with a credible solution to the high variability and incompleteness of non-farm labor markets and iii) offers opportunities for the development and diversification of the local economy upstream and downstream of the agricultural production itself.

Second, we have suggested that multi-purpose farming is environmentally resilient because the biological diversification across ecological, spatial, and temporal scales maintains and regenerates the ecosystem services that provide critical inputs to agriculture. These include maintenance of the soil quality, nitrogen fixation, pollination, and pest control. Agro-bio-diversity is sustained by diversified farming practices, thus reducing negative environmental externalities (i.e. the negative effects on the environment for which no compensation is delivered) and the need for off-farm inputs (Kremen and Miles 2012).

Third, multi-purpose farming is also resilient from a societal point of view as it represents a credible path to re-peasantization (Rosset and Martínez-Torres 2012). Nurturing a built-in learning process within communities of farmers allows farmers to retain a better control over their decision-making environment and the chance to innovate and adjust according to their specific circumstances.

ACKNOWLEDGMENTS

The authors offer profound thanks to the research team of Mr. Kin Mengse, Mr. Phorn Phira, Ms. Ek Makara, Mr. Yim Sopha, Mr. Kvas Ngol, Mr. Chay San, Ms. Hoy Soany, Mr. Prum Viseth, and Mr. Chhem Pheng, for their invaluable work and stirling efforts throughout research process. CEDAC are deeply grateful to the Learning Institute for providing capacity building, coaching and administration support, and to the International Development Research Centre (IDRC) for financing this research. We would like to express special thanks to Mr. Pech Sithan, Ms. Houn Kalyan, and Mr. Chan Bunnara of the Learning Institute for providing capacity building, inputs and administration support to enable this research to be successfully implemented.

The authors also express sincere gratitude to Ms. Meghan Coleman, Ms. San-Mari Esterhuysen and Dr. Yang Saing Koma (CEDAC) who helped in the writing of the research proposal, and to the CEDAC staff members in the field who helped in identifying farmers and study sites, and who made the necessary logistical arrangements.

We also extend our thanks to all farmers who participated in the project, who gave their time and who put so much effort into recording data relating to their households during the year of the research process. The role and value of the stakeholders who allocated their time to answer the questions during the interviews and the Focus Group Discussions for the feasibility survey, and who provided necessary information for the report writing, are also much appreciated.

The Learning Institute and the authors have also greatly benefited from comments and suggestions made by the external peer reviewer, Mr. Christophe Goossens, Coordinator Asia for ADG (Aide au Développement Gembloux). The authors are responsible for any remaining errors in the text.

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