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Impact pathway analysis of ACIAR's investment in rodent control in Vietnam, Lao PDR and Cambodia

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Impact pathway analysis of ACIAR's investment in rodent control in Vietnam, Lao PDR and Cambodia

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Cover: A rat caught by a boy during rodent community action in Vietnam
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Foreword

The Australian Centre for International Agricultural Research's (ACIAR's) involvement in rodent control goes back to 1995, with significant research investments in Vietnam, Lao PDR and Cambodia in the years since then. In particular, researchers have sought environmentally friendly alternatives to control rodents in rice fields, looking for solutions that are acceptable to farmers and that will reduce their reliance on rodenticides that are also toxic to humans.

Reviews of the research have been mostly favourable, and formed the basis for development and implementation of subsequent work. It is now an appropriate time to analyse the extent to which the research has been taken up in these three countries, to determine factors that favour adoption, and identify aspects constraining it, and to lay out a plan for future action.

This impact pathway assessment has focused on the respective country situations. Broadly speaking, the projects have built up the recognition of the importance of rodent control in terms of agricultural production, food security and poverty reduction. Given the longer time frame of involvement, it is no surprise that Vietnam and Laos have the largest number of similar outputs and outcomes, while Cambodia, having become involved much later, is still in the early stage of adoption. It is gratifying that organisations such as World Vision and Germany's development agency Gesellschaft für Internationale Zusammenarbeit (GIZ) now incorporate rodent control and management into their development programs in Vietnam and Laos.

Further evidence of the impact of the research is manifested in the Government of Vietnam's policy directives prescribing community action to adopt environmentally based rodent management. Also, as farmer knowledge of rodent control has improved, there has been a noticeable shift away from the popular use of rodenticides towards more environmentally friendly practices, including the trap–barrier methods developed through the ACIAR projects.

The study has revealed the extent to which uptake of these more benign practices must be considered against the background of many political, historical, socioeconomic, cultural and demographic factors, which differ in the three countries. For instance, people in Laos and Cambodia considered rodent infestation a minor problem even though the damage caused rated second only to insect infestation.

There is still work to be done to sustain and improve on the initial gains that have arisen from the ACIAR-funded research. As presented in the recommendations, integrating research on rodent management within a crop-based program that also considers climate change and natural resource management could be a way forward.

Nick Austin
Chief Executive Officer, ACIAR

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Abbreviations

ACIAR	Australian Centre for International Agricultural Research
ADP	Area Development Program (World Vision); also the abbreviation for ACIAR's Agricultural Development Policy program
AusAID	Australian Agency for International Development
AYAD	Australian Youth Ambassador for Development
CAAEP	Cambodia–Australia Agricultural Extension Project
CARDI	Cambodian Agricultural Research and Development Institute
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTBS	community trap–barrier system
DAFO	District Agriculture and Forestry Office (Lao PDR)
DOA	Department of Agriculture
EBRM	ecologically based rodent management
FGD	focus group discussion
FFS	farmer field school
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (formerly Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH)
ha	hectare
IAS	Institute of Agricultural Sciences (Vietnam)
IPM	integrated pest management
IRM-V	integrated rodent management at the village level
IRRC	Irrigated Rice Research Consortium
IRRI	International Rice Research Institute
KAP	knowledge, attitude and practice
KII	key informant interview
MARD	Ministry of Agriculture and Rural Development (Vietnam)
NAFES	National Agriculture and Forestry Extension Service (Lao PDR)
NAFReC	Northern Agriculture and Forestry Research Centre (Lao PDR)
NAFRI	National Agriculture and Forestry Research Institute (Lao PDR)
NARES	national agricultural and research extension system
NIPP	National Institute of Plant Protection (Vietnam)
NGO	non-government organisation
OAE	Office of Agricultural Extension (Cambodia)
PAFO	Provincial Agriculture and Forestry Office (Lao PDR)
PDA	Provincial Department of Agriculture (Cambodia)
PPD	Plant Protection Department (Vietnam)
PPS	Plant Protection Station (Vietnam)
t	tonne
TBS	trap–barrier system
TOT	training of trainers
UQ	University of Queensland

Executive summary

Since 1995, the Australian Centre for International Agricultural Research (ACIAR) has funded a series of rodent control projects in South-East Asia. The reviews of the earlier projects served as the basis for the development and implementation of follow-on or related projects. However, despite the end-of-project reviews, little was known about the potential and realised diffusion and application of the research results.

This study was carried out to close this knowledge gap and provide an assessment of ACIAR's investment in rodent control through a qualitative and, where possible, quantitative, impact pathway analysis. It involved assessments of the projects undertaken in Vietnam, Lao PDR and Cambodia, and the uptake, where applicable, of the results of the project.

The conceptual framework underlying this study recognises that while agricultural research and development projects are instruments of change, they are not sufficient by themselves to make a significant difference to the livelihoods of the groups for which the research outputs are intended. Following D. Templeton (pers. comm. 2006) and Walker et al. (2008), the framework is termed an 'impact pathway framework'. It not only identifies the pathway from inputs to outputs, outcomes and impacts, but also maps out the processes and cause-and-effect linkages. In addition, it highlights key stakeholders and those factors that enable or inhibit adoption of research results.

Hence, implementation of the impact pathway framework in this study provided information on the contextual environment within which the rodent control projects operated. It also laid down a pragmatic strategy for collecting data and evaluating the key components of change, providing measures of success and documenting lessons learned.

Several approaches were used to gather the data and information needed to answer questions surrounding the diffusion and adoption processes—also to determine what worked, what didn't and why. These included desk reviews of the available project documents, focus group discussions and key informant interviews.

Research activities

The common research activities in all three countries were: participatory research on rodent ecology (breeding, habitat) and taxonomy (species identification); training of trainers, extension workers and farmer leaders in rodent control and management; demonstrations of the community trap–barrier system (CTBS); production and distribution of training/learning/communication/extension materials; and conducting village campaigns through the mass media and interpersonal sources. The projects in Laos and Cambodia each had an Australian Youth Ambassador for Development appointed to do research and train the farmers in rodent ecology and taxonomy.

Key findings and lessons learned

The analysis revealed that the length of exposure to ecologically based rodent management (EBRM) practices has a positive effect on uptake and, hence, impact. Of the three countries, Vietnam had the largest number of projects (six) and the longest exposure (1995–2010) to rodent control and management activities. Laos had two projects (1999–2006), while

Cambodia had just one (2001–2007) and the shortest experience with a rodent control project. These differences largely account for the varying levels of outputs, outcomes and impacts in each of the three countries.

Vietnam and Laos produced the largest number of, largely similar, outputs. Both countries increased their knowledge of rodent ecology and taxonomy and gained understanding of methods for setting up and using the CTBS. Both developed policy recommendations on the reduction of rodenticide use, and also produced materials such as training modules, information booklets and manuals about rodent control.

In Vietnam, EBRM was developed through community action or integrated rodent management at the village level. This community action may or may not use the CTBS. In Laos and Cambodia, the CTBS was demonstrated as the main focus of EBRM intervention.

The outputs of these projects have increased the awareness of the importance of rodent control among farmers, extension officers and other workers—not only for agricultural production, but also for food security and poverty alleviation. This has led to the organisations like non-government organisation (NGO) World Vision and the German development agency Gesellschaft für Internationale Zusammenarbeit (GIZ) incorporating rodent control and management into their development programs in Vietnam and Laos.

The outputs described above were examined at the levels of 'next users' and 'final users'. For all three countries, the term 'next users' refers to the government institutions engaged in agricultural research and extension, together with aid agencies implementing the field projects. The term 'final users' refers to the farmers.

New policies and practices on rodent control

The project outputs were also applied through new policies issued on rodent control. This was most evident in Vietnam, where the results and recommendations from the first two projects resulted in policy no. 09-1998/CT/TTG, issued by the Prime Minister in February 1998. The results of subsequent projects have led to the expansion of the existing government policy on 'strengthening rodent prevention to protect agricultural crops'. The policy specifically prescribed community action, including the timing of that action, which was consistent with the recommendations of the ACIAR project.

Technology dissemination in the three countries was achieved through a combination of face-to-face techniques (training sessions, group meetings, field demonstrations, village campaigns and field visits). The dissemination also involved the use of the mass media (to varying degrees), facilitated by research and extension officers at the national, provincial and district levels. NGOs and development agencies, such as World Vision in Laos and Vietnam and GIZ in Laos, also played a role. The rodent control project in Cambodia was implemented through the Cambodian Agricultural Research and Development Institute and the Office of Agricultural Extension of the Cambodian Ministry of Agriculture, and no external organisations became involved.

Training of farmers was a common form of technology dissemination in all three countries. Techniques included: extension activities and training of trainers as part of the ACIAR projects; incorporating EBRM in integrated pest management through farmer field schools; and distribution of printed materials on EBRM during farmers' classes.

Field demonstrations and cross-visits were all effective mechanisms in the diffusion of EBRM, especially through farmers sharing knowledge as a conduit for technology dissemination. The various mass media outlets also played a part, particularly in Laos and Vietnam.

Positive changes

It is evident that the ACIAR rodent control projects in Vietnam had positive impacts at the community level. The adoption of EBRM resulted in a decrease in the area damaged by rodents, and lower yield losses, which consequently increased the total production and income of rice farmers. The increased production contributed, in turn, to food security. In addition, adoption of the ACIAR project outputs had positive impacts on the environment and also contributed to

improved social cohesion in the community. However, little or no sustained impact can be discerned from the rodent control projects in Laos and Cambodia, where the rodent control projects can still be considered to be in their infancy.

The key to the diffusion of EBRM in Vietnam was the active and coordinated engagement of local institutions. There was also evidence of scaling out, whereby farmers from project areas, through the facilitation of the Plant Protection Department (PPD), provincial sub-PPDs and, in some instances, World Vision Vietnam, shared their experiences with other farmers at non-project sites.

In Laos, the local champions (normally powerful village leaders) were instrumental in getting the technology disseminated and adopted in the village. The use of financial and material incentives also facilitated the diffusion of EBRM, but only in project areas and only during the project period. Community campaigns were held during rodent outbreaks, including a bounty system wherein children were given school supplies according to the number of rodents caught.

Factors that influenced adoption

This study shows that EBRM adoption in the three study countries is a function of the interplay between the enabling and constraining factors, which included political, historical, socioeconomic, cultural, demographic and other related factors. For example, the political system in Vietnam enables a situation in which adoption of any technology is given force by top-down directives from the government.

In Laos, the recent government policy of allocating more upland areas for rubber production affected the drive for rodent control, since rodents from upland farms were driven down to the lowland farms, dampening the initial effort to keep rodent populations at a more manageable level. But a local resolution banning the use of rodenticides and encouraging the domestication of cats for rodent control was successfully put in place.

No policy direction on rodent control has been issued so far in Cambodia. Reports indicate that farmers are catching rodents for live sale to the crocodile farms in nearby provinces. This has given them an incentive to catch rats for additional income. Whether this could minimise the rodent pest population needs further study.

In Laos and Cambodia, people are used to rodents and do not perceive them as a threat. Even though the rodent problem is a serious agricultural production constraint, rated second after insects, the people still considered rodent infestation as a minor problem that could be controlled using conventional methods. But, in the uplands of Laos, the rodent population is higher and conventional methods are not adequate to solve the problem. This has resulted in the belief that it is just something that has to be endured.

Another factor that affected adoption and sustainability of EBRM in all three countries was the low retention rate of government research and extension personnel trained in EBRM and the CTBS, due to study leave and changing jobs. The projects included follow-up fieldwork in pilot communities, but this work and efforts at capacity building have been diminished, as trained personnel left or were transferred elsewhere.

Continuous government support and follow-up projects are needed to sustain adoption and the impact. Adoption of technology takes a long time to be realised. In the case of Vietnam, it took 15 years to achieve the successful widespread adoption of EBRM.

Future actions

To sustain the gains from ACIAR's investment in rodent control projects, the following actions are recommended for the future:

1. enhance government support for establishing the policy and promotion of a national extension program incorporating rodent control
2. sensitise and continue to educate stakeholders
3. strengthen research and extension structures
4. undertake research into the gender dimensions of EBRM
5. link with academia for institutional support

6. conduct capacity building to develop academic and research expertise on rodents and rodent control
7. establish networking with other institutions, such as NGOs
8. establish a surveillance and forecast system
9. execute a trans-boundary agreement among the countries along the Mekong Delta, since environmental changes that affect the rat population in one country will also affect the other neighbouring countries bordering the Mekong River
10. integrate EBRM as part of best practices for natural resource management in rice production, which includes pest management (weeds, insects, diseases and rodents), postharvest management for reducing losses due to rodents, and water management in lowland irrigated and highly intensive rice-cropping systems in South-East Asia. Considering the current climatic changes and variability, a more systematic and holistic approach could be developed for a consistent delivery of comprehensive and integrated pest, water and postharvest management, to improve the livelihoods of small-scale rice farmers in South-East Asia.

1 Introduction

Background

Rice feeds about half of the world's population and is the staple food in Asia. Rodents are considered one of the major constraints on rice farming in Asia, during both the preharvest and postharvest stages of cultivation (Singleton 2003). Rodents are among the top three pest problems in rice production in Cambodia, Lao PDR and Vietnam (Jacob et al. 2003; Singleton 2003; Frost 2007; Douangboupha et al. 2010). Losses to the preharvest yield of rice from rodent infestation are estimated to total between 5 and 10% in Asia. If no serious action is taken to control rodents, losses to rice harvests in Asia could be as high as 30 million tonnes (t)/year[1], which is enough rice to feed 180 million people for 12 months (Aplin et al. 2006).

One of the approaches to rodent control is ecologically based rodent management (EBRM). This combines both cultural and physical rodent management practices:

- ensuring synchrony of cropping (rice plots in a localised area planted within 2 weeks of each other)
- implementing short, 2-week campaigns on rodent control at key periods, such as 1 week before transplanting or within 2 weeks after transplanting—these are carried out in focal habitats, such as village gardens and the banks of main irrigation channels
- reducing the width of irrigation banks in fields to less than 30 cm, to prevent nesting by rodents
- improving general hygiene around villages and village gardens
- promoting synchronous fallow
- demonstrating the use of the community trap–barrier system (CTBS) (Singleton et al. 1999).

Most importantly, EBRM requires holistic systems, with participation by the whole community (not just farmers) to carry out these rodent management strategies.

The CTBS entails the establishment of an early planted 'trap crop' to lure rodents to the traps, which ideally should be put in place in surrounding rice fields approximately 2 weeks before the trap crop is planted. The trap crop is usually 20 × 20 m, surrounded by a plastic barrier that has at least one multiple-capture live-trap along each side. Each trap has an entry point for rodents leading directly into it; they are monitored daily for trapped rodents. The CTBS provides a 'halo effect', reducing rodent damage in an area of 10–15 hectares (ha) (Singleton et al. 1999). One distinct advantage of CTBS is that it does not use poisons, although management and labour costs may be higher than for typical baiting systems.

The Australian Centre for International Agricultural Research (ACIAR) commissioned a body of research on EBRM. This started in 1995, covering seven Asian countries: Cambodia, China, Laos, Indonesia, Malaysia, Myanmar and Vietnam. The most recent project was implemented in Indonesia and Vietnam, and was completed in March 2010. The organisations primarily commissioned were the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Sustainable Ecosystems (formerly Division of Wildlife and Ecology) in Canberra, and the University of Queensland (UQ), with collaboration from the national agricultural research and extension system (NARES) in selected partner countries. In total, ACIAR spent around A$3.9 million on rodent control projects, with commissioned and collaborating organisations contributing a further

[1] This figure was around 4.7% of the world's total rice production in 2005.

A$3.3 million in cash or kind, and the Australian Agency for International Development (AusAID) providing A$317,200 (Table 2).

In Asia, EBRM has been disseminated as one possible response to rodent pest problems in the Mekong Delta. However, despite the significant investment, spanning more than 15 years, little was known about the diffusion and uptake of the research results, the constraints and enablers affecting adoption, and farmers' and farmer intermediaries' perceptions about the usefulness of EBRM. The purpose of this analysis was to fill these knowledge gaps and to provide information that ACIAR could use to guide its decision-making process on investment in rodent control.

Objectives of the analysis

The aim of this study was to provide a holistic assessment of the ACIAR investment in rodent control projects, by undertaking a qualitative and, where possible, quantitative, impact pathway analysis. The countries considered in the analysis were Vietnam, Laos and Cambodia.

Specifically, the study sought to:

- depict the 'impact pathways' for EBRM in the three countries
- assess the factors enabling or constraining the promotion of EBRM to farmers and its adoption at the farm or country level
- estimate the level of adoption of EBRM by end users
- provide a detailed assessment of what techniques worked, what didn't, and why
- provide recommendations for future research.

2 Framework and methodology

Framework

The analysis followed the basic impact pathway framework presented by D. Templeton (ACIAR, pers. comm. 2006), which is anchored on the theory of change[2] and has been shown to be a useful evaluation tool (Davis et al. 2008; Walker et al. 2008; Templeton and Jamora 2010; Stern et al. 2012). Using an impact pathway framework as an evaluation tool primarily involves tracing the pathway to change from research outputs (the deliverables), to outcomes (use of the deliverables by the next and final users), to impact (the ultimate change in social, economic and/or environmental conditions that occurs with widespread adoption). The basic outline of an impact pathway is shown in Figure 1. Here, projects are viewed as transformational instruments but by themselves they are not sufficient to cause change. While the simplified schematic representation is linear, in reality the pathway from the inception of an agricultural research project to its higher order impact can be diffuse, involving time lags, dead ends and feedback loops.

In this report, the term *inputs* refers to the research investments (cash and in-kind) made by ACIAR and the collaborating organisations at different periods in the three countries to implement the suite of rodent control projects. The investments were used to support the activities necessary to produce the research *outputs* (i.e. the deliverables such as technologies, knowledge and capacity built, and management and policy recommendations). Broadly speaking, the activities fell into two categories: research on rodent ecology, biology and control, and capacity building. In line with these activities, the primary research outputs are knowledge of EBRM and the capacity built to apply it.

Following the impact pathway framework, *outcomes* are the external use, adoption or influence of the project outputs by next users (e.g. research and extension institutes, non-government organisations (NGOs) and development agencies) and final users (e.g. farmers and policymakers) that result in practice changes needed to achieve the intended impact (i.e. the desired changes in economic, environmental and social conditions beyond the life of the project).

In the case of the rodent control projects, the next users included the NARES in each country, such as: the Plant Protection Department (PPD) in Vietnam; the National Agriculture and Forestry Research Institute (NAFRI) and the Northern Agriculture and Forestry Research and Extension Centre (NAFReC) in Laos; the Cambodian Agricultural Research and Development Institute (CARDI) and the Office of Agricultural Extension (OAE) within the Ministry of Agriculture, Forestry and Fisheries in Cambodia; and other organisations, such as NGO World Vision in Vietnam and Laos, and the German development agency Gesellshaft für Internationale Zusammenarbeit (GIZ) in Laos. The final users are the rice farmers, for whom the adoption of EBRM is expected to contribute to increased yields, lower production costs, higher farm incomes and, finally, improvements in economic, environmental and social conditions.

[2] A theory-of-change model outlines the various steps in the causal chain from the intervention to outputs, outcomes and impacts. A sound theory of change recognises the role of the key stakeholders along the causal chain, and highlights the underlying assumptions, perceived risks and external factors. Further, unintended effects and rival explanations should also be considered. The term 'impact pathway' is often used more or less synonymously with theory of change, although theories of change are also thought of as building on impact pathways by making more explicit, and challenging, the assumptions and risks.

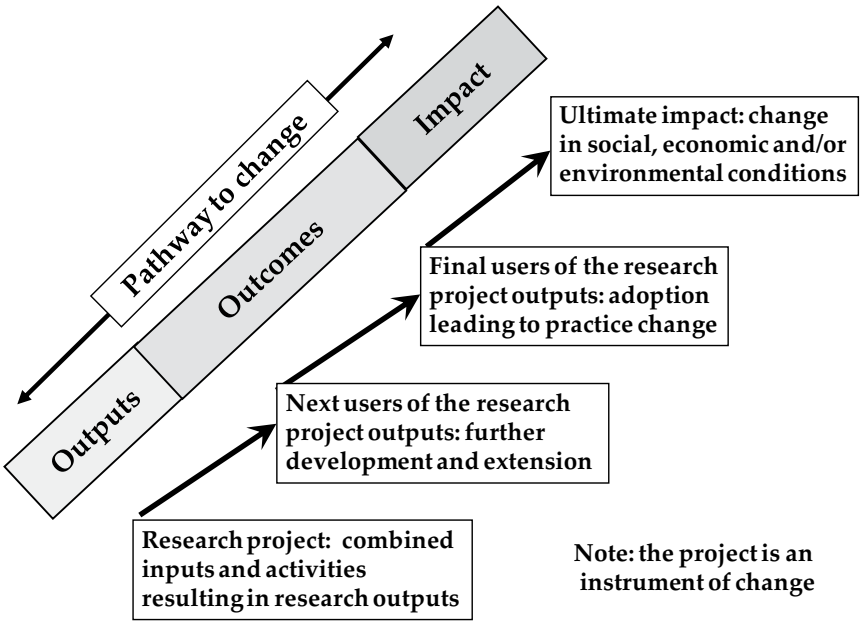


Figure 1. Impact pathway analytical framework (Source: D. Templeton, pers. comm. 2006)

However, as identified during the course of this analysis, the pathway from the research project to the next and final users resulting in eventual impact is complex, with numerous factors affecting the level of adoption of EBRM at the community and farm levels and, consequently, the extent of its impact. Obtaining a clearer understanding of the complexity of the processes involved, including the enabling and constraining factors, and drawing some lessons from this understanding, are the focus of the remainder of this analysis.

Locale

Data collection for the impact pathway analysis was undertaken in selected communes, villages, districts and provinces in the three countries. The provinces visited (Figure 2) were those where the projects were implemented. In addition, non-project sites (or diffusion sites) were also visited, to obtain information on technology diffusion. Diffusion sites can be:

- a village from another province
- a village within a province where the project was implemented but located in a different district
- another village within a district where the project was implemented.

In all, 19 communes/villages were visited in the three countries. The number of villages visited in each province, by country, is shown in Table 1.

Methods and data-gathering instruments

In each study area, several approaches were used to gather the necessary information for the pathway analysis. A desk review of the available documents on rodent control projects in each country was performed to gather the information related to the conceptualisation, components and implementation of the projects. Focus group discussions (FGDs) were conducted with 10–15 male and female farmers (the final users of the research outputs) in each village to assess the impact pathway that contributed to the adoption/non-adoption of EBRM, and to gather information about farmers' experiences, problems and suggested courses of action for the sustainability of rodent control and management efforts.

Figure 2. Provinces where the impact assessment study took place in Vietnam, Lao PDR and Cambodia

To obtain information on the level of diffusion of the rodent control technologies by the next users, key informant interviews (KIIs) were held with consultants and project staff of the local collaborating institutions of the former ACIAR rodent projects, with extension workers, and with staff and representatives from the organisations involved in the implementation of earlier rodent control projects in the country (e.g. ACIAR Country Manager in Vietnam, World Vision in Vietnam and Laos, and GIZ in Laos). In Cambodia, the collaborating agencies were CARDI and OAE in Kampong Cham and Kampong Thom provinces—the latter as the diffusion province. In Laos, NAFRI and NAFReC were counterpart agencies. In Vietnam, KIIs were held with the deputy head of PPD at the national level, the head/vice head of the provincial sub-PPDs, and the head/deputy head of Plant Protection Stations (PSSs) in the respective districts. The purpose of the KIIs was to gain the perspectives of the informants on the adoption of EBRM and the impact pathways of rodent control projects, as well as their future plans for agricultural programs, particularly rodent management, in their respective countries.

Table 1. Number of villages where focus group discussions were conducted, by country and province

Country (dates of visit)	Province	Number of communes/ villages	Remarks
Vietnam (16–25 September 2010)			
Mekong Delta (southern Vietnam)	An Giang	3	2 project treatment sites, 1 diffusion site (another district)
	Soc Trang	1	Project treatment site
Red River Delta (northern Vietnam)	Ha Nam	2	1 project treatment site, 1 diffusion site (same district)
	Hung Yen	1	1 diffusion site (another province)
South-central	Bin Thuan	1	Project treatment site
Subtotal		**8**	
Cambodia (7–14 January 2011)			
	Kampong Cham	3	2 project treatment sites, 1 diffusion site (another district)
	Kampong Thom	1	1 diffusion site (another province)
Subtotal		**4**	
Lao PDR (16–24 October 2010)			
	Luang Prabang	3	Project sites (2 treatments, 1 control)
	Luang Namtha	4	Project sites (2 treatments, 2 controls)
Subtotal		**7**	
Total		**19**	

In addition to reviewing the project documents, all published and unpublished scientific papers that resulted from the ACIAR rodent control research undertaken in Vietnam and Laos were used to complete the picture of the impact pathways of all the projects.

3 Impact pathway of ACIAR rodent control projects

In this section, ACIAR's projects on EBRM in Vietnam, Laos and Cambodia are assessed to determine the extent of scaling out (i.e. the diffusion of the technology from the project sites to other locations) and scaling up (i.e. the incorporation of EBRM in government policies). As the projects have different time lines and different key players influencing the uptake of the technology, the impact pathways for each country and each project are presented separately. Note that the outputs and outcomes from one project were inputs in the succeeding projects, not only in the project host country but also in neighbouring countries.

Although the ACIAR rodent control and management projects were implemented over 15 years, the two projects in Laos and the one in Cambodia were funded following a review of the first two projects in Vietnam (Table 2). There were six rodent control projects in Vietnam. Following the findings of the first two ACIAR projects, two further ACIAR-funded projects were implemented in collaboration with World Vision Vietnam and AusAID. The last project in Vietnam (and Indonesia) focused on developing effective pathways for delivery and uptake of integrated, ecologically based methods for rodent management in poor farming communities.

Projects in Vietnam

Initial projects

The first rodent control project was entitled 'Management of rodent pests in Southeast Asia' (AS1/1994/020) and was conducted from 1 January 1995 until 31 December 1998. The geographical focus was Australia, Indonesia and Malaysia. Eighteen months after this project started, another project ('Management of rodent pests in Vietnam'—AS1/1996/079), with a sole geographical focus on Vietnam, was implemented (1 July 1996 to 31 December 1998) and, as discussed below, integrated into the first project. The objectives of these projects were to:

- understand the processes and factors that limit rodent pest populations
- assess the efficacy, and undertake a cost–benefit analysis, of the traditional and physical methods of rodent control
- develop a pilot rodent management strategy.

In the first project, Vietnamese scientists from the Institute of Agricultural Science (IAS) and the National Institute of Plant Protection (NIPP) participated in the annual project coordination meetings and workshops. Realising the importance of this project to Vietnam, and because of the escalating losses to the Mekong Delta rice crop caused by rats, the Ministry of Agriculture and Rural Development (MARD) requested further assistance. This resulted in the smaller Vietnam-specific project. The smaller project was conducted in Tien Giang, Tra Vinh, Can Tho, Soc Trang, Bac Lieu and Ho Chi Minh provinces in southern Vietnam, and Ha Bac and Vin Phuc provinces in northern Vietnam. CSIRO was the commissioned organisation for both these projects. In the case of the Vietnam-specific project, IAS in Ho Chi Minh City and NIPP in Hanoi served as the country collaborators. The small project also received technical assistance from the International Rice Research Institute (IRRI) through IRRI's integrated pest management (IPM) project in Vietnam.

Table 2. Rodent control and management projects analysed by country

Country and project code	Project title	Inclusive dates	Budget
Vietnam			
AS1/1994/020	Management of rodent pests in Southeast Asia	1 January 1995 – 31 December 1998	A$1,911,162 (ACIAR contribution: A$994,488) A$22,762 (Vietnam component)
AS1/1996/079	Management of rodent pests in Vietnam	1 July 1996 – 31 December 1998	A$179,060 (ACIAR contribution: A$135,660) (Vietnam the only collaborating country)
AS1/1998/036	Management of rodent pests in rice-based farming systems	1 January 1999 – 30 June 2003	A$2,672,449 (ACIAR contribution: A$1,214,600) A$291,504 (Vietnam component)
Capacity-building for Agriculture and Rural Development (CARD) 2000/024	Enhancing capacity in rodent management in the Mekong Delta region using non-chemical methods	July 2000 – mid October 2002	A$317,200 (AusAID CARD funding)
PLIA/2000/165	Facilitating farmer uptake of ACIAR project results: World Vision collaborative program Component 4—Rat control in rice-based farming systems	1 January 2001 – 31 December 2007	A$1,676,507 (ACIAR contribution: A$1,452,769) A$83,066 (Vietnam component) (extracted from Palis et al. 2004)
ADP/2003/060	Implementation of rodent management in intensive irrigated rice-production systems in Indonesia and Vietnam	1 April 2006 – 30 March 2010	A$1,309,868 (ACIAR contribution: A$757,880) A$540,979 (Vietnam component)
Lao PDR			
AS1/1998/036	Management of rodent pests in rice-based farming systems	1 January 1999 – 30 June 2003	A$2,672,449 (ACIAR contribution: A$1,214,600) A$101,000 (Laos component)
ADP/2004/016	A systems approach to rodent management in upland environments in Lao PDR	1 January 2005 – 31 December 2006	A$318,543 (ACIAR contribution: A$215,939) (Laos the only collaborating country)
Cambodia			
ADP/2000/007	Farmer-based adaptive rodent management, extension and research system in Cambodia	1 July 2001 – 31 March 2007	A$758,823 (ACIAR contribution: A$515,973) (Cambodia the only collaborating country)

The impact pathway for the first two projects is presented in Figure 3 (pp. 30–31). This diagram provides summary information on the research projects in terms of the financial inputs and the main activities and outputs. In addition, it provides information at the outcome and impact level, highlighting the key next and final users and how the results of the research were used after completion of the projects. Notably, these projects did not directly lead to a change in social, environmental or economic conditions at the community level, but they did lead to further research on rodent control—depicted as scientific impacts.

Inputs

The total budgets for these projects were $1,911,162 for AS1/1994/020 ($22,762 of which was the Vietnam component) and $179,060 for AS1/1996/079.

Activities

The main activities focused on research and capacity building. Research areas included the ecology of rodents and the use of physical methods of rodent control. Annual project consultation meetings were conducted to update the research team on the progress of the project. Capacity building included both on-the-job training of the in-country project team (scientists and technicians) and more formal training. While building the knowledge and skills of the in-country and Australian scientists was essential for ensuring the technical outputs of the projects were produced, the project also left a legacy in terms of increasing the in-country capabilities in scientific research. Training workshops were also delivered to PPD staff and extension workers to equip them with the skills necessary to demonstrate and pilot the CTBS in the field.

Outputs

The outputs from these projects were knowledge of the biology and ecology of rodent pests, resulting in the identification of the optimal timing, location, scales and actions for rodent management. These outputs were consistent with the goals of sustainable agriculture with minimal impact on the environment and social soundness. Specifically, they included: (1) knowledge of the different rodent species, and of factors that limit the rodent population and the efficacy of the CTBS; (2) rodent management recommendations and an integrated rodent management at the village level (IRM-V) package; and (3) policy recommendations for rodent management.

Outcomes

Despite the short duration of the projects, several useful outcomes were achieved. The next users—PPD staff and extension workers—gained an increased understanding of the efficacy of the CTBS, and the biology and ecology of rodent pests, enabling them to pilot the use of the CTBS and demonstrate it to participatory farmers.

In addition, the Government of Vietnam used the results and policy recommendations to make a major policy change on rat control and management. From that, the Prime Minister issued policy no. 09-1998/CT/TTG, which directed all provinces to adopt IRM-V and establish farmer groups to control rodents, encouraging the farmers to use physical or cultural methods of rat control (Office of the Prime Minister, Vietnam 1998). Before this policy change, farmers relied heavily on the use of rodenticides.

Impacts

Recommendations of the project review team resulted in further ACIAR investment in rodent control in Vietnam. New projects were also recommended and implemented in Laos and Cambodia, as discussed below.

Continuing rodent control research in Vietnam

Following the first two rodent control projects (AS1/1994/020 and AS1/1996/079), ACIAR managed a further three projects in Vietnam:

- 'Management of rodent pests in rice-based farming systems' (AS1/1998/036)
- 'Enhancing capacity in rodent management in the Mekong Delta region using non-chemical methods' (AusAID's CARD project 2000/024)
- 'Facilitating farmer uptake of ACIAR project results: World Vision collaborative program', Component 4—Rat control in rice-based farming systems (PLIA/2000/165).

They were conducted in several provinces in the Red River Delta and the Mekong River Delta. AS1/1998/036 was implemented in Me Linh district, Vin Phuc province, in the Red River Delta; CARD 2000/024 was undertaken in the provinces of Tien Giang and

Soc Trang in the Mekong Delta; and PLIA/2000/165 was carried out in three districts (Bac Binh, Tuy Phung and Ham Thuan) of Binh Thuan province in south-central Vietnam.

The collective objectives of these three projects in Vietnam were to:

- establish and monitor the effectiveness of IRM-V
- use the IRM-V technologies developed by the previous ACIAR projects, including the CTBS, as the technical component of a larger World Vision Vietnam rural development project in south-central Vietnam
- extend the community-based rodent management approaches developed in the ACIAR-funded projects by training PPD extension staff.

Figure 4 (pp. 32–33) illustrates the pathway from inputs to impact of these three projects in Vietnam.

Inputs

The total budgets for these projects were A$2,672,449 (Vietnam component: A$291,504) for AS1/1998/036, A$317,200 (total AusAID funding) for CARD project 2000/024 and A$1,676,507 (Vietnam component: A$83,066) for PLIA/2000/165 (see Table 2).

Activities

The main activities comprised capacity building and participatory action research. These activities focused on piloting the effectiveness of IRM-V. For the capacity-building component, the main focus areas were rodent biology, taxonomy and identification of rodent pest species, sociology and participatory processes, fieldwork and data analysis, set-up and management of CTBSs, and development of extension materials.

In support of the training activities, the extension materials developed were distributed to trainees. The use of the CTBS was piloted in several villages at the major project sites. In northern Vietnam, trials on the use of the CTBS were conducted in four subvillages, with 10 CTBSs established per season. In addition, IRM-V was carried out in two subvillages at the project sites. In south-central Vietnam, World Vision incorporated rodent control with the use of the CTBS in IPM techniques. Twenty-one CTBSs were established per season. In the Mekong Delta, 12 CTBSs in each of two districts per province were established with the cost of the material subsidised at the hamlet level in Tien Giang and Soc Trang provinces.

The participatory action research activities included CTBS demonstrations and piloting IRM-V. Here, the modes of delivering the results of the projects included: (1) farmer participatory research, where activities were demonstrated to, and discussed with, the farmers; (2) capacity building and action research, in which extension workers and farmers were given hands-on training; (3) active partnership and cooperation among farmers and village agricultural officers; and (4) demonstration of the mechanisms of the CTBS at all project sites. Materials (plastic fences, rat traps and seeds for planting the trap crop) and labour required to set up a CTBS cost A$181 (VND750,000) of which 50% was for materials subsidised by the projects. The other 50% was for labour, which was contributed by the farmers and comprised maintenance of the CTBS, including daily checking of the rat traps, and keeping records of the rats caught (Palis et al. 2004).

The IRM-V was conducted in northern Vietnam only, due to the presence of established farmer cooperatives. These cooperatives facilitated the implementation of IRM-V, which requires community action.

Outputs

The main outputs for these projects were increased knowledge of rodent biology, ecology and effective control methods, and capability built largely through piloting CTBSs in the Red River Delta, the Mekong River Delta and south-central Vietnam. PPD staff, extension workers, farmers, and members of the farmers' cooperatives and associations were trained in the ecology and population dynamics of rodents.

Outcomes

Following the training, the PPD staff and extension workers promoted CTBS technology, advised farmers about rodent control and management, and scaled out IRM-V to other districts. Results of the study conducted by Palis et al. (2004) showed that, in northern Vietnam, IRM-V was scaled out to two subvillages in Me Linh district, Vin Phuc province. Moreover, the provincial government of Hai Phung allocated A$23,432–35,148 (VND200–300 million) to rodent control from 1998 to 2000, for training,

publications and CTBS demonstrations. Also, PPD and World Vision Vietnam staff provided advice to farmers in the control villages, where there were no CTBS demonstrations. The IRV-M modules were also integrated in the 18 Area Development Programs (ADPs) of World Vision Vietnam. In southern Vietnam, as an offshoot of the Tien Giang and Soc Trang experiences, the PPD of Bac Lieu province adopted the use of CTBSs in several districts. Fifty CTBSs were established for demonstration purposes, using a partial subsidy of A$6,069 (VND50 million; equating to A$121 (VND1 million) per CTBS) from the provincial government for CTBS materials (Palis et al. 2004).

IRM-V and the CTBS were adopted by the farmers in the project sites and expansion villages[3] of the Red River Delta and Mekong River Delta. The adoption of the CTBS, however, was not sustained in these regions, due to economic (high up-front cost) and technical constraints (establishment of the trap crop 2 weeks ahead of the planting period). Likewise, in south-central Vietnam, both IRM-V and the CTBS were adopted by the farmers at the project sites. But it was only IRM-V that was adopted in the expansion villages through the farmer cooperatives. The adoption of the CTBS was also not sustained due to economic and technical constraints.

The adoption of IRM-V in both the project and expansion villages, and the CTBS in the project sites during the project life, resulted in a change in rodent control practices, and reductions in the areas damaged by rodents, yield losses and input costs. In the final year of the projects in the treatment villages, CTBSs also proved to be effective in reducing the use of rodenticides and plastic fences.

Impacts

For these projects, some impacts on economic, environmental, social and scientific contributions have been documented (see Palis et al. 2004). Perceived community-level economic impacts included increased rice production and higher incomes for farmers, due to the reduction in yield losses[4]. For example, at the project sites in northern Vietnam, farmers estimated that yield losses were reduced by 0.7 t/ha/year during the project period, due to IRM-V and CTBSs. Even higher reductions in yield losses of 4.5 t/ha/year and 3.0 t/ha/year were reported by farmers in south-central Vietnam and southern Vietnam, respectively (Palis at al. 2004).

Environmental impacts could be inferred through the reduction in the use of plastic fences and rodenticides. For example, it was reported that, compared with the pre-project (1998) levels, by 2002 a dramatic reduction occurred in the number of farmers using plastic fence to surround their whole crop area—from 100% to around 30% for both treatment and control groups. Likewise, the frequency of chemical rodenticide applications per cropping season decreased from three to one, which concurs with earlier findings (see Brown et al. 2006). Plastic fences, when not properly disposed of, may clog irrigation canals and, when burned, may emit harmful gases.

Social impacts included changes in health and social capital. The health impact was achieved through an increased awareness of rat-borne diseases among researchers, extension officers and farmers. The reduction in the rat population also lessened the contamination of grain and water by rat urine, which causes leptospirosis among humans and livestock. In terms of social capital, social/community cooperation was enhanced by working together or increasing the synergy among stakeholders, resulting in a more cohesive and healthier interaction among community members.

Scientific impact was evident from the publication of the project results. The growing body of literature about rodent management has benefited the scientists engaged in rodent research after the completion of these projects. In fact, the favourable review of these projects led to the development and implementation of another project that focused on developing effective pathways for delivery and uptake of EBRM.

[3] In northern Vietnam, expansion villages that are around 17 km away from the project sites were chosen since they were project sites of World Vision (Nga 2009). In south-central and southern Vietnam, expansion villages were chosen based on rodent damage, regardless of the distance from project sites.

[4] In northern Vietnam and south-central Vietnam, yearly reduction in yield losses was the sum of two cropping seasons, while in southern Vietnam reduction in yield losses was the sum of three cropping seasons.

Research to further increase uptake

Given the success of the earlier projects, ACIAR funded another project, entitled 'Implementation of rodent management in intensive irrigated rice-production systems in Indonesia and Vietnam' (ADP/2003/060). Building on earlier results, the main goal of this project was to develop an effective pathway for delivery and uptake of the results of piloting EBRM in intensive irrigated rice-production systems in Vietnam and Indonesia. Thus, the results and experiences from other projects provided significant inputs for this project. Figure 5 (pp. 34–35) illustrates the impact pathway for this project.

In Vietnam, the project was implemented in An Giang province in the Mekong Delta and Ha Nam province in the Red River Delta. These provinces typically have intensive lowland irrigated cropping systems and are known to have chronic rodent problems. The project was carried out through CSIRO, PPD, World Vision Vietnam and the Irrigated Rice Research Consortium (IRRC) of IRRI as collaborating institutions. The support of PPD, agricultural extension agencies and local political institutions (people's committees and farmer cooperatives) became instrumental in achieving the objectives of the project. The policy directive of the Prime Minister in 1998 also provided impetus for the continuous adoption of EBRM in the study areas and at the other sites as well.

Inputs

The total budget for this project was A$1,309,868 of which A$540,979 was spent in Vietnam.

Activities

The ACIAR project enabled the chain of activities leading to the diffusion and adoption of the technology. These included, among others: training of PPD support staff to ensure adoption and implementation of EBRM; training of farmers through farmer field schools (FFSs) and IPM classes where modules on EBRM were integrated; formation of rodent control groups at the commune level; and use of mass media to disseminate information about EBRM.

Outputs

As with the earlier projects, a significant output of this project was the capacity built. Implementation of this project resulted in a further increase in the number of trained PPD staff at the provincial and district levels, to assist with implementation of EBRM in their respective areas. Because of the PPD extension activities, farmers in other villages outside the study areas also received training related to EBRM. This resulted in the adoption of community action to control rodents. More importantly, the topics in EBRM training modules were integrated into the national IPM and '5R + 1M' and '3 reductions, 3 gains'[5] programs.

Outcomes

The improved knowledge of the staff at the national, provincial and district levels of the PPD and extension offices enabled them to be effective in delivering their services to farmers and farmer cooperatives. The EBRM modules were also integrated by the PPD into the national FFS program. The PPD, in collaboration with World Vision Vietnam, was also able to scale out EBRM to other districts and provinces. An example of this was the expansion of EBRM in three communes in Hung Yen province in the Red River Delta.

The diffusion of the technology was enabled by the combination of various modalities at all levels. In Vietnam, key to this was the role played by the local institutions, from the people's committees to the PPSs, sub-PPDs and PPD, their composite technical experts and extension workers, and the various farmer groups, including farmer associations in the Mekong Delta and the farmer cooperatives in the Red River Delta. In some communes, the formation of rodent control groups facilitated the implementation and adoption of EBRM at the project sites. Information about EBRM and rodent control was disseminated and communicated to extension workers and farmers through the mass media, including local and national television channels, newspapers and radio, and by public address system at the commune level.

In Vietnam, the evidence of scaling out was also clear. Farmers from project areas, through the facilitation of the PPD, sub-PPDs and, in some instances,

[5] The '5R + 1M' program means: reductions in a) seed rate, b) pesticide use, c) fertiliser use, particularly nitrogen, d) water use and e) postharvest losses; and use of high-quality seeds. The 5R + 1M program was a development of the '3 reductions, 3 gains' program. The three reductions refer to reductions in seed rate, pesticide use and nitrogen use, while the three gains refer to an increase in income, less human exposure to toxic chemicals and less environmental pollution.

World Vision, shared their experiences with other farmers at non-project sites. The project reported a significant diffusion of EBRM in neighbouring villages, districts and provinces. In 2009, all 11 districts in An Giang province and 152 cooperatives in Ha Nam province implemented community actions (P. Brown, unpublished ACIAR annual project report 2009). Scaling out was facilitated by village meetings, demonstrations and exchange field visits to other farms, where the use of rodent traps had been demonstrated at all project sites. The campaigns brought the technology into actual use and led to its village-wide adoption.

Training and the use of mass media (radio, print and television) were also instrumental in widening the breadth of technology adoption, even in non-project areas. However, the extent of scaling out was higher in some areas than others. For example, it was higher in the Red River Delta than in the Mekong Delta. This was because of the presence of strong farmer cooperatives, which formed rodent control groups, and a more extensive integration of rodent management into the IPM/FFS programs in all provinces in the north, compared with the south. In the south, the presence of farmer cooperatives is reported only in Bac Lieu province. In most provinces in the south there are farmer associations and IPM clubs, but no rodent control groups have been formed.

MARD and PPD as next users were also able to scale up the results of the projects. Up-scaling was clearly evident in Vietnam, where MARD issued an order (official telegram no. 21/CD-BNN-BVTV on 'Strengthening prevention of rodents to protect crops') dated 8 November 2010 and the PPD a letter (no. 1676/BVTV-TV) on 29 September 2010. These technically embodied the recommendations associated with EBRM from the standing directive (policy no. 09-1998/CT/TTG) issued by the Prime Minister on 18 February 1998 on urgent measures to eradicate rodents to protect crops (Office of the Prime Minister, Vietnam 1998). The order directed MARD to plan rat control for each period during the crop season, in cooperation with the agencies and mass organisations in the local communities. Specifically, it prescribed community action with specified timing for each action, consistent with the recommendations of the ACIAR project.

The order also further regulated the use of rodenticides, by directing the media and other local propaganda agencies to inform the public about the dangers and safety issues involved in their use. It also directed the functional units of the state to strengthen control of the pesticide industry. Furthermore, the order directed specialised agencies to support the effort, including providing support to village organisations and cooperatives in the campaign to control rodents (MARD 2010). These directives became instrumental in the adoption and expansion of EBRM sites, especially in the north. In the south, EBRM adoption in Bac Lieu province was in response to the national policy no. 09-1998/CT/TTG.

Impacts

All of the measures mentioned above have contributed to the community-level impacts, such as improved economic, environmental and social conditions. There was also a useful contribution to science and research.

Observable changes in economic conditions included reduction in the area damaged by rodents and an increase in yield. In Ha Nam province, a study conducted by Nga (2009) reported that the area damaged by rodents decreased by 93.5%, from 4,894 ha in 2005 to 318 ha in 2009. This resulted in a reduction in yield loss from 5–15% in 2005 to 3–7% in 2009, with an average increase in yield of 0.49 t/ha. Although other factors may have contributed to the reduction in yield losses, farmers attributed the reduction to the better rodent management practices they had learned from the intensive training courses and guidelines on rodent management. The reduction in yield losses and reduced outlays for rodenticides led to increased income for farmers. Net of rodent management cost and other production costs, the average net income of farmers in Ha Nam province increased by VND2.282 million/ha—from VND6.547 million/ha in 2005 to VND8.829 million/ha in 2009 (Nga 2009). These figures were not verified during the fieldwork done for this study but the farmer participants in the FGDs confirmed that the increase in yield was largely attributed to the reduction in yield losses due to rodent damage.

In addition to changes in economic conditions, environmental benefits were also observed as a result of shifting from the use of chemical rodenticides and plastic fences to more environmentally friendly methods for controlling rodents. For example, it was reported that farmers in Ha Nam and An Giang provinces reduced their use of rodenticides by 52% and 37%, respectively.

In terms of social impacts, working together for a common goal has led to a cohesive interaction among the different sectors; namely, farmers, farmer leaders, political leaders, youth and women in the community. These improvements in social cohesion offer the possibility of greater support for the continued use of EBRM. For example, Brown et al. (2010) and Palis et al. (2011) showed that there were also strong shifts toward the implementation of community actions, from 36 to 62% of famers in Ha Nam and from 5 to 11% in An Giang.

The scientific impact is evident from the presentation of research results at conferences and the publication of papers in journals and books. The publication of these project results contributes to the existing body of literature about rodent control and management and is useful to students, practitioners and other researchers in this field.

While the EBRM projects in Vietnam have gone a long way, much is still needed to extend the project results beyond the project sites and diffusion villages. As such, there is a need for a wider scaling out of the adoption of EBRM. Sustainability of EBRM should be one of the main considerations of the Government of Vietnam. A follow-on study related to this may be considered by the Government of Vietnam in collaboration with international research and funding institutions.

Projects in Lao PDR

Initial project

Laos was included among the countries included in the ACIAR project, entitled 'Management of rodent pests in rice-based farming systems' (AS1/1998/036), which was implemented between 1999 and 2003. It was carried out by CSIRO Sustainable Ecosystems, with NAFRI as country collaborator. The impact pathway for this project is depicted in Figure 6 (pp. 36–37).

Inputs

The total budget for this project was A$2,672,449, with the Laos component accounting for A$101,000.

Activities

The activities for Laos under this project included training and research, similar to those undertaken in Vietnam. NARFI research and extension staff members were trained on the principles of rodent ecology and management. NAFRI staff also attended masterclasses on rodent biology and management in Australia.

Piloting of the CTBS was established in four villages in the upland provinces in Luang Prabang and Luang Namtha. To carry out these activities, particularly the research aspects, an intern from the Australian Youth Ambassador for Development (AYAD) program assisted with the project, especially with rodent taxonomy. Before the demonstration and actual setting up of the CTBS, some farmer leaders were also invited to conduct research on the history of rodent outbreaks, breeding and identification of the species of rodents common in the village. Also included was an appraisal of the postharvest impact of rodents.

Outputs

The main outputs from this project included knowledge on rodent outbreaks and their ecology and biology. NAFRI staff and farmer participants of the project became aware of the recommended rodent control methods and postharvest losses due to rodent infestation.

Outcomes

The capacity-building activity of the project led to enhanced capability in NAFRI and the establishment of the National Rodent Management Laboratory. Another important outcome was realisation that CTBS technology has limited application in upland shifting cultivation, due to limited water availability, changes of crop mixes, and the topography of the upland environment. However, the CTBS was found to be effective in reducing rodent-induced losses in grain storage areas.

Impacts

Despite the outcomes, there was no significant community-level impact from this project since the outcomes were realised only while the project was ongoing. However, lessons learnt and experiences from the project did lead to a follow-on project, ADP/2004/016, as outlined below.

Follow-on project

This new project, entitled 'A systems approach to rodent management in upland environments in Lao PDR' (ADP/2004/016), aimed to develop robust solutions

to rodent management in upland cultivation systems, based on an understanding of the population dynamics of the key rodent pests. It also sought to determine the sociological and cultural factors that influence farmers' adoption of rodent management. The project was implemented in the provinces of Luang Prabang and Luang Namtha. Figure 7 (pp. 38–39) summarises the impact pathway for this project.

Inputs

The total budget for this project was A$318,534, with Laos the only collaborating country.

Activities

The capacity-building activities focused on training sessions covering rodent biology, ecology and control options and were conducted for both the government extension workers and farmers. Research activities included pre- and post-surveys of farmers' knowledge, attitude and practice (KAP) on rodent control; collection of data on rodent populations, breeding and rodent pest outbreaks; assessment of crop damage caused by rodents; and analysis of social and wealth profiles of each community or village. Supporting the training and research activities was the preparation of publications on rodent pest identification and control options.

Outputs

These research and capacity-building activities led to increased knowledge on: farmers' KAP on rodent control; rodent populations, breeding, ecology and the pattern of past rodent pest outbreaks; and the extent of crop damage due to rodents. A sociocultural profile of the community before rodent control management was also produced. Based on the knowledge generated, the project developed manuals on key rodent pests, and on rodent control practices. These manuals comprised photographs and descriptions of the main pest species, identification keys and recommended control strategies, providing useful tools for a better understanding of rodent control, not only for extension workers but farmers as well.

Outcomes

The next users of the outputs of the project were researchers from NAFRI and extension officers from the Provincial Agriculture and Forestry Offices (PAFOs) and the District Agriculture and Forestry Offices (DAFOs). The results of the project, such as new knowledge about rodent behaviour, and the manuals on rodent species and their control, were important inputs to their extension work, especially in introducing EBRM to farmers. Together with farmer leaders, who were also trained in rodent control, they passed on the knowledge to other farmers in the village.

Village leaders were also defined as next users. But even before the rodent control project, villages had already adopted a policy on non-use of rodenticides. New knowledge on the extent of damage by rodents and of their ecology, as well as the impact of rodenticide use on humans and the environment, strengthened and supported the policy on banning the use of rodenticides in Laos. The introduction of EBRM offered the villagers another environmentally friendly option for rodent control, in addition to the pre-existing domestication of cats that would prey on rodents. This anti-rodenticide policy provided increased scope for the use of EBRM and its adoption by a wider population of farmers in the area.

Aid agencies, such as World Vision Laos and GIZ, were also next users of the project results. World Vision extended the technology to other districts in Luang Prabang and GIZ included rodent control management in its training activities for World Vision's ADPs for farmers in several provinces of Laos. Such efforts broadened the opportunities for EBRM to be introduced as an option to the farmers.

Farmers were the final users of the technology. At the project sites, farmers present during the FGDs conducted for this study said that, in addition to their traditional methods of controlling rodents (digging large pits and using cats), they would continue to use the community-based approach to rodent management. Community campaigns were held during rodent outbreaks, including a bounty system wherein children were given school supplies according to the number of rodents caught. However, the high investment in materials needed to set up CTBSs constrained their continued use of the technology, although they saw its effectiveness when used in grain storage areas.

On the whole, the project activities led to several noticeable changes at the adopter level. Similar to other countries where EBRM had been implemented, use of rodenticides in the village decreased. Reports indicate that during the project, the use of rodenticides declined by 39% (Brown and Khamphoukeo 2007, 2010). As the

farmers became aware of the ecology of rodents, there were changes in the cropping calendar. Resource maps were also developed. These contributed to a reported reduction in rodent damage to upland and lowland rice and maize (responses from the farmers present during the FGDs).

Noticeable changes were recorded in the rodent control practices of farmers. During the field visits conducted for this study, farmers said that, with the use of EBRM and the CTBS, they now believed that they would be able to save time and money in controlling rodents since they no longer needed to buy dangerous rodenticides and spend time burying the dead rodents. Also, due to strong village leadership, the rodent control champions were identified in the villages and the spirit of working together in the future could be harnessed to achieve better rodent control. The reduction in the areas damaged by rodents likewise led to an increase in crop yields, according to the farmers.

There was no evidence of scaling up the rodent control strategy using EBRM. Although a policy exists on raising cats and the non-use of rodenticides at the village level, there are no specific directives from higher authorities. Consequently, more can be done in scaling up of the EBRM technology to strengthen the rodent management in Laos, since policy at the village level may change with the changes in local leadership. In most areas where the use of rodenticides was banned, the move actually came before the project; hence, it could not be considered as part of the scaling up attributable to the project.

Impacts

Community-level impacts of the project included the following: increased crop harvest that led to increased income; improved environmental conditions that contributed to better human health; and stronger social cohesion. Systematic rodent control has lessened the damage to crops, giving farmers a much better harvest. Whereas before they regarded rodent pest damage as 'normal', they now appreciate the additional income they could have earned from the damaged crops. Supporting the drive against the use of chemicals for rodent control has also contributed to lessening the risks to the environment. This, in turn, has contributed to promoting better human health. The need for synchronised activities and collective action in implementing EBRM could further enhance social cohesion among villagers—a trait that existed before the introduction of the project in Laos—because EBRM provided another venue to exercise group cooperation and collective action (information from responses of farmers during the FGDs conducted for this study).

Project in Cambodia

The rodent control project in Cambodia, entitled 'Farmer-based adaptive rodent management, extension and research system in Cambodia' (ADP/2000/007), had its roots in the results of the ACIAR projects in Indonesia and Vietnam, especially AS1/1998/036. The Cambodian project was commissioned by UQ, with CARDI and OAE as the collaborating institutions. In addition to the objectives of improving rodent pest management and testing the applicability of the CTBS in Cambodia, the project envisioned providing CARDI with the opportunity to develop the skills of its staff in conducting research and working with farmers. The impact pathway for Cambodia is depicted in Figure 8 (pp. 40–41).

Inputs

The total budget for this project was A$758,823, with Cambodia the only collaborating country.

Activities

The activities conducted for this project centred on training and action research. The training activities included training of trainers (TOT) on 'technical implementation procedure of the trap–barrier system (TBS) for field rat management', which was conducted by CARDI among district agricultural extension officers who would serve as future trainers of extension workers. Similar to Laos, an AYAD was deployed in the study sites to assist in conducting the activities. Another 3-day training session on the same topic was conducted for extension workers who were directly supervising the farmers. This was held in Samrong commune, Prey Cheor district, Kampong Cham province, through collaboration between CARDI and the Cambodia–Australia Agricultural Extension Project (CAAEP) II.

A KAP baseline survey on rodent management was also conducted. Other activities included documenting

technical options for rodent management at the project sites and investigating opportunities for using the TBS as an entry point for the introduction of community-based actions. The CTBS was also piloted at two sites, and its use as a common property demonstrated in Samrong commune.

Outputs

The training activities undertaken for the project resulted in improved knowledge among CARDI and OAE staff and extension workers on establishing the CTBS. Overall, researchers, extension workers and farmers gained a good understanding of the technical, economic and social aspects of rat management. Manuals, brochures and handouts on rodent management were also produced and used in the training activities. In addition, these extension materials were distributed to extension workers and farmers.

The results of the KAP baseline survey provided an understanding of management options consistent with needs of the farmers and the community, and developed behaviour and information requirements for extension and participatory research processes.

Outcomes

CARDI, a new institution at the time of the project, gained a good understanding of the rat population and conducted regular meetings with farmers. In this way, the staff members were exposed to dealing with farmers and gained skills in working with the farming communities. OAE was also able to extend the use of the CTBS to other areas outside the pilot sites. One of the significant outcomes was the establishment of good communication between CARDI and OAE, something that was not present before the project. It also developed external linkages between CARDI and OAE and the institutions in Australia. CARDI and OAE, as the next users of the technology, also recognised the importance of rat management on a wider scale. One of the CARDI staff was sent to Australia for her PhD studies.

Farmers at the project sites acquired greater knowledge of effective rodent management and became confident in selecting sites for the construction of CTBSs. However, the KIIs and FGDs conducted among the next and final users as part of this study revealed that adoption was high only during the time the project was operating. The farmers admitted that, after the project, they were not able to continue using the CTBS due to the high cost of materials. In addition, results from the KIIs and FGDs indicated that the majority of farmers discontinued CTBS use after the monetary benefits of participating in the project stopped, with the villagers saying that they were busy with activities that were more important than rodent control.

The informants stated that the concept of community action was relatively new and they had some difficulty working as a group. It could be inferred that this was due to the historical experience that they had had with cooperatives. On the other hand, farmers present during the FGDs admitted that since they now know the timing of rat control, working individually but concurrently will add value to collective rodent management. More importantly, farmers became aware of some other rodent control techniques, like modification of traps, which can stand alone and suit local conditions (P. Brown, unpublished report 2003). These were not considered by the project because it mainly focused on the CTBS.

The review conducted by P. Brown (unpublished report 2003) indicated that OAE was able to pilot the CTBS in another district, but again the farmers were reluctant to use it due to financial constraints. Moreover, there was no evidence of scaling up rodent control.

Impacts

The results of the evaluation of the rodent project in Cambodia by P. Brown (unpublished report 2003), verified during field visits, indicate that the project had not made any significant impacts at the farmer and community levels. A 3-year period was not sufficient for the community to absorb the new technique. A follow-up study is needed to provide continuity and reinforce what has been started in the area.

In all the impact pathways discussed above, the promotion of EBRM technologies to farmers, including the CTBS, was done through the combined face-to-face modalities of training, group meetings, field demonstrations, village campaigns, field visits and the use of mass media.

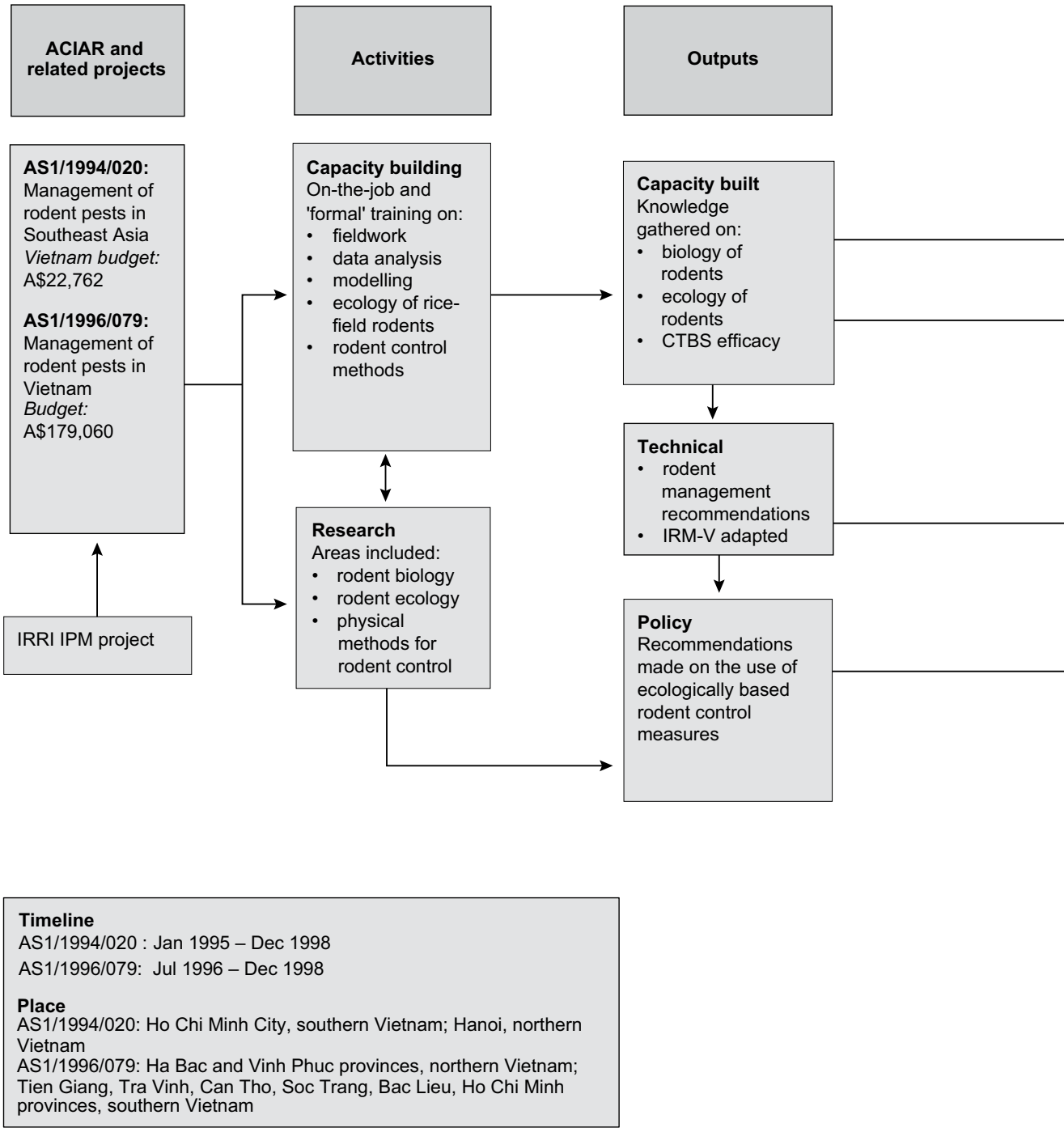
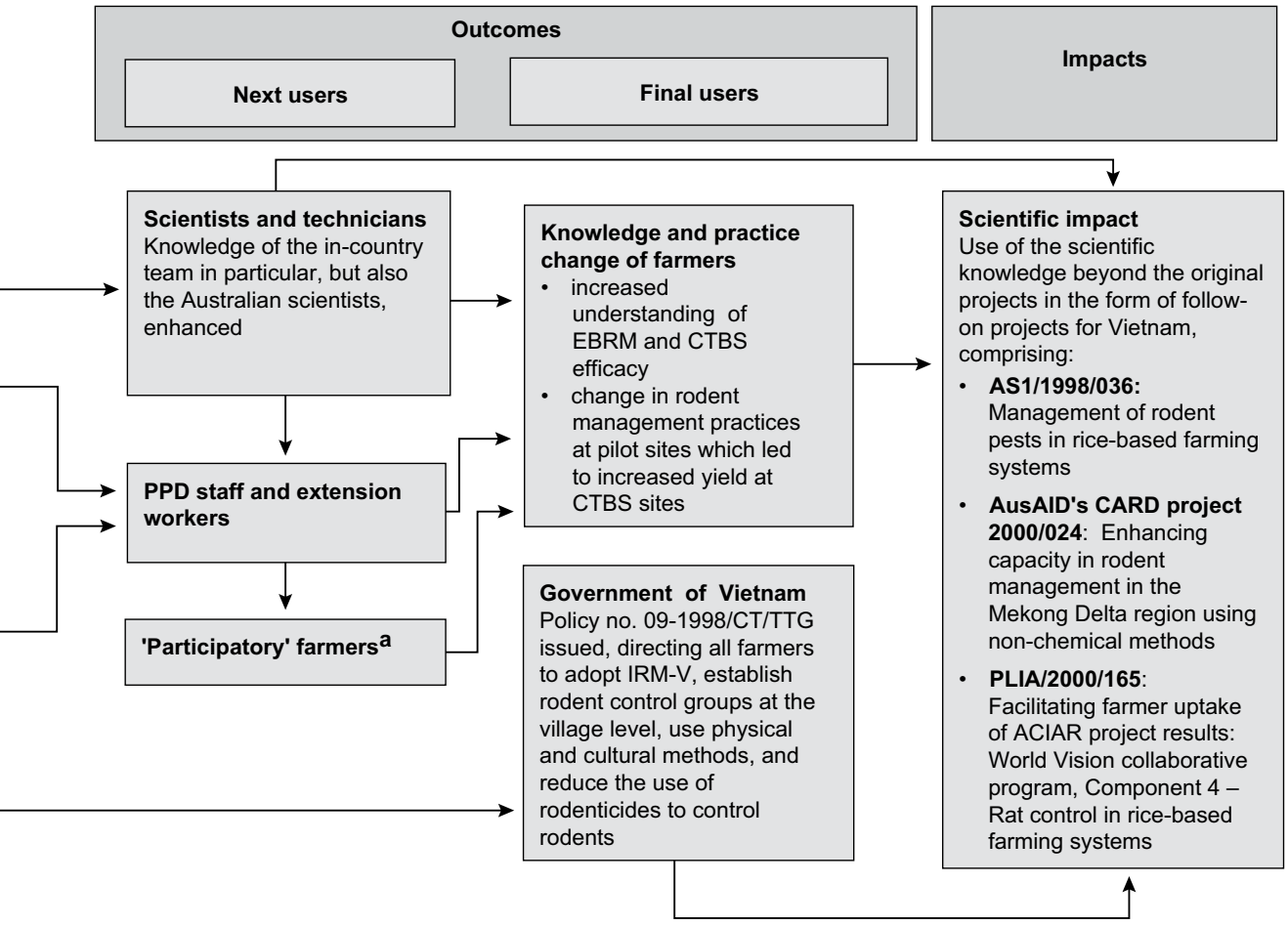


Figure 3. Impact pathway in Vietnam for ACIAR projects AS1/1994/020 (Vietnam component) and AS1/1996/079 (see p. 8 for abbreviations)



AS1/1994/020
Rat ecology and taxonomy studies in northern and southern Vietnam

AS1/1996/079
Northern Vietnam: Rodent research group conducted training among the technical staff of the PPDs in six provinces

Southern Vietnam: CSIRO staff provided training on CTBS plus trap-crop technology and rodent pest management among IAS staff

1998: Follow-on projects proposed for Vietnam

a. While participatory farmers may benefit during the project through productivity gains, community-level impacts are ideally measured beyond the life of the project to provide a sense of sustainability. Hence, participatory farmers are considered as next rather than final users here. In a sense, they are farmer intermediaries who may encourage the use of the technology by farmers who did not participate in the project.

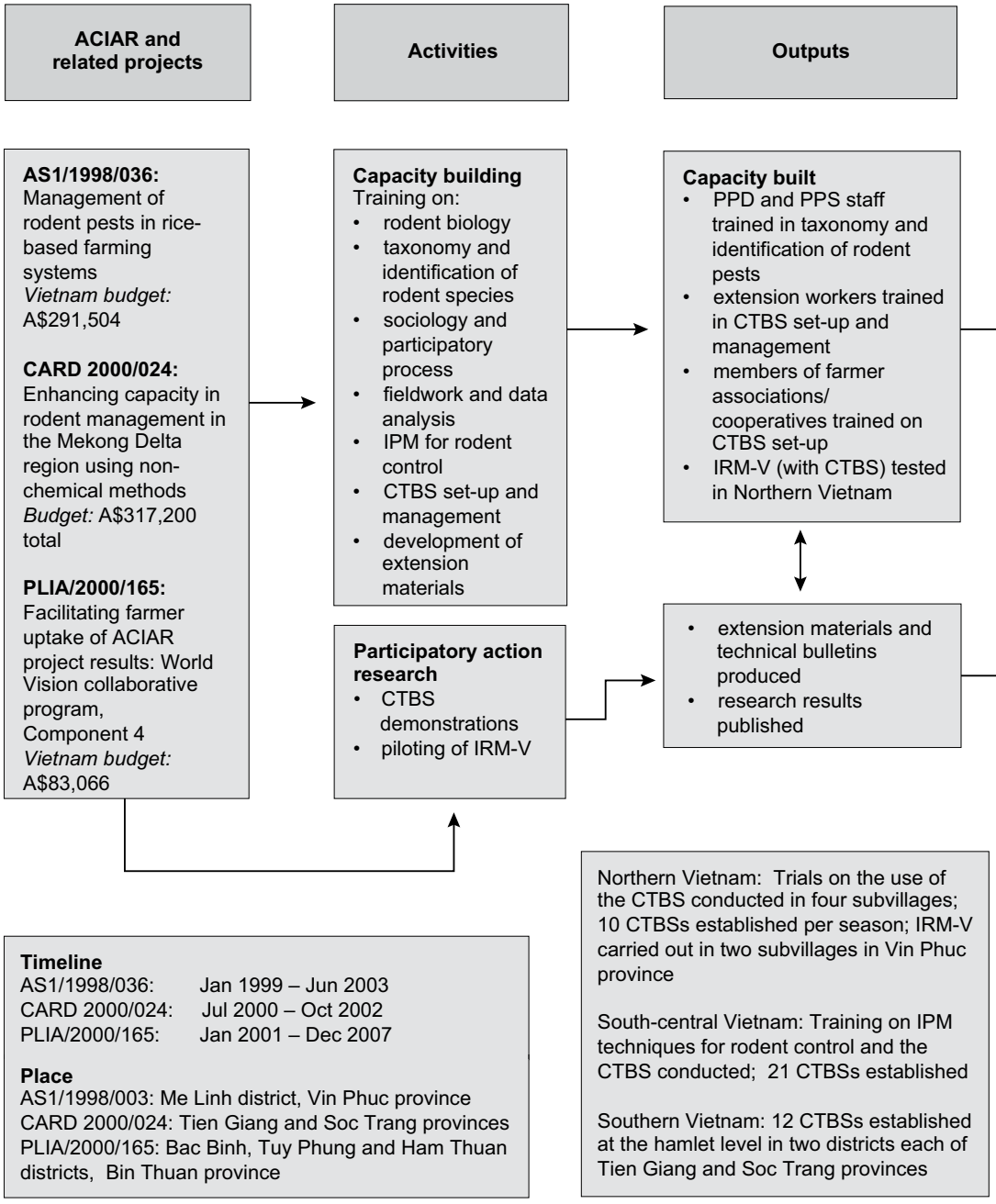
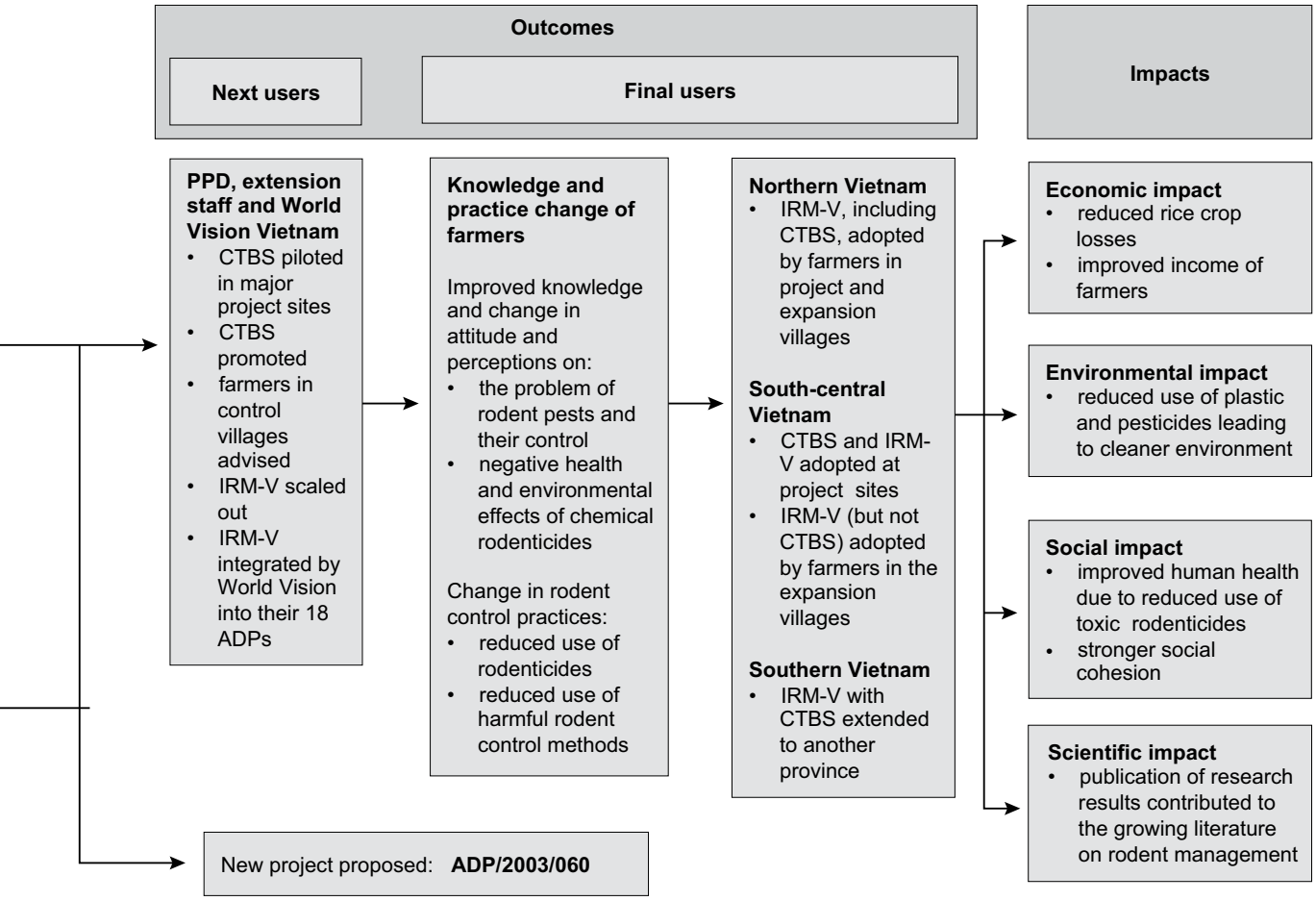


Figure 4. Impact pathway in Vietnam for ACIAR projects AS1/1998/036 (Vietnam component), PLIA/2000/165 and CARD 2000/024 (Component 4) (see p. 8 for abbreviations)



Northern Vietnam: 2003: IRM-V scaled out in two subvillages in Me Linh district, Vin Phuc province
2002–2003: Reduced yield loss by 0.7 t/ha/year at the study sites in Vin Phuc. (Even higher reductions in yield losses of 4.5 t/ha/year and 3.0 t/ha/year were reported by farmers in south-central Vietnam and southern Vietnam, respectively.)

South-central Vietnam: Based on the Bac Binh experience, World Vision integrated IRM-V in their 18 ADPs

Southern Vietnam: Bac Lieu became the extension province (allocated funds for the use of the CTBS)

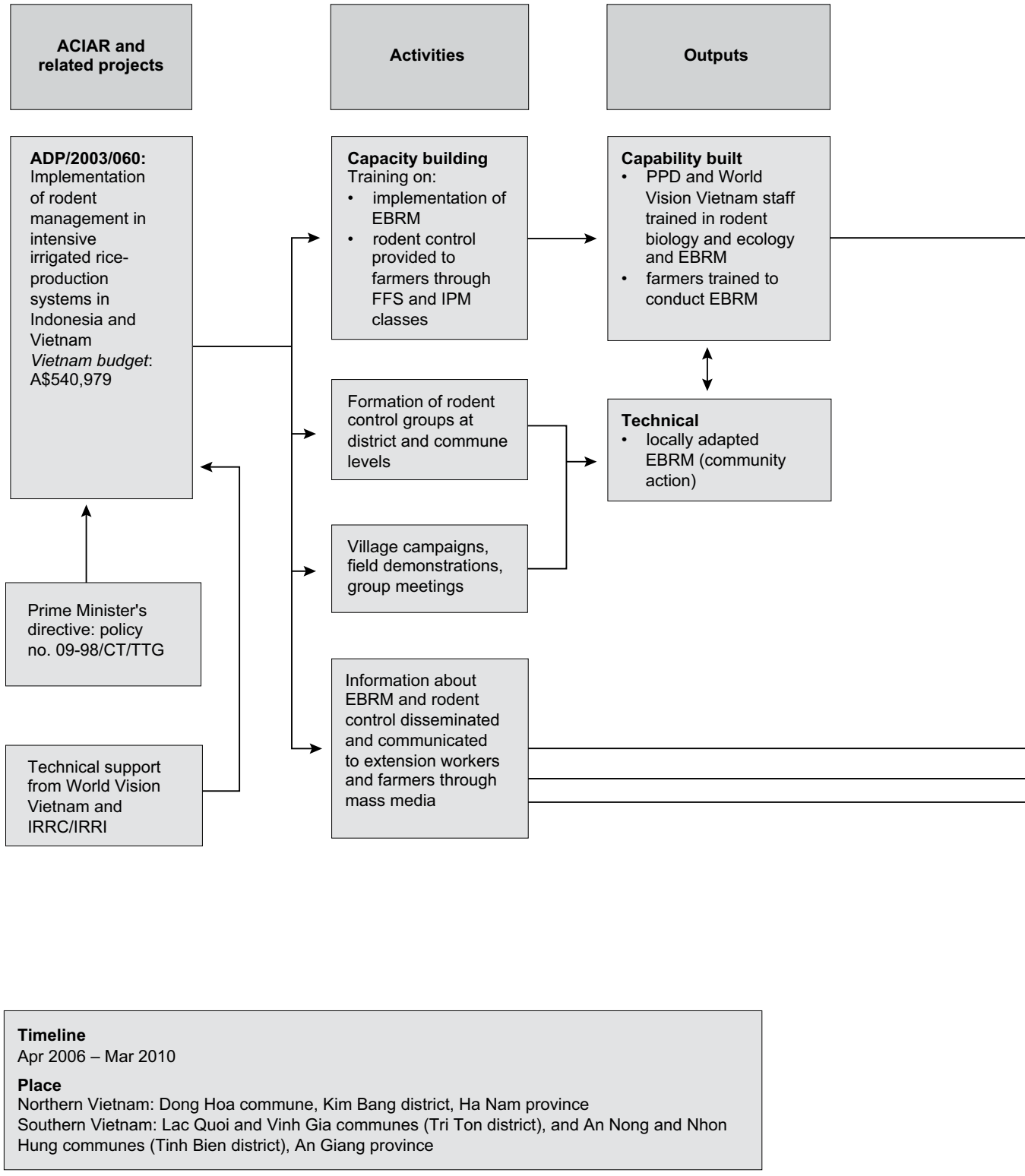
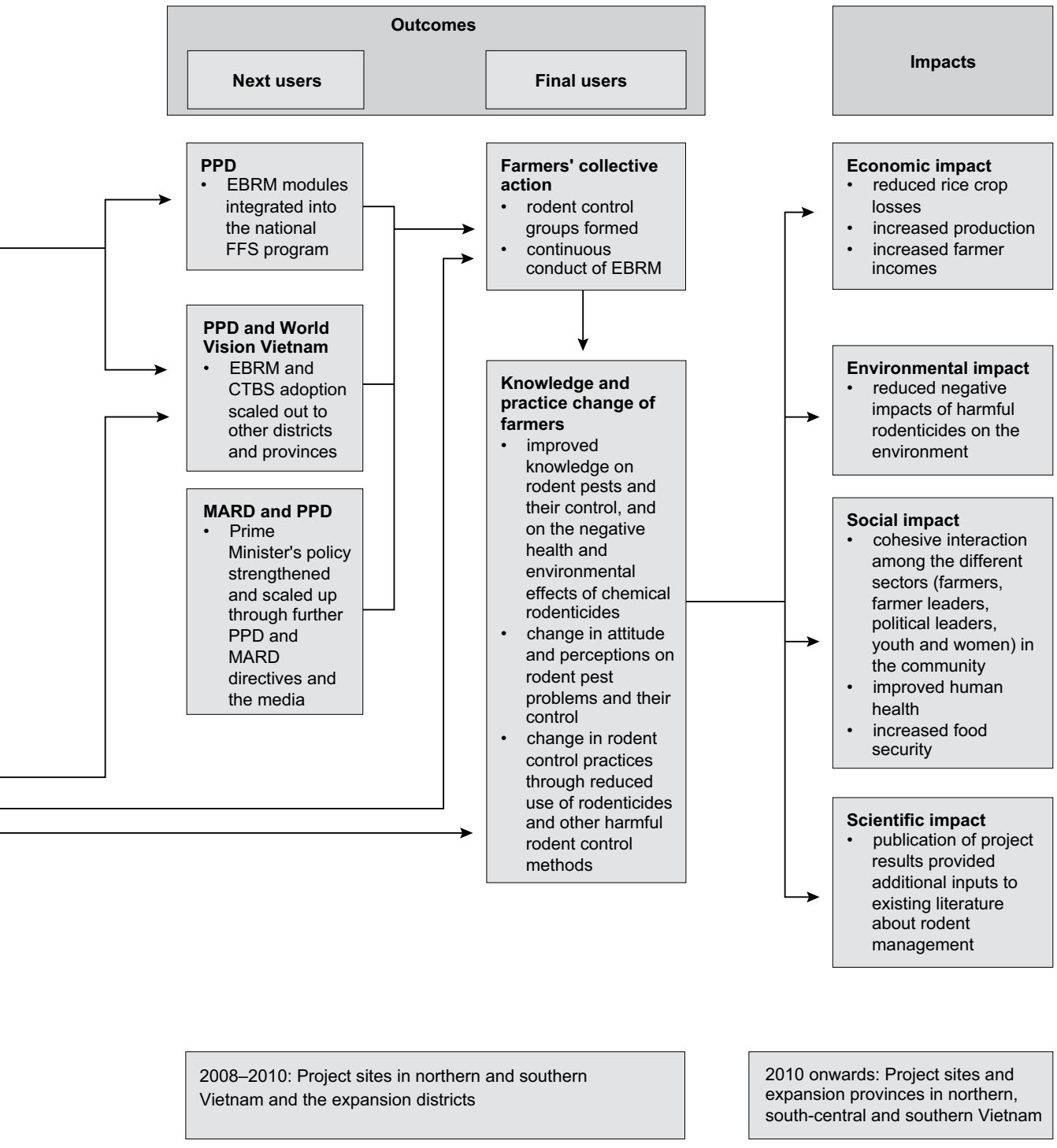


Figure 5. Impact pathway in Vietnam for ACIAR project ADP/2003/060 (Vietnam component) (see p. 8 for abbreviations)


Outcomes
Next users
Final users
Impacts
PPD
• EBRM modules integrated into the national FFS program
PPD and World Vision Vietnam
• EBRM and CTBS adoption scaled out to other districts and provinces
MARD and PPD
• Prime Minister's policy strengthened and scaled up through further PPD and MARD directives and the media
Farmers' collective action
• rodent control groups formed
• continuous conduct of EBRM
Knowledge and practice change of farmers
• improved knowledge on rodent pests and their control, and on the negative health and environmental effects of chemical rodenticides
• change in attitude and perceptions on rodent pest problems and their control
• change in rodent control practices through reduced use of rodenticides and other harmful rodent control methods
Economic impact
• reduced rice crop losses
• increased production
• increased farmer incomes
Environmental impact
• reduced negative impacts of harmful rodenticides on the environment
Social impact
• cohesive interaction among the different sectors (farmers, farmer leaders, political leaders, youth and women) in the community
• improved human health
• increased food security
Scientific impact
• publication of project results provided additional inputs to existing literature about rodent management
2008–2010: Project sites in northern and southern Vietnam and the expansion districts
2010 onwards: Project sites and expansion provinces in northern, south-central and southern Vietnam

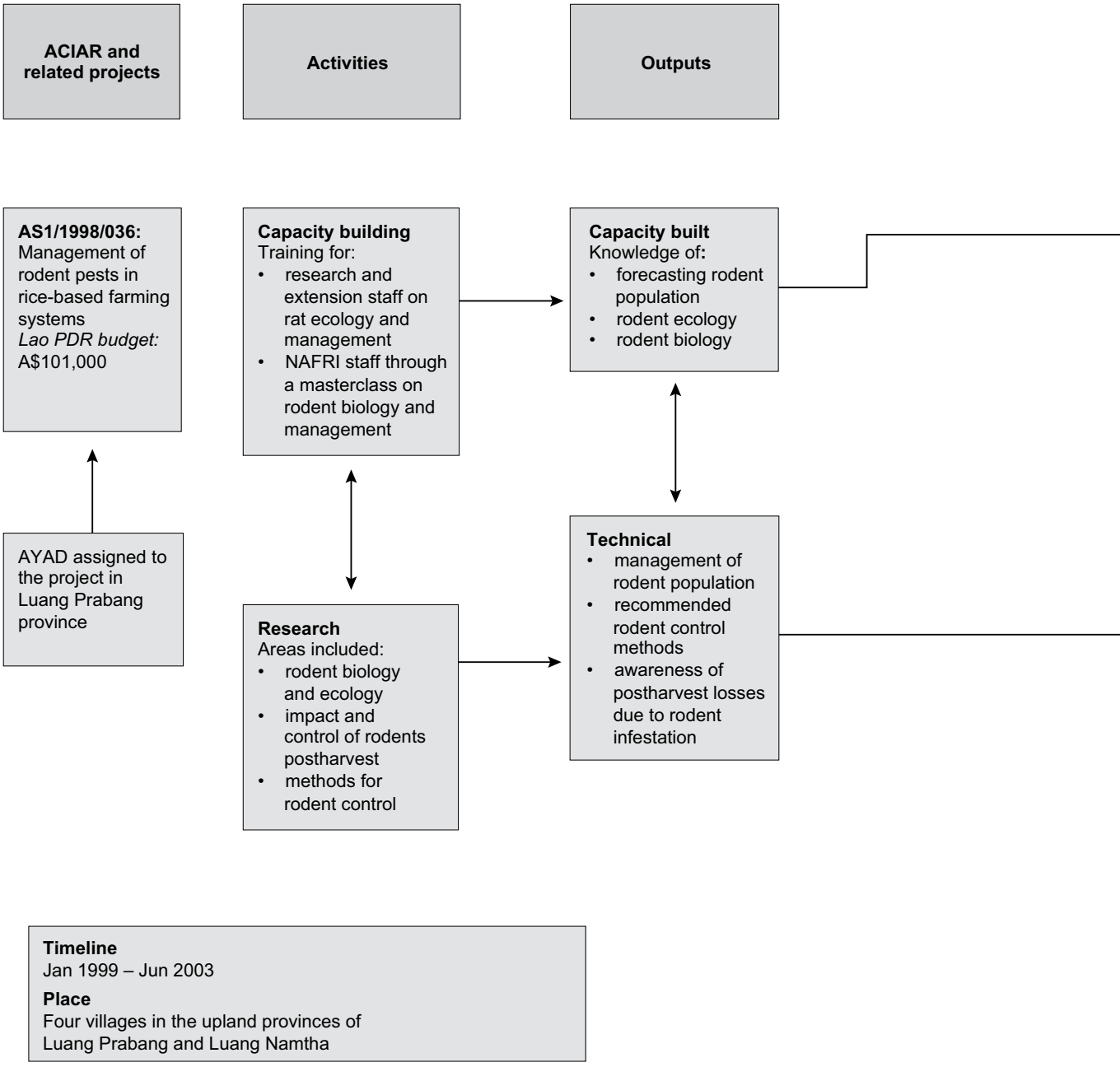
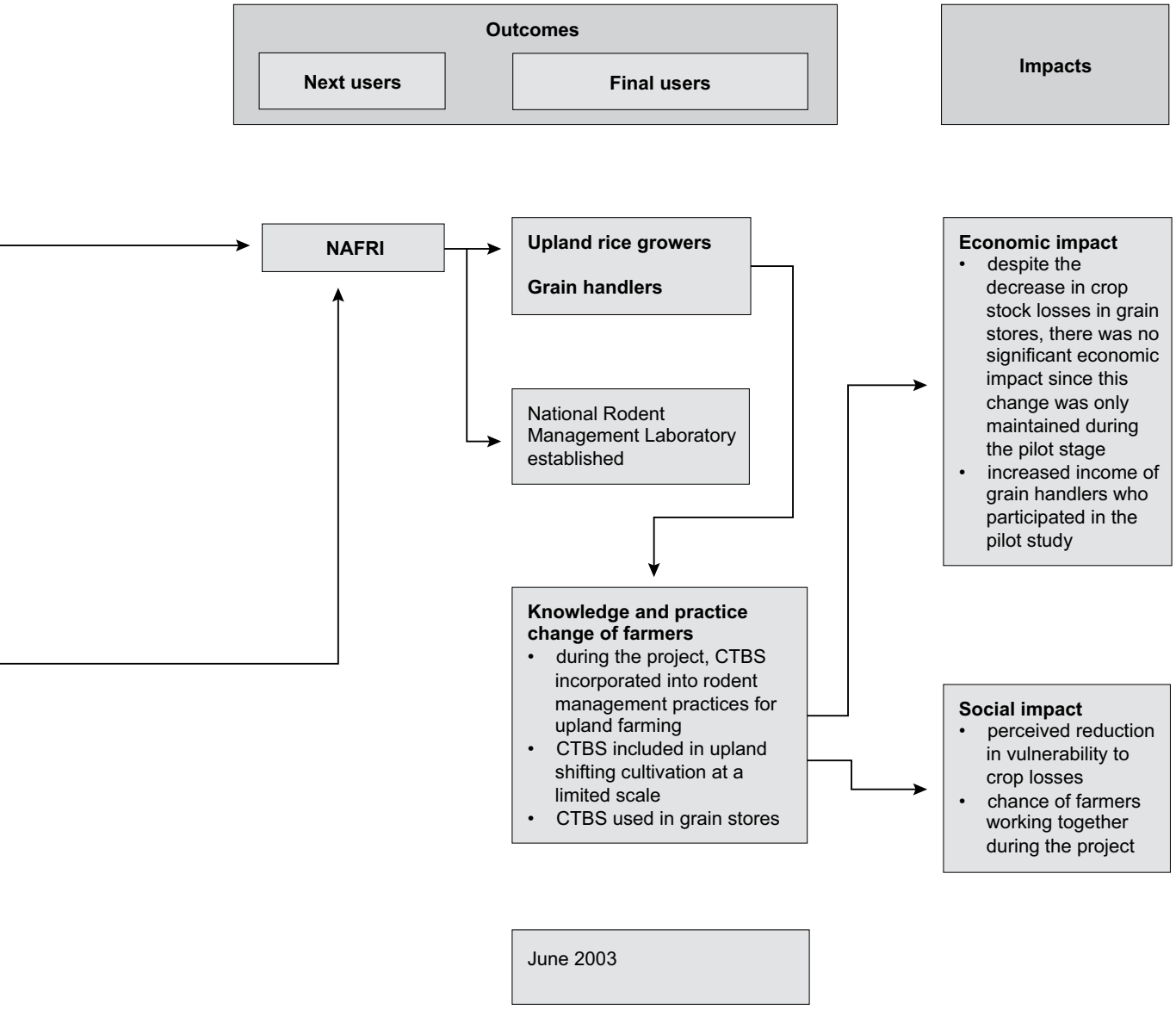


Figure 6. Impact pathway in Lao PDR for ACIAR project AS1/1998/036 (Lao PDR component) (see p. 8 for abbreviations)


Outcomes
Next users
Final users
Impacts
NAFRI
Upland rice growers
Grain handlers
National Rodent Management Laboratory established
Economic impact
• despite the decrease in crop stock losses in grain stores, there was no significant economic impact since this change was only maintained during the pilot stage
• increased income of grain handlers who participated in the pilot study
Knowledge and practice change of farmers
• during the project, CTBS incorporated into rodent management practices for upland farming
• CTBS included in upland shifting cultivation at a limited scale
• CTBS used in grain stores
Social impact
• perceived reduction in vulnerability to crop losses
• chance of farmers working together during the project
June 2003

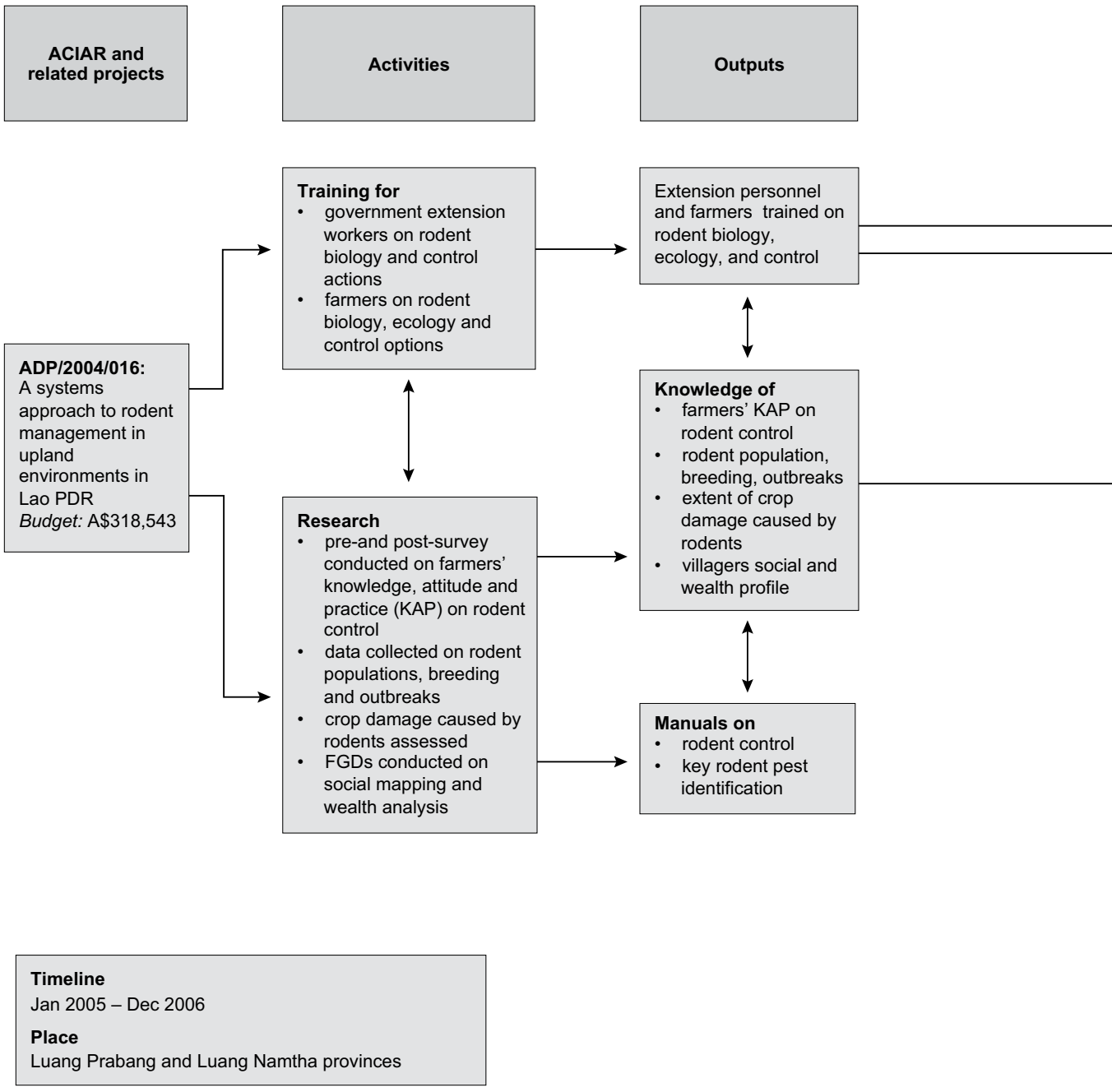
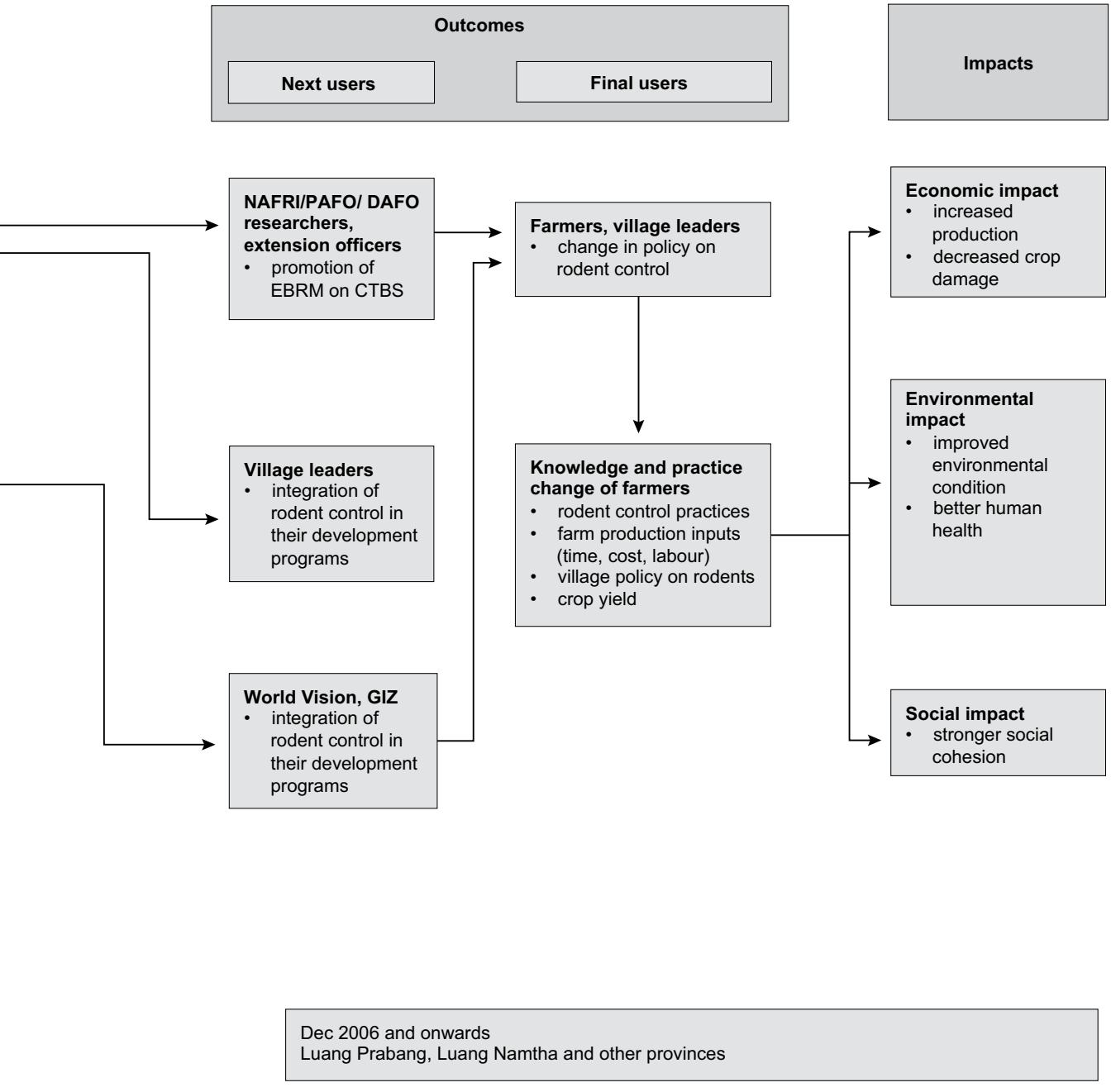


Figure 7. Impact pathway in Lao PDR for ACIAR project ADP/2004/016 (see p. 8 for abbreviations)


Outcomes
Next users
Final users
Impacts
NAFRI/PAFO/ DAFO researchers, extension officers
• promotion of EBRM on CTBS
Farmers, village leaders
• change in policy on rodent control
Economic impact
• increased production
• decreased crop damage
Village leaders
• integration of rodent control in their development programs
Knowledge and practice change of farmers
• rodent control practices
• farm production inputs (time, cost, labour)
• village policy on rodents
• crop yield
Environmental impact
• improved environmental condition
• better human health
World Vision, GIZ
• integration of rodent control in their development programs
Social impact
• stronger social cohesion
Dec 2006 and onwards
Luang Prabang, Luang Namtha and other provinces

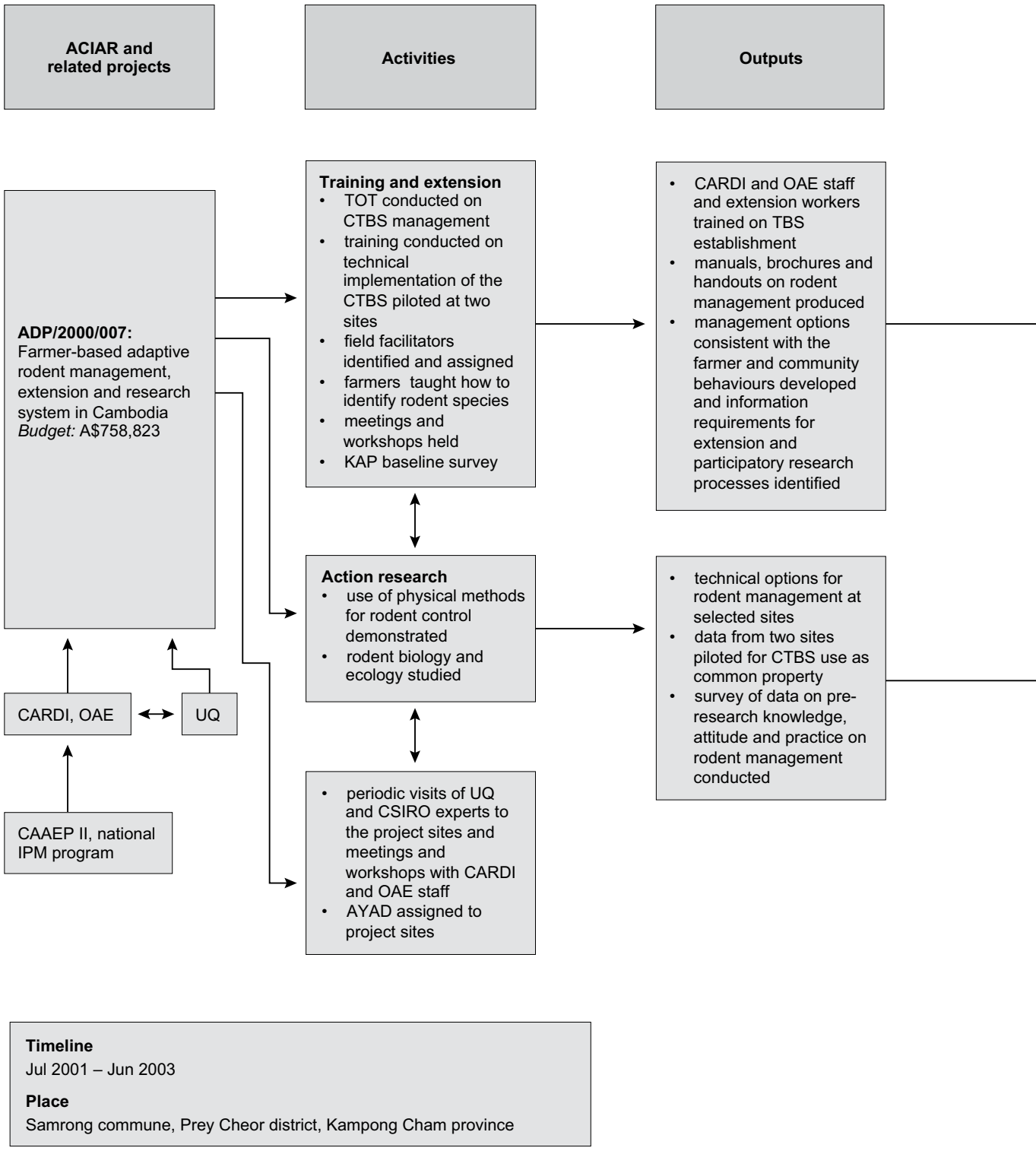
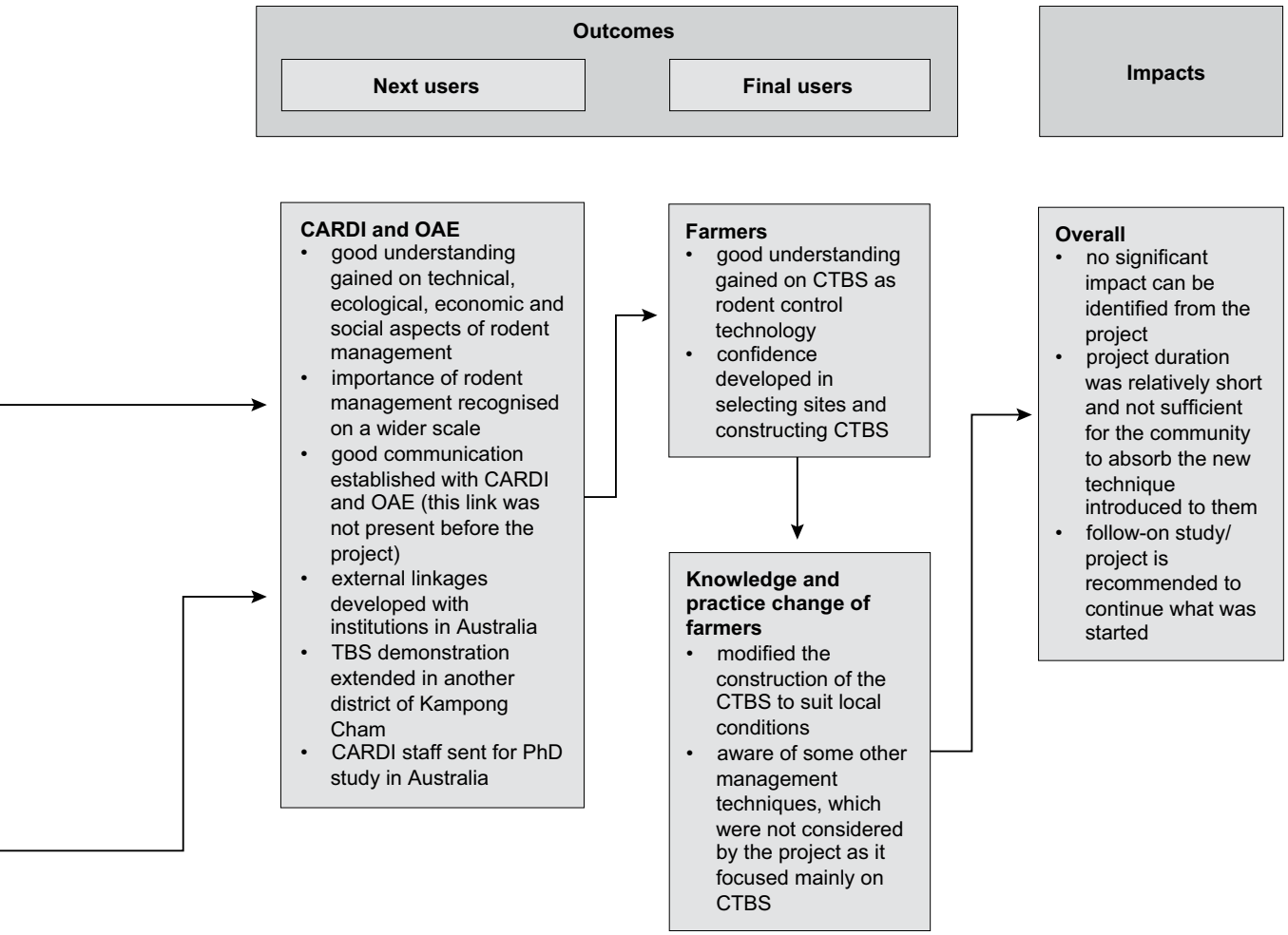


Figure 8. Impact pathway in Cambodia for ACIAR project ADP/2000/007 (see p. 8 for abbreviations)



2002 – TBS demonstrated in one village in Oriang Ov District , Kampong Cham province
2007 – CARDI staff member, Ms El Sotheary obtained her PhD from the UQ at Gatton

4 Factors that affect adoption

The adoption of EBRM is a function of the interplay between a complex of enabling and constraining elements that include political, historical, socioeconomic, cultural, demographic and other related factors.

Political and historical factors

Although Cambodia, Laos and Vietnam are physically connected along the Mekong River Delta, their political structures and histories differ. The political system in Vietnam enables a situation in which adoption of any technology is given force by top-down directives from the government. In the case at hand, the Prime Minister's directive in February 1998 (policy no. 09-1998/CT/TTG) provided a strong driver for rodent management across the whole country. Another directive that gave impetus to rodent control was the government policy issued in 2008, during an outbreak of the brown planthopper, which mandated that all rice farmers practise synchronised planting—one of the components of EBRM. Similarly, an order from PPD (letter no. 1676/BVTV), issued to MARD on 29 September 2010, and an official telegram from MARD (no. 21/CD-BNN-BVTV) to the people's committees on 8 November 2010, provided further impetus to the adoption of EBRM.

Evident in the government-issued orders is a tacit recognition of the intricate web of institutional linkages and networks among the various levels of state agencies involved, from the agriculture bureaucracy to the political branches such as the people's committees and the people's council. Furthermore, the adoption of EBRM was assisted by the presence of strong partnerships between the agricultural agencies (PPSs, sub-PPDs, PPD), farmer groups and local government units.

The people's committees are the executive bodies that carry out local administrative duties. Every people's committee has an agricultural officer—normally an officer of a farmer cooperative or farmer association. Likewise, the PPD, the repository of crop protection knowledge, is responsible for extending crop protection technologies, and has strong linkages with the people's committees at the provincial, district and village levels. Since the PPD is responsible for recommending or endorsing policies about crop protection to the central authority and to farmer groups, the implementation of government orders was smooth and efficient.

Another key factor for successful adoption of EBRM in Vietnam, particularly at the project sites, was the presence of local community groups (which in Vietnam took on the role of what in other countries are labelled civil society organisations)—from farmer associations in the Mekong Delta to cooperatives in northern and south-central Vietnam. The cooperatives and associations, all in close collaboration with PPD and people's committees, have provided technical advice to farmers, to help them increase both production and household income (through loans etc.) and to act as a bridge between the government and farmers.

In the north, for each agricultural cooperative, there were subfarmer groups, such as the plant protection team and the rodent control group. The plant protection team is responsible for monitoring insect and disease infestations and providing advice to farmers on the pest control actions they should take. The rodent control group is responsible for monitoring rodent damage and implementing rodent control actions. In the south, together with the farmers' association, the subgroups of the village people's committee, such as those representing the women, youth and soldiers, worked together for community action to manage the rodent problem.

The variations in the adoption of community action between northern and southern Vietnam were due to the greater historical experience of collective farming, which is more apparent in the north than in the south. Thus, transaction costs are lower in the north, where agricultural cooperatives are present. This is evident in the more extensive scaling out beyond project areas in Ha Nam province in the north, compared with An Giang province in the south.

At some sites, the positive role of an NGO-intermediary, e.g. World Vision, was also cited. The involvement of World Vision has contributed to the adoption and diffusion of EBRM through its incorporation in its ADPs in Vietnam. Also, the capacity-building component of World Vision's ADPs has helped farmers to strengthen cooperatives.

In Laos, the different policy directions that could have influenced the adoption of technology include: land allocation policy and government thrust; local resolutions; and village leadership. The Government of Lao PDR has a land allocation policy through which a family can own the right to use certain parcels of land in the uplands—the size depends on the number of family members. The land allocation policy prohibits slash-and-burn systems. It also requires each household to devote at least a hectare of its farm to rubber, to help the government comply with its commitment to supply the rubber needs of China. This change in land use, from agriculture to forestry, has drastically affected the movement of rodents from the uplands (where there is no longer any food for them) to the lowlands, where rice fields and grain stores have now become highly susceptible to rodent attacks.

The local laws and resolutions encouraging the raising of cats and banning the use of chemical rodenticides have provided the enabling factors to encourage the villagers to adopt the rodent trap technology and other indigenous methods, which are much safer than rodenticides. During the FGDs conducted for this study, farmers reported that cats can reduce rodent damage by 5–6%.

Also, as cited by the World Vision program quality director in Laos, experience has shown that the success of any program depends on the political will and leadership capacity of the village head. The village leader is highly regarded by the community and so could serve as a role model for others in the village who are considering adoption. Just like an arrowhead, the leader could point the way for the introduction, adoption and maintenance of rodent control technologies. It thus pays off to ensure that investment for any intervention, such as capacity building in Lao villages, includes the local village leaders as primary stakeholders.

The same holds true in Cambodia, where farmers relied heavily on authorities or authority figures for decisions about field activities. Innovations can be easily introduced if the person introducing a new technology is an authority figure. The CTBS was introduced by the OAE extension workers who, at the village level, could be considered as authorities. Hence, the farmers cooperated, but the CBTS arrangement was effective only at the initial stage. To sustain an activity at the community level, a strong and credible leader is essential.

Socioeconomic and cultural factors

The adoption of community action in Vietnam was assisted by its compatibility with the communitarian attributes of Vietnamese society. In Vietnam, coordinated community action is the norm rather than a novel concept. The Chinese influence of Confucianism, which is viewed as both a philosophy of life and as a religion, emphasises the importance of loyalty, respect for authority and peacefulness (Quang 2003). Respect for social hierarchies is therefore basic to Vietnamese families and society. By far the most important of these values are those associated with family and community, in which individual interest is subordinate, if not irrelevant, to the welfare of the whole group (Muoi 2002).

The adoption of EBRM in Vietnam was also assisted by the cultural compatibility of one of its pillars—the reduction in the use of chemicals—with the fact that rodents in Vietnam are part of the diet, particularly in the south. There was a cultural incentive to avoid chemically based technologies in rodent management. This both protects the health of farmers and animals by removing the threat of exposure to dangerous chemicals and ensures a poison-free diet when they serve rodents on the table. The attractiveness of community activities was also enhanced by their compatibility with the cultural orientation of the Vietnamese toward

merriment and camaraderie; things they enjoy when the whole village partakes of its 'catch' after a whole day of acting together as a community. Thus, the sense of community that is already present in Vietnamese society strengthens community cohesion and further assists the adoption of EBRM.

The CTBS, as earlier mentioned, may or may not be a necessary element of EBRM. However, in Laos and Cambodia, the CTBS was the main technology promoted and validated. Economic factors are a key consideration in the adoption of the CTBS. In all three countries, the high investment cost of setting up a CTBS, along with high maintenance and transaction costs, constrained its continued adoption. For example, FGDs in Laos indicated that farmers found the CTBS effective but the cost of the traps required is quite expensive. This discouraged them from continuing to use it when the project support ended. The biggest trap used during the CTBS demonstrations, which costs 70,000 Lao kip, was considered quite a big investment for a poor farmer and expensive compared with locally made ones costing only 800–1,000 kip/unit.

There is evidence that local knowledge has provided logic to local adaptation of the technology. Farmers tend to innovate and deviate from what is recommended, based on social, cultural and economic considerations. For example, adoption of technology is modified by the farmers' own pragmatic considerations, and may run counter to what is prescribed. In An Giang province in Vietnam, some farmers pointed out that community action should happen only once, contrary to the prescribed frequency of two to three times per cropping season. They felt that it was no longer necessary to do it when there were no crops in the fields.

This is something that the ACIAR project could have documented more extensively, as it could provide some insights on how local knowledge about rodents could be harnessed to fine-tune the more scientifically based prescriptions for their management. It may also be a key consideration in lowering the transaction costs, particularly if they are influenced by resistance to project-driven and top-down interventions.

In Laos and Cambodia, people are used to having rodents and do not perceive them as a threat, even though the rodent problem has been rated second (after insects) among their production constraints (Schiller et al. 1999). Farmers consider it a minor problem and resort to conventional methods when controlling rodents. Farmers also said that they are catching rodents for live sale to the crocodile farms in nearby provinces. This has given them an incentive to catch rodents for additional income. But, in the uplands of Laos, where the rodent population is higher, conventional methods have not been adequate to overcome the problem. This is compounded by the prevailing thought that the rodent problem is something over which they have little control (Schiller et al. 1999). Until this cultural mindset is overcome, it will remain a deterrent to the adoption of the CTBS or any other improved technologies for rodent control in Laos.

Based on the findings of this study, volunteerism was apparently lower in Laos and Cambodia than in Vietnam. During the FGDs in Laos, it was evident from the farmers' responses that they participated in projects only when they were paid. 'Ratmen' or rodent collectors also persisted only as long as they were paid by the project (30,000 kip/month) and, as soon as the project ended, they went back to their old practices.

The concept of community action was hardly recognised in Laos and Cambodia, compared with Vietnam. Nevertheless, there are also other constraining factors that need to be looked into. For Laos, the merging of villages, which is tantamount to the merging of people from different ethnic groups, may constrain immediate community action from happening. Laos is a country composed of more than 160 ethnic groups, each with their own identity and language (Government of Lao PDR 2006). Also, the ecological landscape of the upland farming systems in the north makes it difficult for farmers to work together on rodent management. For Cambodians, their bad experiences of working together in cooperatives in their recent history have given them a dislike of the words *cooperative* or *collective*. Nonetheless, a new concept of cooperatives is emerging, and farmers are now receptive to forming farmer groups and working in a farmer association or farmer cooperative.

In Cambodia, religious or supernatural beliefs influence the adoption/rejection of a new technology. The belief that you should not harm an animal or else you will become that type of animal in your next reincarnation restrains many farmers from catching or killing rodents. How scientists can use these traditional beliefs to facilitate the introduction and adoption of rodent

control technology, such as the CTBS, is a big challenge. How do we deal with farmers, who, because of religious beliefs, refuse to do something that would kill rodents?

Other factors

A prominent factor that affected the continuity of the adoption of rodent control technologies in all of these countries was the low retention rate of trained personnel, due to study leave and job changes. In the Lao province of Luang Prabang, the project was not sustained because nobody took it over when the assigned extension staff went on study leave. The situation is the same in Cambodia and Vietnam, with very few rodent experts in either country.

In a situation similar to Vietnam (except in An Giang province), most farmers in Cambodia have small farm sizes. In Samrong, for example, the fields of the FGD participants ranged from 0.5 to 3.0 ha. This is way below the estimated 15-ha 'halo of protection' provided by a CTBS. This means that several field owners will benefit from a CTBS, even if it is located in the field of only one farmer. Since those with fields in the surrounding 15 ha are also direct beneficiaries, logically the CTBS should be owned by the collective. Everyone involved should set up the CTBS, maintain it and share in the cost. However, the high investment and transaction costs increase the likelihood of 'free riders', which constrains the widespread adoption of the CTBS.

Another factor affecting adoption of EBRM is the lack of assessment of the ecology and biology of the rodent pest species through a population study (P. Brown, unpublished report 2003). This was further affirmed by the lead researcher in Cambodia who said that the CTBS technology developed from other countries was simply introduced and tested without considering the local knowledge and available scientific information about the rodent biology and ecology in the country. Although it was claimed that there was an improved understanding of the population dynamics of the main pest species (e.g. *Rattus argentiventer, Bandicota indica* and *Mus musculus),* more appropriate management strategies may have been developed had they been incorporated in the CTBS testing.

ACIAR project ADP/2000/007 (in Cambodia) relied heavily on the results of studies of population dynamics from other ACIAR-funded rodent projects (e.g. AS1/1998/036 in other countries in South-East Asia). However, these may not necessarily be applicable for translation to the situation in Cambodia because of the different landscape. For example, there are differences in the spatial and temporal farming systems during the wet and dry seasons between Cambodia and other South-East Asian countries. The results emphasise the important role of landscape factors, especially the annual flooding cycle of the Mekong River, in determining the spatial and temporal distribution of rodent damage. This was particularly lacking in ADP/2000/007.

Another limiting factor is the absence of 'true' replicate or control sites. This factor limits the evaluation of the results and effectiveness of community-based rodent management techniques. In the review of ADP/2000/007 conducted by P. Brown (unpublished report 2003), it was recommended that 'suitable untreated sites (control) need to be identified for collection of data to support further socioeconomic analysis'.

5 Requirements for sustaining adoption

Sustainability of a project depends on numerous factors. Efficacy and efficiency of the new technology does not ensure acceptance by the target community. A more holistic approach should be the policy of all agencies that wish to introduce a new technology. The CTBS is a good example. There is a body of data that would prove the superiority of this technology over other techniques currently used by the farmers. It is a simple technology, backed by scientific studies of rodent and rice biology and how they interact in a given environment (Singleton et al. 1999). It is ecologically friendly and an efficient way of dealing with the rodent problem. But all of these factors are not enough to encourage adoption of the technology by farmers in Vietnam, Laos and Cambodia. After the introductory stage and after the funding support for the materials stopped, the use of the TBS in Laos, Cambodia and Vietnam also stopped. The common excuse was that the cost of the necessary materials was too steep for the small farmers. The result is that very few individual farmers use it, although in Vietnam the CTBS is used as a community-action strategy.

This cost constraint cannot be ignored, especially where projects are dealing with impoverished farmers. Even if the farmers could be convinced that the CTBS is effective in curbing the damage caused by the rodents on the farm, they still did not adopt it in Laos and Cambodia. This is because adoption does not depend on a single variable; in this case, increased profit. Other factors that deterred adoption of the CTBS is that it is tedious to construct and continuous maintenance is a must. Moreover, some of the benefits extend to non-adopters, encouraging free riders. A farmer tending a TBS alone might not feel too altruistic, knowing that a lot of contiguous farms will benefit from the TBS that he alone had paid for and maintained. Especially in Cambodia, where farmers are not so keen about collectives or cooperatives, kinship ties might be an alternative for collective setting up of TBSs.

In Laos and Cambodia, farmers at the study sites seemed to have a gained good understanding of the CTBS technology for controlling rodent damage in their rice crops. However, farmers are aware of some other management techniques that were not considered by the project because it mainly focused on the CTBS. Other environmentally friendly rodent control methods, such as the use of metal sheets, bamboo traps and pit holes, are available and should be incorporated within the project.

A strong recommendation from a seasoned development worker of World Vision based in Laos is to ensure that there will always be a follow-up activity related to the project, even after the scheduled ending of the project. To provide transition for the institutionalisation of the project concept in the agricultural development plan of a province, financial and technical supports should not stop abruptly once the project has ended.

Institutional support

Vietnam is fortunate to have a strong institutional arrangement favourable to scaling out and scaling up of EBRM. In addition to the very supportive stance of the national government in the form of policy pronouncements—from the prime minister to MARD

and to the PPD in the provinces—there is a strong linkage among local organisations and institutions, from the national to the village level. This enables sustainability of adoption in Vietnam, especially in the north.

The ACIAR projects have taken advantage of this network of support by establishing linkages with various research institutions and social organisations. We note that the communication arrangements among these institutions are fairly well established (Brown et al. 2010). However, it was observed during the FGDs and KIIs conducted for this impact pathway study that the link between university-based research institutions and the agricultural bureaucracy in Vietnam, at least with regard to rodent management, remains on an individual basis. There is a need to strengthen its institutional network.

Research and extension activities of government agencies rely heavily on government funding. To ensure sustained adoption of the technology introduced by any project, there must be proper reporting of the technology and its results to the higher authorities. Before any project is terminated, the project implementer must convince the authorities of its benefits and make sure that appropriate policies, including budget allocations, are in place. International and local NGOs working on agricultural development in the area must also be included in the process. They could be a good source of technical expertise and funding.

Interdisciplinary research should be a continuing activity, to provide basic data for other activities related to capacity building. Hard science research should be complemented with social science research. Lectures, training and workshops should not be for the male farmers alone, but include other sectors of society (e.g. women or youths). Indigenous and scientific knowledge, about rodents in this case, can also be incorporated into children's lessons at school. Education should not be alienating. It should incorporate local knowledge into the school curriculum—an assurance that the knowledge is being transmitted to the next generation.

We recognise that the success of any project and adoption of its results depend on the support of the local government or people's committee; the strong linkage evident between the agricultural sectors on the one hand and the people's committees on the other is positive and enabling. Vietnamese farmers' cooperatives and associations have plant protection teams, which are responsible for monitoring or surveillance of the rodents affecting the community; they also organise training sessions on rodent management. In addition, there are rodent control groups in farmers' cooperatives in Vietnam, while in Laos, the rodent control groups are self-organised by farmers. In Cambodia, OAE could be effective in training local rodent biology experts, who would then train other villagers about: the identification of different species present in their area; species-specific behaviour; and, specifically, feeding and reproduction. Local farmers, armed with scientific thinking that they can incorporate with their traditional knowledge, might come up with ideal solutions that do not run counter to their beliefs and practices.

Knowledge gained can be useful only if it is applied for the benefit of all. It can be sustained if it is acquired, assimilated, applied by everybody and passed on to the next generation. It is more sustainable when everybody has the mindset that the problem affects the whole community, not just the farmers. As such, it is everybody's responsibility to solve the problem, through collective action.

The abovementioned aims can be attained through multisectoral support and continuous capacity building. Government agencies, political units, local and foreign NGOs, private individuals and other interest groups could collaborate to help and educate the target population to improve its capacity to sustain the new technology. Well-established linkages should be maintained and new ones developed, to widen the network and provide more benefits to the farmers.

Research and extension structures

As in most developing countries, research and extension in Cambodia, Laos and Vietnam are handled by separate agencies. The results from research institutions are transferred to farmers by extension agencies. Unless a partnership between research and extension exists, along with an effective mechanism for the transfer of technology from research to extension and finally to end users, sustainability of adoption is at risk.

The extension structure of the agricultural bureaucracy in Vietnam is fairly well established and is replicated at many levels of operation, from the commune to the district, and to the province. The PPD, responsible for crop protection extension, has its own networks with research institutions, such as NIPP in the north and IAS in the south. However, what is apparent is the dearth of expertise on rodents. Despite the policy directive of the Prime Minister (policy no. 09-1998/CT/TTG, 18 February 1998), the focus was more on village implementation of EBRM, but there was no continuing research on rodents conducted at IAS after the first ACIAR rodent project in Vietnam. Research agencies in general face many problems—from very few trained personnel, to low or no funding for research, and low salaries for research workers. Although, through the ADP/2003/060 project, three Vietnamese scholars studied in Australia doing research on rodents—one from an NGO for an MSc in social science, and two from PPD for PhDs in rodent ecology and management.

Based on an interview with a staff member of IAS in Vietnam, there is a move to convert government research institutions into semi-private and self-funding entities. This may provide both an opportunity and a threat to the research capacity of those institutions. On the one hand, it could lead to more operational autonomy and provide more avenues to establish linkages with external partners and funding sources. On the other hand, and with the relatively large number of agricultural research institutions, this new arrangement could also lead to competition for limited funds. That outcome could distort research priorities according to the agenda of external funding agencies. In this context, the fate of rodent research in general, and of EBRM in particular, may be affected by external drivers that may favour the use of chemicals. This is a possible scenario, given the aggressive approach of agrochemical companies that even provide research and development funds to research institutions, if only to promote the adoption of their preferred technologies.

Agricultural technology transfer and extension in Laos flow through a government structure called the National Agriculture and Forestry Extension Service (NAFES) and the Department of Agriculture. NAFES has to coordinate and link with PAFOs at the provincial level, and with DAFOs at the district level to implement extension activities through both of these levels. NAFES has its offices up to the provincial level only. PAFOs and DAFOs are under the Department of Agriculture, which is on a co-level with NAFES. Thus, to have an effective extension program, there should be a close partnership between NAFES and the Department of Agriculture, along with the research institutions under NAFRI.

In Cambodia, unless the rodent project is jointly undertaken by research and extension institutions, the adoption of EBRM would be futile. For example, CARDI should be an equal partner with the Department of Agricultural Extension.

Capacity building

Training of trainers (TOT) was conducted all over Cambodia, Laos and Vietnam. The fairly well-established training infrastructure in Vietnam for agriculture in general, not only about rodents, provides positive opportunities for deepening and broadening capacity-building efforts. Topics on rodent management were already included in the IPM/FFS curriculums. There was even a mechanism to replicate them at the commune level, where farmer-trainers who attended the TOT could, with funding support from the commune, organise a FFS in their own commune. In the regular FFSs, the funding comes from the relevant agencies at the national, provincial, district and commune levels. However, for IPM training specific to rat management, the funding comes from the national IPM program of PPD, but only when the rat problem is large.

The same thing occurs in Cambodia and Laos, where topics on rodent management are incorporated in the IPM or FFS curriculums. However, a challenge remains in the development of academic and research expertise on rodents.

The ACIAR projects have addressed this by facilitating the training of key persons in each country on rodent biology and management. These are key contributions toward sustaining EBRM initiatives, but would be contingent on the appropriate placement of the trained personnel in strategic positions, to carry out technical and policy support roles after completion of their training programs.

Networking with other institutions

While there is a strong link between the agricultural bureaucracy and the political offices at various levels, partnerships between university-based researchers and government-based researchers in general is weak, especially in rodent management. This is an area that needs attention.

The presence of World Vision and GIZ was a positive force in the adoption and scaling out of EBRM in some areas. This is a model that may need to be replicated in many areas of the country, where support from international NGOs and development agencies could contribute to the diffusion of EBRM.

Future users

Rodents are migratory; hence, they cross national boundaries, as has been observed in the Mekong Delta provinces bordering Cambodia. Thus, the adoption of synchronous planting in Vietnam, which has a positive effect on rodent management, is undermined by the fact that the bordering provinces in Cambodia have a different planting season. Cognisant of this, as well as of the other positive benefits that may come, there is a need to have trans-boundary agreements with Cambodia, and even Laos, on issues pertinent to rodent management. The Association of Southeast Asian Nations (ASEAN) mechanism, which is now in place and has been used for other trans-boundary issues (such as the haze problem involving Indonesia, Singapore and Malaysia) may be a useful conduit to consider, and could be a future user of the project outputs.

6 Conclusions and recommendations

Conclusions

Based on the above findings and discussion, we have reached the following conclusions:

1. The ACIAR rodent control projects have brought about social, scientific, economic and environmental impacts at the project sites and, to a certain extent, to the relevant countries as a whole. However, except for Vietnam, it remains to be seen whether the adoption, scaling up and scaling out of EBRM will be continued.

2. The CTBS, as a component of EBRM, has a low acceptance level among farmers due to the high investment cost. Likewise, except in Vietnam, the concept of community action was barely introduced or adopted. This needs further sensitisation of the intermediaries and the end users of EBRM, particularly on community action. Other environmentally friendly rodent control methods that are used by the farmers can be incorporated into EBRM.

3. Follow-up activities are needed to sustain the pathway. There are strong indications that, after a project concludes, the tendency is for the farmers to go back to their previous practices.

4. The projects in Laos and Cambodia are in their infancy and it is too soon for the impacts to be deeply rooted. In these countries, where CTBS was the sole EBRM intervention, the projects appeared to fail to establish CTBS adoption because of economic considerations.

5. The problem of rodent control and management is quite complicated. Because of the migratory behaviour of rodents, the issues and problems go beyond the boundaries of individual countries. This means that rodent control and management approaches have to be discussed at a higher level. For the Mekong Delta countries, this could be at the level of the Mekong Delta Management Council.

6. The interplay of political, social, cultural, historical and economic factors is critical in the adoption of EBRM. The technology must conform to the social, cultural and political norms and history of the country. The successes and experiences in one country cannot be easily transferred to other countries, due to the differences in these factors.

7. For pathways and impacts, Vietnam appears to have progressed further than Cambodia and Laos. The pathway for Vietnam was facilitated by PPD, from the national down to the district level. In Laos, the pathway was started by NAFRI and picked up by World Vision and GIZ. However, there is insufficient evidence at the moment to measure the impacts due to the project and these institutions. In Cambodia, CARDI and OAE have started the pathway but much remains to be done to establish its impact.

Recommendations

The following recommendations have been drawn from the experience of the ACIAR projects on technology adoption, diffusion, the impact pathway generally and especially the sustainability of EBRM.

There is a need for continuous government support and follow-up projects to sustain the pathway

Adoption of technology can take a long time to be achieved. In the case of Vietnam, it took 15 years before the adoption of EBRM. The continuous implementation of EBRM in the projects in Vietnam made it possible for the activities to be accepted by the target end users, the farmers. To attain widespread adoption of EBRM and sustain its adoption in Vietnam, continuous government support is needed to scale it out across the country. A budget for mobilising community action should be allocated by MARD in each province.

The projects that began in 1999 in Laos and 2001 in Cambodia focused mainly on the use of the CTBS, with the objective of assessing whether it could be used as an entry point to introduce EBRM. Therefore, there is a need for follow-up projects in these two countries that will focus on the development and implementation of EBRM techniques suited to each country's ecological landscape, in which community action is emphasised and existing indigenous, environmentally friendly rodent control technologies are integrated.

Sensitise and continue to educate the stakeholders

Unless the farmers, farmer intermediaries and villagers see the rodent problem as one that merits serious attention, i.e. requires sustained management, their motivation to attend to it will not be as high or as sustainable. There is a need to sensitise the people to the severity of the problem by showing and explaining to them scientific data, transformed into everyday language. As problems with rodents may change, due to changes in the internal or external environments, continuous education about recent developments in the field is imperative. This could be done through the mass media and by interpersonal communication through training. The government must see to it that funding is available for this purpose.

Also, this will require a well-planned communication and education strategy. Governments can choose from a number of communication approaches designed to achieve behavioural changes. The chosen approach should be appropriately designed, based on the intended stakeholders, messages and social context. A more strategic communication–education plan can be drafted to include also the local people's willingness to pay for rodent control.

Integrate EBRM into existing agriculture-related programs

Rodent control and management are just one part of crop protection extension activities. It would be more effective if rodent control and management were integrated into the existing agriculture programs, such as IPM/FFS curriculums. Thus, there is no need to 're-invent the wheel' to come up with a separate program for rodent control. Although it is reported that this is done in Vietnam and Cambodia, through the initiative of the extension agencies, the integration could be strengthened further through policy directives from a higher authority, such as the agriculture ministry, or the prime minister or president of the country.

Network with other local and foreign institutions to build a cadre of rodent experts

A project's efforts in capacity building will come to naught if, after a while, those trained in rodent control leave or transfer somewhere else. During the fieldwork for this assessment study, it was established that there is a dearth of experts on rodents in the research and extension arms of the government. Also, there is very limited tie-up between them and academia, particularly government universities, as sources of technical experts. Forging agreements between academia and research and extension agencies could be a cost-effective approach to finding additional experts. There must be a commitment on the part of the government to train more rodent scientists and technical people, and to make them stay to help the government. This can be done through either a formal degree or non-formal training and the provision of reasonable incentives, so that these experts will stay in government service. As shown in Laos and Vietnam, World Vision made a significant contribution to the diffusion and implementation of the rodent projects. In Laos, GIZ is also including rodent management in its agricultural projects. This lowers the transaction costs and facilitates the diffusion of the technology.

Establish a surveillance and forecast system

There is a need to build up a database system that can be used to monitor and forecast crop diseases and pest infestation, such as that of rodents. The data can be at the national, regional and local levels. There is a need to determine what data should be collected and how they should be collected and processed. Local people may be

involved in the data collection, to enable them to also learn about the problem. This, in a way, is a mechanism for participation and capacity building in the project.

Future research priorities

From the results of the analysis, the following issues appeared to be lacking in the projects and may need further work.

Gender dimensions of EBRM

Many studies have been carried out on gender and rice production. Although the positive impacts and success of EBRM in adoption and technology diffusion have been documented, little is known about the gender dimension of the project. No study has examined the gender dimensions of the ACIAR-funded rodent projects. The literature showed that women shared in farm activities; however, in the rodent projects, the gender dimension was not explicitly stated. During the field visits, it was discovered that, after land preparation, male farmers looked for non-farm employment in the cities and left the maintenance of the farm to the women. It was also established during the FGDs that some women leaders could be invited to lead the EBRM activities. Consequently, it is imperative that a closer look be given to the gender dimensions of the rodent projects.

An integrated project that considers, in unison, climate change, rodent management and natural resource management best practices

The changing climate may greatly affect rodent populations and ecology and thus may have consequent effects on damage to rice fields and their yields. Thus, a study of the impact of climate change on rodent population dynamics, with a projection to the effects on damage and yield losses, is important.

Likewise, EBRM could be integrated into the best practices for natural resource management in rice production. This includes pest management (weeds, insects, diseases and rodents), postharvest management for reducing losses due to rodents, and water management, especially in lowland irrigated, highly intensive rice-cropping systems in South-East Asia. Considering the current climatic changes and variability, this approach would then provide a systems approach to develop consistent delivery of comprehensive and integrated pest (weeds, insects and rodents), water and postharvest management, to improve the livelihoods of small-scale rice farmers in South-East Asia.

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No.	Author(s) and year of publication	Title	ACIAR project numbers
1	Centre for International Economics 1998.	Control of Newcastle disease in village chickens	AS1/1983/034, AS1/1987/017 and AS1/1993/222
2	George P.S. 1998.	Increased efficiency of straw utilisation by cattle and buffalo	AS1/1982/003, AS2/1986/001 and AS2/1988/017
3	Centre for International Economics 1998.	Establishment of a protected area in Vanuatu	ANRE/1990/020
4	Watson A.S. 1998.	Raw wool production and marketing in China	ADP/1988/011
5	Collins D.J. and Collins B.A. 1998.	Fruit fly in Malaysia and Thailand 1985–1993	CS2/1983/043 and CS2/1989/019
6	Ryan J.G. 1998.	Pigeonpea improvement	CS1/1982/001 and CS1/1985/067
7	Centre for International Economics 1998.	Reducing fish losses due to epizootic ulcerative syndrome—an ex ante evaluation	FIS/1991/030
8	McKenney D.W. 1998.	Australian tree species selection in China	FST/1984/057 and FST/1988/048
9	ACIL Consulting 1998.	Sulfur test KCL–40 and growth of the Australian canola industry	PN/1983/028 and PN/1988/004
10	AACM International 1998.	Conservation tillage and controlled traffic	LWR2/1992/009
11	Chudleigh P. 1998.	Postharvest R&D concerning tropical fruits	PHT/1983/056 and PHT/1988/044
12	Waterhouse D., Dillon B. and Vincent D. 1999.	Biological control of the banana skipper in Papua New Guinea	CS2/1988/002-C
13	Chudleigh P. 1999.	Breeding and quality analysis of rapeseed	CS1/1984/069 and CS1/1988/039
14	McLeod R., Isvilanonda S. and Wattanutchariya S. 1999.	Improved drying of high moisture grains	PHT/1983/008, PHT/1986/008 and PHT/1990/008
15	Chudleigh P. 1999.	Use and management of grain protectants in China and Australia	PHT/1990/035
16	McLeod R. 2001.	Control of footrot in small ruminants of Nepal	AS2/1991/017 and AS2/1996/021
17	Tisdell C. and Wilson C. 2001.	Breeding and feeding pigs in Australia and Vietnam	AS2/1994/023
18	Vincent D. and Quirke D. 2002.	Controlling *Phalaris minor* in the Indian rice–wheat belt	CS1/1996/013
19	Pearce D. 2002.	Measuring the poverty impact of ACIAR projects—a broad framework	
20	Warner R. and Bauer M. 2002.	*Mama Lus Frut* scheme: an assessment of poverty reduction	ASEM/1999/084
21	McLeod R. 2003.	Improved methods in diagnosis, epidemiology, and information management of foot-and-mouth disease in Southeast Asia	AS1/1983/067, AS1/1988/035, AS1/1992/004 and AS1/1994/038
22	Bauer M., Pearce D. and Vincent D. 2003.	Saving a staple crop: impact of biological control of the banana skipper on poverty reduction in Papua New Guinea	CS2/1988/002-C
23	McLeod R. 2003.	Improved methods for the diagnosis and control of bluetongue in small ruminants in Asia and the epidemiology and control of bovine ephemeral fever in China	AS1/1984/055, AS2/1990/011 and AS2/1993/001
24	Palis F.G., Sumalde Z.M. and Hossain M. 2004.	Assessment of the rodent control projects in Vietnam funded by ACIAR and AUSAID: adoption and impact	AS1/1998/036

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No.	Author(s) and year of publication	Title	ACIAR project numbers
25	Brennan J.P. and Quade K.J. 2004.	Genetics of and breeding for rust resistance in wheat in India and Pakistan	CS1/1983/037 and CS1/1988/014
26	Mullen J.D. 2004.	Impact assessment of ACIAR-funded projects on grain-market reform in China	ADP/1997/021 and ANRE1/1992/028
27	van Bueren M. 2004.	Acacia hybrids in Vietnam	FST/1986/030
28	Harris D. 2004.	Water and nitrogen management in wheat–maize production on the North China Plain	LWR1/1996/164
29	Lindner R. 2004.	Impact assessment of research on the biology and management of coconut crabs on Vanuatu	FIS/1983/081
30	van Bueren M. 2004.	Eucalypt tree improvement in China	FST/1984/057, FST/1987/036, FST/1988/048, FST/1990/044, FST/1994/025, FST/1996/125 and FST/1997/077
31	Pearce D. 2005.	Review of ACIAR's research on agricultural policy	
32	Tingsong Jiang and Pearce D. 2005.	Shelf-life extension of leafy vegetables—evaluating the impacts	PHT/1994/016
33	Vere D. 2005.	Research into conservation tillage for dryland cropping in Australia and China	LWR2/1992/009 and LWR2/1996/143
34	Pearce D. 2005.	Identifying the sex pheromone of the sugarcane borer moth	CS2/1991/680
35	Raitzer D.A. and Lindner R. 2005.	Review of the returns to ACIAR's bilateral R&D investments	
36	Lindner R. 2005.	Impacts of mud crab hatchery technology in Vietnam	FIS/1992/017 and FIS/1999/076
37	McLeod R. 2005.	Management of fruit flies in the Pacific	CS2/1989/020, CS2/1994/003, CS2/1994/115 and CS2/1996/225
38	ACIAR 2006.	Future directions for ACIAR's animal health research	
39	Pearce D., Monck M., Chadwick K. and Corbishley J. 2006.	Benefits to Australia from ACIAR-funded research	AS2/1990/028, AS2/1994/017, AS2/1994/018, AS2/1999/060, CS1/1990/012, CS1/1994/968, FST/1993/016 and PHT/1990/051
40	Corbishley J. and Pearce D. 2006.	Zero tillage for weed control in India: the contribution to poverty alleviation	CS1/1996/013
41	ACIAR 2006.	ACIAR and public funding of R&D. Submission to Productivity Commission study on public support for science and innovation	
42	Pearce D. and Monck M. 2006.	Benefits to Australia of selected CABI products	
43	Harris D.N. 2006.	Water management in public irrigation schemes in Vietnam	LWR1/1998/034 and LWR2/1994/004
44	Gordon J. and Chadwick K. 2007.	Impact assessment of capacity building and training: assessment framework and two case studies	CS1/1982/001, CS1/1985/067, LWR2/1994/004 and LWR2/1998/034
45	Turnbull J.W. 2007.	Development of sustainable forestry plantations in China: a review	
46	Monck M. and Pearce D. 2007.	Mite pests of honey bees in the Asia–Pacific region	AS2/1990/028, AS2/1994/017, AS2/1994/018 and AS2/1999/060

IMPACT ASSESSMENT SERIES <CONTINUED>

No.	Author(s) and year of publication	Title	ACIAR project numbers
47	Fisher H. and Gordon J. 2007.	Improved Australian tree species for Vietnam	FST/1993/118 and FST/1998/096
48	Longmore C., Gordon J. and Bantilan M.C. 2007.	Assessment of capacity building: overcoming production constraints to sorghum in rainfed environments in India and Australia	CS1/1994/968
49	Fisher H. and Gordon J. 2007.	Minimising impacts of fungal disease of eucalypts in South-East Asia	FST/1994/041
50	Monck M. and Pearce D. 2007.	Improved trade in mangoes from the Philippines, Thailand and Australia	CS1/1990/012 and PHT/1990/051
51	Corbishley J. and Pearce D. 2007.	Growing trees on salt-affected land	FST/1993/016
52	Fisher H. and Gordon J. 2008.	Breeding and feeding pigs in Vietnam: assessment of capacity building and an update on impacts	AS2/1994/023
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54	Monck M. and Pearce D. 2008.	Impact of improved management of white grubs in peanut-cropping systems	CS2/1994/050
55	Martin G. 2008.	ACIAR fisheries projects in Indonesia: review and impact assessment	FIS/1997/022, FIS/1997/125, FIS/2000/061, FIS/2001/079, FIS/2002/074, FIS/2002/076, FIS/2005/169 and FIS/2006/144
56	Lindner B. and McLeod P. 2008.	A review and impact assessment of ACIAR's fruit-fly research partnerships—1984 to 2007	CP/1997/079, CP/2001/027, CP/2002/086, CP/2007/002, CP/2007/187, CS2/1983/043, CS2/1989/019, CS2/1989/020, CS2/1994/003, CS2/1994/115, CS2/1996/225, CS2/1997/101, CS2/1998/005, CS2/2003/036, PHT/1990/051, PHT/1993/87 and PHT/1994/133
57	Montes N.D., Zapata Jr N.R., Alo A.M.P. and Mullen J.D. 2008.	Management of internal parasites in goats in the Philippines	AS1/1997/133
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59	Chupungco A., Dumayas E. and Mullen J. 2008.	Two-stage grain drying in the Philippines	PHT/1983/008, PHT/1986/008 and PHT/1990/008
60	Centre for International Economics 2009.	ACIAR Database for Impact Assessments (ADIA): an outline of the database structure and a guide to its operation	
61	Fisher H. and Pearce D. 2009.	Salinity reduction in tannery effluents in India and Australia	AS1/2001/005
62	Francisco S.R., Mangabat M.C., Mataia A.B., Acda M.A., Kagaoan C.V., Laguna J.P., Ramos M., Garabiag K.A., Paguia F.L. and Mullen J.D. 2009.	Integrated management of insect pests of stored grain in the Philippines	PHT/1983/009, PHT/1983/011, PHT/1986/009 and PHT/1990/009
63	Harding M., Tingsong Jiang and Pearce D. 2009.	Analysis of ACIAR's returns on investment: appropriateness, efficiency and effectiveness	
64	Mullen J.D. 2010.	Reform of domestic grain markets in China: a reassessment of the contribution of ACIAR-funded economic policy research	ADP/1997/021 and ANRE1/1992/028

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No.	Author(s) and year of publication	Title	ACIAR project numbers
65	Martin G. 2010.	ACIAR investment in research on forages in Indonesia	AS2/2000/103, AS2/2000/124, AS2/2001/125, LPS/2004/005, SMAR/2006/061 and SMAR/2006/096
66	Harris D.N. 2010.	Extending low-cost fish farming in Thailand: an ACIAR–World Vision collaborative program	PLIA/2000/165
67	Fisher H. 2010.	The biology, socioeconomics and management of the barramundi fishery in Papua New Guinea's Western Province	FIS/1998/024
68	McClintock A. and Griffith G. 2010.	Benefit–cost meta-analysis of investment in the International Agricultural Research Centres	
69	Pearce D. 2010.	Lessons learned from past ACIAR impact assessments, adoption studies and experience	
70	Harris D.N. 2011.	Extending low-chill fruit in northern Thailand: an ACIAR–World Vision collaborative project	PLIA/2000/165
71	Lindner R. 2011.	The economic impact in Indonesia and Australia from ACIAR's investment in plantation forestry research, 1987–2009	FST/1986/013, FST/1990/043, FST/1993/118, FST/1995/110, FST/1995/124, FST/1996/182, FST/1997/035, FST/1998/096, FST/2000/122, FST/2000/123, FST/2003/048 and FST/2004/058
72	Lindner R. 2011.	Frameworks for assessing policy research and ACIAR's investment in policy-oriented projects in Indonesia	ADP/1994/049, ADP/2000/100, ADP/2000/126, AGB/2000/072, AGB/2004/028, ANRE1/1990/038, ANRE1/1993/023, ANRE1/1993/705, EFS/1983/062 and EFS/1988/022
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74	Brennan J.P. and Malabayabas A. 2011.	International Rice Research Institute's contribution to rice varietal yield improvement in South-East Asia	
75	Harris D.N. 2011.	Extending rice crop yield improvements in Lao PDR: an ACIAR–World Vision collaborative project	CIM/1999/048, CS1/1995/100 and PLIA/2000/165
76	Grewal B., Grunfeld H. and Sheehan P. 2011.	The contribution of agricultural growth to poverty reduction	
77	Saunders C., Davis L. and Pearce D. 2012.	Rice–wheat cropping systems in India and Australia and development of the 'Happy Seeder'	LWR/2000/089, LWR/2006/132 and CSE/2006/124
78	Carpenter D. and McGillivray M. 2012	A methodology for assessing the poverty-reducing impacts of Australia's international agricultural research	
79	Dugdale A., Sadleir C., Tennant-Wood R. and Turner M. 2012	Developing and testing a tool for measuring capacity building	
80	Fisher H., Sar L. and Winzenried C. 2012	Oil palm pathways: an analysis of ACIAR's oil palm projects in Papua New Guinea	ASEM/1999/084, ASEM/2002/014, ASEM/2006/127, CP/1996/091, PC/2006/063, PC/2004/064, CP/2007/098

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No.	Author(s) and year of publication	Title	ACIAR project numbers
81	Pearce D. and White L. 2012	Including natural resource management and environmental impacts within impact assessment studies: methodological issues	
82	Fisher H. and Hohnen L. 2012	ACIAR's activities in Africa: a review	AS1/1983/003, AS1/1995/040, AS1/1995/111, AS1/1996/096, AS1/1998/010, AS2/1990/047, AS2/1991/018, AS2/1993/724, AS2/1996/014, AS2/1999/063, AS2/1996/090, AS2/1996/203, AS2/1996/149, AS2/1997/098, CP/1994/126, CS2/1990/007, EFS/1983/026, FST/1983/020, FST/1983/031, FST/1983/057, FST/1988/008, FST/1988/009, FST/1991/026, FST/1995/107, FST/1996/124, FST/1996/206, FST/2003/002, IAP/1996/181, LPS/1999/036, LPS/2002/081, LPS/2004/022, LPS/2008/013, LWR/2011/015, LWR1/1994/046, LWR2/1987/035, LWR2/1996/049, LWR2/1996/163, LWRS/1996/215, LWR2/1997/038, SMCN/1999/003, SMCN/1999/004, SMCN/2001/028, SMCN/2000/173
83	Palis F.G., Sumalde Z.M., Torres C.S., Contreras A.P. and Datar F.A. 2013	Impact pathway analysis of ACIAR's investment in rodent control in Vietnam, Lao PDR and Cambodia	ADP/2000/007, ADP/2003/060, ADP/2004/016, AS1/1994/020, AS1/1996/079, AS1/1998/036, CARD 2000/024, PLIA/2000/165

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