



## **Crop Profit Groups and Farmer Participation in Research: Some Experiences from Cambodian Upland Regions**

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**Abstract** Reductions in poverty and improvements in food security are important issues for farmers and agricultural regions in Cambodia. In this paper we relate our approach and experience working in upland areas of Battambang Province to improve agricultural, environmental and social outcomes for farm families and villagers. Small farm sizes and observed low levels of agricultural productivity exacerbate poverty and food insecurity. We have approached this challenge by first investigating and demonstrating new agricultural methods (or technologies) in a farming systems context, through developing a network of farm trials and demonstrations. To this is added activity in contextual economic and social assessment of new versus old farming methods and management, with the objective of farmer adoption of improved methods and associated increases in farm family incomes. We have formed Crop Profit Groups of local farmers to assess the economic costs and benefits of changed management in the main cash crops of maize and soybean. We have also investigated marketing and value-chain issues since these affect upland farmers in important ways. Our approach has been to bring expertise to each situation and adopt a co-learning approach with local farmers, government officials and NGOs. Education and capacity-building of Cambodian collaborators has been an important part of the work. While our work is not yet finished we have found a genuine willingness by the Cambodian farmers to consider new ‘ways of doing things’ and be involved in assessing their own incentives to change. A variety of approaches are used in training and capacity building of the local researchers and officials. There seem to be substantial economic incentives to change some farming practices, but issues of farm input supply availability, markets and prices received for farm produce, transport costs and infrastructure appear to constrain improved farm and regional outcomes.

**Keywords** Cambodia, agriculture, environment, technology, poverty, food security,

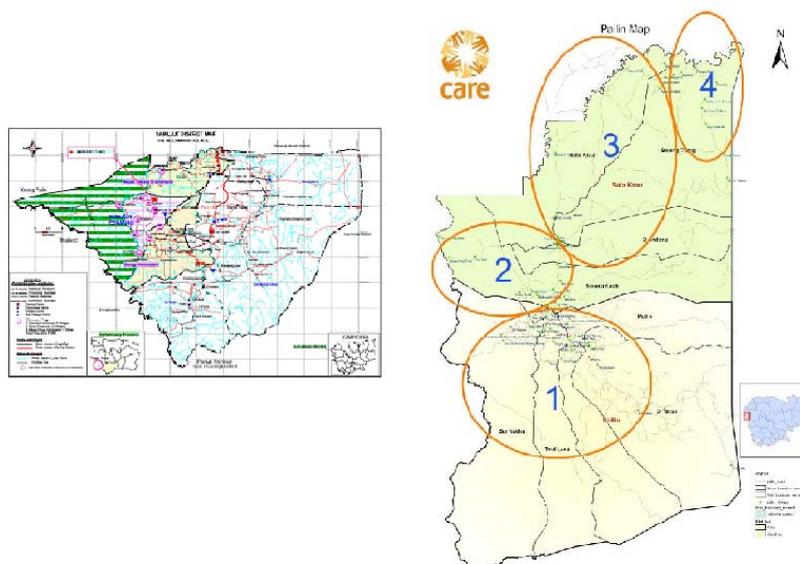
## INTRODUCTION

Reductions in poverty and improvements in food security are primary objectives of project funding supported by the Australian Centre for International Agricultural Research (ACIAR), the Cambodian Agricultural Research and Development Institute (CARDI), and non-government organizations (NGOs) such as CARE-Cambodia (CARE) and the Maddox Jolie-Pitt Foundation (MJP). In this paper we draw on information and experiences from a number of ACIAR-funded projects in the upland regions of Cambodia. In recent years Cambodia has regained self-sufficiency in rice production and some research and development (R&D) priorities have moved to non-rice farming systems in upland regions. In the north-western Provinces of Battambang and Pailin the main non-rice field crops are maize and soybean, with mungbean, peanut, sesame and cassava also being important.

Our objectives in this work have been to investigate typical farms, farming systems, crop management and use of crop technologies to see whether improved management can be introduced and demonstrated so that, if adopted by farmers, our activities lead to improved farm-family incomes. The process followed has been one of assessing the existing situation, choosing and physically demonstrating new crop technologies and management, and then assessing the financial and social implications for change at the farm level. Throughout our focus has been on talking to farmers and farmer groups about how they do things at present, and asking what they might think of the opportunity to change - a co-learning approach. Our project work is not yet finished, so the outcomes of our R&D are not yet obvious - at least in terms of substantial uptake of new crop technologies by upland farmers.

As well, we have been keen to consider the environmental implications of our work and to neither impose external paradigms on these upland farmers nor to repeat mistakes that might have been made in other places and earlier times. This has involved a balancing of agricultural production, farm-family income and environmental objectives. In this paper we discuss issues that have been confronted in undertaking this balancing task.

Our recent work has focused on three districts, Pailin and Sala Krau in Pailin Province, and Samlaut in Battambang province, of north-west Cambodia. The target villages and clusters are shown in Fig. 1. Village clusters are Baysey, Bor Tangsu, Ou Ro El and Prey Santeah in Pailin district, and Beoung Run, Kampong Touk, Kantout and Sre Reach in Samlaut district.



**Fig. 1 Target villages and clusters - Samlaut (left) and Pailin (right)**

## CONDITIONS

### **Rural development, environmental outcomes and agricultural development ethics**

Agricultural development activity in developing countries must face ethical questions such as ‘what type of agricultural paradigm should be promoted in developing agricultural communities?’ and ‘how can the expressed needs of farm families, village communities and national governments be accounted for in agricultural development activities?’ (Chrispeels and Mandoli 2003). There are alternative ways of improving farm family incomes, in terms of the agricultural technologies and management that can be promoted, and we can make choices based on the underlying moral and ethical belief systems of both the funding agency (and country) and the recipient communities (and country).

The traditional agricultural paradigm of production to feed the world at the lowest possible food price is being challenged by changes in societal thinking about the impacts of such changes on agricultural societies and the natural environment. The (western) utilitarian agricultural ethic of judging actions by their effects on fellow human beings (the greatest good for the greatest number of people) can be interpreted as emphasizing production without a full consideration of other (more nuanced) impacts. With a projected increase in world population an important need is for future agricultural production systems to be able to satisfy the associated increases in demand for food. But can that be accomplished without further detrimental effects on natural ecosystems and changes to a (perhaps idealized) view of how rural and urban societies should develop? The International Food Policy Research Institute (IFPRI) has a 2020 vision of a world:

- where every person has access to sufficient food to sustain a healthy and productive life;
- where malnutrition is absent;
- where food originates from efficient, effective, and low-cost food systems; and
- where food production is compatible with sustainable use of natural resources (IFPRI undated).

**How has our project matched against these sustainability and food security goals?:** The current project (Cambodian Crop Production and Marketing Project (CCPMP), see <http://ccpmp.pbworks.com/>) has four communities of practice - Production, Socio-Economics, Marketing and Value Chain. The teams associated with each community of practice conduct specific and coordinated activities to achieve the project goals. A Continuous Improvement and Innovation Approach to project management and evaluation was used (Madzivhandila et al. 2008). In this paper we focus on the Production and Socio-Economics team activities, but first we set the overall project context and report the perspectives of the project participants.

### **Cambodian agricultural priorities and institutions**

**National R&D priorities:** The Royal Cambodian Government’s National Poverty Reduction Strategy (2003-2005) committed research centres and extension systems to focus on small-scale farmers and place emphasis on the use of improved tools and management practices for cropping systems. Priority was given to diversification and intensification of sustainable agricultural production with few external inputs as well as cost-effective management practices.

**Institutional priorities in Cambodia:** CARDI was established in 1999 by the Royal Government of Cambodia as a semi-autonomous institute. It has a vision of partnerships for livelihood improvement and economic growth in Cambodia, and a mission to contribute to the Royal Government of Cambodia Policies on poverty reduction and economic development (CARDI undated). CARE has worked for some time in Cambodia, initially (in the 1990s) with the United Nations to help refugees. Since then CARE has shifted its focus to long-term development programs, helping poor communities improve their standard of living (CARE undated). MJP is dedicated to eradicating extreme rural poverty, protecting natural resources and conserving wildlife; MJP promotes sustainable rural economies that directly contribute to the health and vitality of communities, wildlife and forests (MJP undated).

## Upland crop production in Cambodia

**Constraints to crop production:** Dillon and Hardaker’s (1993) conceptualization of the constraints to production at the farm level has been adapted for this project as shown in Fig. 2. Biological and bio-physical constraints are addressed by the Production team, and other socio-economic constraints are addressed by the Socio-Economics, Marketing and Value Chain groups.



**Fig. 2 Project focus on constraints to crop production in Cambodia**

**New crop production technologies considered:** The new upland crop management technologies considered within CCPMP have been: (1) rhizobium inoculation of legume seeds, (2) the application of urea (Nitrogen (N)) fertilizer to maize, (3) changes in crop rotations and/or crop sequencing, (4) use of reduced or conservation tillage, (5) integrated pest management (IPM) for insects, and (6) weed control in crops. These have been trialed on farmer fields by project staff and subjected to farm management economic analysis.

### Project activities and methodologies

**Production team activities:** The CCPMP Production team activities have involved establishing trials of new crop technologies in farmer fields. These trials are supervised in establishment, maintenance and extension activities by the project team, especially the CARE and MJP officers. Careful experimental designs and plot planning and management have been conducted to facilitate farm walks and extension activities to demonstrate to farmer and village groups the possible physical changes that might accompany changes in crop management and technology use. The development of crop production information and publications for insect and weed identification has been an important part of the Production activities.

**Socio-Economic team activities:** Economic evaluation activities have been conducted on the basis that farm profits and economic incentives are important to these farmers in considering farm practice change (further discussion below). Pannell et al (2006) considered that adoption of rural innovations depends on a range of personal, social, cultural and economic goals. ‘Adoption occurs when the landholder perceives that the innovation in question will enhance the achievement of these personal goals. Innovations are more likely to be adopted when they have a high ‘relative advantage’ (perceived superiority to the idea or technology that it supersedes) and when they are readily triable (easy to test and learn about prior to adoption)’ (Pannell et al., 2006). We have focused mainly on the economics of technology and management and less on social analysis in this project.

The Socio-Economic activities have consisted of several components. One economic activity has involved conducting economic analyses of new crop management and technology in the upland farm context. These activities have allowed us to estimate the likely economic appeal of our technologies to the target farmer groups and hence to rank and prioritize the technologies in terms of project focus. The economic assessments have considered the likely return on investment (ROI) to an upland farmer from undertaking the management change (adopting the technology) in the context of the cost of capital and size of the economic gain. A second component has involved training the Cambodian project officers in conducting simple economic comparisons, and then using a Crop Profit Framework in farmer workshops to consider new technologies. A third

component involves conducting village workshops to assess economic and social issues for farmers in possible changes to their crop management and technology use. Each of these activities is discussed below.

Economic methodologies used have been relatively simple enterprise profit (gross margin) and partial budgeting approaches to compare existing and alternative management as set out by, among others, Malcolm et al. (2005). What do we mean by the ROI, or as it is sometimes called the marginal rate of return (CIMMYT, 1988)? For simplicity let's use an example of an upland farmer investing in a crop input like rhizobium - where the rhizobium must be purchased, applied to legume seed at sowing and a higher yield is expected to be achieved. We want to calculate the expected return and compare it with the extra cost. This extra cost is the amount of money invested by the farmer in the new crop technology.

From trial information we have an idea of how the yield might change and so we undertake an economic analysis for a typical upland farm to show the likely benefits before any farmer decision is made about using the technology. The analysis is conducted to provide information to the farmer about the decision to invest in rhizobium. The expected net benefit is the value of extra returns (extra yield multiplied by the price expected to be received by the farmer) less the extra cost (the cost of the rhizobium). There may also be other extra costs (e.g. harvest of a larger crop) which need to be included. The total extra cost is the amount invested which we assume is borrowed by the farmer.

The marginal rate of return (CIMMYT, 1988, p.32) is the marginal (or extra) net benefit divided by the marginal (or extra) cost, expressed as a percentage. As an example if \$1 is borrowed and invested in a new crop input so that the expected net benefit is, say, \$0.50 then the ROI is 50%. The size of this ROI can be compared to the cost of capital or set according to some minimum or target rate that accounts for such attitudes as the risk attitudes of indigenous farmers (Scott and Freeman, 2007). While it is not possible to provide an exact minimum or target figure, CIMMYT (1988) suggested a possible target rate of (a) twice the cost of capital, or (b) higher rates such as 50 to 100% (especially for farms in developing countries). In Cambodia the cost of capital to farmers is often 3% per month or more, so that a minimum ROI for new crop technologies or management change could be 100% per annum or more.

The Crop Profit Group framework was adapted from an ACIAR project in South Africa aimed at improving beef production for small farmers (see Madzivhandila et al., 2008). This framework is shown in Fig. 3, where the potential changes in enterprise economic return at the farm level can be identified in terms of partial productivity measures on the costs or returns side of the enterprise profit equation.

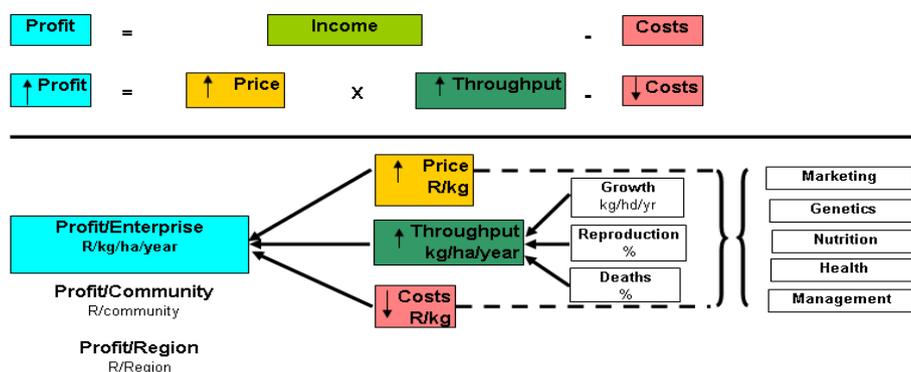


Fig. 3 Crop Profit Group framework

The village workshop approach conducted using Participatory Rural Appraisal methods (e.g. see de Zeeuw and Wilbers, 2004) relied on accompanying farmer groups at field walks conducted by the Production team and then taking those groups into workshops to conduct conversations

about technologies and rural change. Similar activities have been reported by Sophal and Acharya (2002) and Sedara et al (2002).

## **RESULTS**

A picture of upland cropping systems and farm families in Cambodia was developed through surveys (Farquharson et al. 2006a). Average farm sizes of the surveyed farms in Battambang, Kampong Cham and Takeo Provinces were small (2-8 ha), capital (mechanical) equipment included draft animals, ox carts and mouldboard ploughs as well as tractors and disc ploughs in some areas. Levels of farmer education were relatively low and farm-family incomes were small. The cost of borrowing money for crop inputs in rural Cambodia can be 3-5% per month or more, depending on the source of funds. Problem areas for crops included low yields, lack of knowledge (especially about insects), concerns about profitability, land/soil constraints, labour/equipment issues and agronomic and climate risk (including drought). There were significant numbers of female farmers.

Other background information has been provided from MJP (2008), where a comprehensive survey was conducted to identify the poorest and most vulnerable households in Samlaut. Four categories were identified: poorest (extremely poor) with incomes generally less than US\$1/day, poor with an income generally less than \$2/day, middle with an income of \$5-7/day, and high with an income of \$8-10/day. Villages were ranked according to these categories and allocated into clusters for attention (Fig. 1).

Three reports were available from CARE - Samaiyar and Sopheap (2007a and b) and Kiereini (2007). Samaiyar and Sopheap (2007a, b) specifically targeted 28 villages in three clusters. Contributing factors to food insecurity were that 14% of rural households were landless in 2004, another 19% possessed less than 1ha of land, and that the variable climate and the frequency of natural calamities also contributed to food insecurity.

Outputs from CCPMP are in a number of different formats. Martin and Chanthy (2007) have published a crop weed identification manual in a hard-copy format suitable for farmer/field use.

For the Socio-Economic activities an important early question related to the farmers' basic farm management orientation. In contrast to rice production in Cambodia, which has traditionally been of a subsistence nature, the upland production of maize and soybean is primarily for sale to domestic and export buyers for human and animal consumption. Hence it is mainly commercially oriented and so farm profits and farm management economics were assumed to be important drivers for decisions and processes within the project.

Training in economic evaluation methodologies (gross margin, partial budgeting and ROI analyses) has been conducted via workshops and written notes (Scott 2008). This economic framework was the basis of the Crop Profit Group framework used in the village workshops.

Economic evaluations of crop production technologies were conducted and reported in Farquharson et al. (2006b, 2008) and Scott and Freeman (2007). These evaluations were for prospective technologies that were not yet available to farmers. The analysis of Scott and Freeman (2007) in the Samlaut district involved comparing improved with farmer practice based on crop yields from field demonstrations and expressing the economic result as a ROI figure (as explained above). Their main result was indicative return of 743% for rhizobium inoculation of peanut seed. Farquharson et al. (2006b) used data from on-farm trials to assess the likely advantages for upland farmers of changing crop technology and management. Their main result (expressed in terms of ROI) was that rhizobium inoculation could return up to 600% for soybean. These are very high numbers based on a substantial yield improvement from rhizobium trials and an expected low cost for the technology. This technology was not available to upland farmers at the time of these analyses.

This indication of high potential return for rhizobium inoculation was mirrored in the village workshops where upland farmers indicated a strong preference for trying this technology. In 2010 inoculum will be introduced and distributed for farmers to try themselves. Other recent trial data for the application of N fertilizer (urea) to maize showed only modest yield improvement and it

seems that the upland soils retain a substantial level of the soil fertility that was present when they were (relatively recently) cleared for farming. Hence the project activities will not proceed with a strong recommendation for farmers to apply N fertilizer to maize. From observation in the field, adequate fallow and in-crop weed control would do more to improve maize yields.

Another technology considered within the project was of changes in crop rotations or crop sequencing. Such changes (from a monoculture) in other places have shown substantial improvement in crop performance due to insect, weed and disease threats being reduced with the use of varied crop sequences. In the Cambodian uplands the wet season allows two crops to be grown, and generally there is a different crop grown in the early to the main wet season. Given that the crops include legumes plus grains there appears to be an adequate amount of crop variation and there did not seem to be a need to further investigate the gains from changing crop sequences.

The fourth technology considered was reduced or conservation tillage to minimize soil erosion. Crop establishment methods in the upland areas are mixed, with some traditional methods such as mouldboard ploughing by oxen and planting by hand and stick, while other farmers own or hire tractors with disc ploughs and planters to establish crops. The development of a small-scale planter for farmer use has been investigated but the capital costs to construct and market such planters are considered prohibitive. No further action has been taken on this technology.

The fifth technology is IPM, especially with respect to insect control. Our project has strongly emphasized the use of IPM for insects by running workshops on insect identification and discussion of appropriate ‘soft’ chemical sprays, and also through training of a PhD student in Australia. An insect identification manual is being developed. Another approach to IPM has been the ‘Jorani project’ to develop educational material (including a children’s book) for the primary school Life Skills curriculum (Martin et al., 2010). The Jorani project provides technical training and resource materials to teachers including an IPM workshop manual and an illustrated insect identification guide. It is being introduced to years 4-5 in five primary schools on a trial basis in Samlaut district.

From our observations of farmer crops in the upland regions weed control is a major constraint to crop yields and profits. A number of issues are relevant here. In the past much crop weeding (by hand) has been performed by (often landless) laborers from nearby villages. More recently upland farmers have been using chemicals for weed control, but these chemicals are imported mainly from Thailand and the labels and instructions are written in Thai, which the farmers cannot read. We have discussed this with farmers in our workshops and they report that they do not understand how to appropriately apply these chemicals and we have observed inappropriate handling procedures injurious to human health.

We have observed that the price of labour has increased substantially in these districts – in 2005 farmers were paying 5000 Riel/day for labour to plant, weed and harvest crops but by 2009 this had risen to 10,000 R/d in Pailin and 12,000 R/d in Samlaut. Such a change in the price of an important farm input could be expected (by simple economic logic) to force cash-oriented farmers to adjust the use of crop inputs.

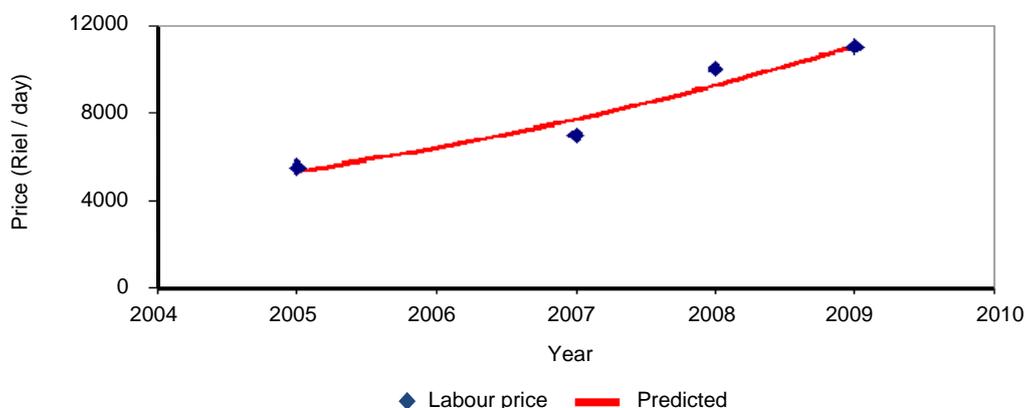
An analysis using a simple model with a limited amount of data developed the relationship shown in Fig. 4. The natural exponential function applied to data of labour price (P) over time (T), was analysed as shown in Eq. (1).

$$P = ae^{bT} \quad (1)$$

The advantage of this model is that the b-coefficient can be interpreted as an average annual growth rate in the dependent variable. The estimated b-coefficient of 0.185 (t statistic 5.36) indicates that the growth rate in the price of labour has been around 18% per annum.

In a recent (2009) visit to the project districts we asked questions of farmers at the field days and in the village workshops about weed control practices in their crops. In particular we asked them about the cost of weeding by hand (the traditional practice) and the costs of using herbicides. The results were that the cash costs of hand weeding were generally double, or more, the cost of using chemical sprays to control weeds. However, the farmers confirmed that weed control in crops is essential for successful crop production, and that if they did not control weeds the resultant yields would be either zero or completely uneconomic. Hence the project will focus more on

chemical weed control using appropriate (soft) chemicals and application rates, and also on operational health and safety issues for farmers in applying chemicals.



**Fig. 4 Actual and predicted price of labour, Battambang Province**

## DISCUSSION

Our Cambodian project experiences have touched on a number of issues relating to agricultural development as it relates to poverty alleviation, improvements in food security and agricultural development ethics. The farm and village systems that we have worked in are characterized by small-scale farmers with low financial reserves, low levels of education and low levels of agricultural productivity. Their institutions do not provide reliable input supplies or competitive markets for their outputs, and their cost of credit is very high. Hence many of them are vulnerable to climatic and market price risk.

Their farm objectives are stated to be commercial; hence we have used an economic framework to initially evaluate new crop technologies. We have conducted discussions with farmers using a Crop Profit Group approach to focus on potential benefits and costs of changing farming practices. This production economic focus has been set alongside discussions of social issues for change. We have not considered any fundamental changes to the type of agriculture practiced (e.g. changing to tree from field crops) in these districts although such changes are interesting to consider.

Chrispeels and Mandoli (2003) discussed the traditional agricultural production paradigm which has been criticized for not considering effects on the natural environment or social structures within communities. The expressed primary concern (by the Royal Cambodian Government, the NGOs and the Australian funding body) for poor farmers in Cambodia has been to reduce poverty and improve food security, and this has been taken as the primary objective in our project work. We have interpreted the best means of addressing these goals as through improvements in agricultural productivity and profitability so that farm family incomes are raised. But while doing this we have been aware of the need to consider environmental and social implications.

There is a (sometimes muted) debate in Cambodia about ‘sustainable’ farm practices, particularly in relation to the use of agro-chemicals for pest control, and fertilizer and hybrid seeds for crop production. We are now observing a change in the use of farm labour because of the opportunity cost of labour has risen. These are ongoing challenges that we need to address in our project.

Our main conclusion regarding agricultural technologies, based on farm trials and contextual economic analysis of farm trial data, is that rhizobium inoculation of legume seed prior to sowing seems to offer a major opportunity for improving crop productivity and profitability.

For crop production it is also apparent that insects, weeds and diseases need to be controlled; otherwise agricultural production is simply not feasible. We have focused on IPM as a desirable

insect control approach and strongly emphasized provision of better information and training to farmers (and their children), and the education of scientific and extension R&D staff.

For weed control the price of labour has risen – whether because of improved income-earning opportunities off the farm or a shortage in labour supply is unknown. Because weed control is essential for successful crop production, and because the farmers are profit oriented, the only option is to use a cheaper means of weed control. An appropriate response from projects such as ours appears to be to improve the information available to, and skills of, farmers in using appropriate (softer) chemicals to achieve cost-effective crop production. However, it is not known whether such a practice is 'sustainable'.

Capacity building for Cambodian personnel by the project has involved Australian PhD study for one Cambodian researcher in IPM; training of local research and extension officers in field identification of insects for IPM, the production and distribution of a weed identification manual, and training workshops for economic and statistical analysis; and discussions with farmer groups about the crop profit framework including returns, costs and profits.

New research ideas and priorities have been developed in the course of the project, using a continuous improvement and innovation approach to (1) review, (2) plan, (3) act, and (4) evaluate project activities. This allowed revision of thinking about project focus, from which new activities and information were developed. This information was transmitted to farmers through project activities which included the local agricultural extension network. Other ways of taking new ideas to upland communities included preparation of education material for primary school curricula (Martin et al. 2010) and further investigation of placing technical material in university courses.

## **CONCLUSION**

As individual project members we have come to this work with our own ideas on agricultural development ethics and agricultural development paradigms. The institutional setting of agricultural development entities in Cambodia (the Government, government institutions and NGOs) have set out their priorities in the stated visions and mission statements as specified here. Our work has been within the spirit of those institutional objectives and consistent with an agricultural development ethic that is aimed at making immediate improvements in the welfare of Cambodian upland farm families while minimizing detrimental effects on the natural environment and local communities.

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