Final technical Report

DFID Aquaculture Research Programme:
Project R6380Cb

Addressing technical, social and economic constraints to rice fish culture in Laos, emphasising women's involvement

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Executive Summary

The purpose of this project was to increase understanding of the technical, social and economic constraints to rice-fish culture in Lao PDR, emphasising women's involvement, through investigation of the resource management and communications systems and participatory research to investigate how to maximise profit from rice fish systems. It was conceived as an opportunity to expand understanding of the biological and social dimensions of aquatic resources management to underpin the development of less intensive forms of aquaculture which can play a role in securing and enhancing the livelihoods of poor people in the region.

The outputs of the project contribute to the DFID development goal of *a sustainable increase in yields from small-scale semi-intensive and extensive aquaculture systems through improved management* via products to improve productivity and influence policy. The contribution of the outputs offered to beneficiaries by this project is embodied in a strategic approach to designing and implementing a system which takes account of the complexity and diversity in natural resources, and the risk faced by individual farm families. The system represents a unique mechanism, designed through an iterative and interactive research process in which farmers and local institutions are collaborative partners. Through the conduct of trials, farmers and extension institutions have developed experience in participatory research and the capacity to work in concert with each other and with research and development institutions (both local and remote). The development of communications channels between farmers and institutions reduces farmers' transaction costs in the adoption of fish production in rice fields. Fish yield increments of 200-300% have been observed on farms and the impacts of technology express themselves in income changes, which have been identified and measured for households. Access to technology for the poorest (a small number of whom volunteered for the trials along with self-sufficient and surplus wealth-category farmers), who do not have access to savings, was possible by substituting their labour for financial investments. The project defines roles for key players devolving the research and development to farmers and field workers. It values local knowledge whilst acknowledging roles for outsiders. Sustainable impact is attempted through the instigation of an iterative process, which leads towards the refinement of the existing system of research and development at a rate consistent with local capacity.

The specific *a priori* emphasis on the involvement of a women's organisation with a wide geographic influence and institutional cohesion (the Loa Women's Union) as a key target group in natural resources research is an effective method to support the active participation of women.

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Acknowledgements

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1 Background

With a per capita annual income of $ 230, Lao PDR ranked amongst the poorest countries in the world, the economy remaines undiversified and heavily dependent on the natural resource base accounting for 60% of GDP and occupying 85% of the workforce (World Bank, 1993). Fish had traditionally contributed the major portion of animal protein intake of the rural population in the LaoPDR (85% of the total) but due to increasing population pressure and declining natural fish stocks consumption levels were very low (7kg/person/year) (Phonivaay, 1994). The Laotian riverine fisheries had declined by 20% over recent years (Cavas, 1994) and production in lakes and reservoirs had declined by 60% in the past 15 years (Phonviaay, 1994). Aquaculture was the first priority programme of the Department of Livestock and Veterinary Services, Ministry of Agriculture and Forestry and was widely recognised as having great potential to offset current declining fish production trends. Rice was the chief food crop in LaoPDR (approx. 1 million metric tonnes annually) and the development of rice fish culture was a key component of the LaoPDR Inland Fisheries Development Policy, 1994.

Recent research implied that fish production from rice fields not only represented a sound farming system that could dramatically increase farmers income and increase fish production (Ghosh and Pathak, 1988; Mukhopadhyay, Das and Roy, 1989; 1990; Bimbao, Cruz and Smith, 1990; Lightfoot, Roger, Cagauan and DeLa Cruz, 1990; Lightfoot, Cagauan and DeLa Cruz, 1990; Piepho and Alkaemper, 1991,DeLa Cruz, Lightfoot, Costa-Pierce, Carangal and Bimbao, 1992 Sollows 1993; Dela Cruz, 1994) but also an important tool in support of integrated pest management (IPM) (Waibel, 1992;Ramaswamy, 1994; Kamp and Gregory,1994; Akhteruzzaman, Gupta, Sollows and Kohinoor, 1994).

By the mid nineties, some development and extension work was underway through Care/ODA in Bangladesh, ICLARM/IRRI and the Department of Agriculture in the Philippines, the Indonesian Government, in Java and Northern Sumartra, the Department of Fisheries and Department of Agriculture in Thailand. In addition a number of regional workshops (Ubon, Thailand, 1988; Munoz, Philippines, 1989 and Subang, West Java, Indonesia, 1993) had identified the vast potential for rice fish culture and resolved that, of particular importance was *socio-economics and adaptive research - knowing farmers needs, resources, constraints and problems*. The Third Asia Regional Rice-Fish Workshop on Rice Fish Culture Research had prepared a resolution to donor agencies indicating the progress achieved and outlining the importance and need for research in rice fish, signed by representatives of DFID (then ODA), CARE, FAO, IRRI, ICLARM, IDRC and others in1994.

Although potential for fish production in rice fields had been demonstrated, the important researchable constraints in the context of the LaoPDR were to understand existing resource management systems and communication systems in order to support the development of sustainable local resource use strategies.

2 Project Purpose

In recent decades the main developments in aquaculture in S E Asia have related to intensification of production systems (especially large-scale commercial shrimp farming). This trend has failed to produce significant benefits for poor people and has had a negative impact on the environment. An opportunity existed to expand understanding of the biological and social dimensions of aquatic resources management to underpin the development of less intensive forms of aquaculture which can play a role in securing and enhancing the livelihoods of poor people in the region. The purpose of this project was therefore to increase understanding of the technical, social and economic constraints to rice-fish culture in Lao PDR, emphasising women's involvement, through investigation of the resource management and communications systems and participatory research to investigate how to maximise profit from rice fish systems.

3 Research Activities

Many research programmes and projects use the phrase *participatory approach* to describe a wide range of aims and activities and a number of typologies of participation and on-farm research have been described (e.g. Arnstein, 1971; Biggs, 1987). However, the term is ambiguous in the research and development context and it is used to describe very rudimentary levels of consultation between researchers/developers and communities as well as approaches which meaningfully support people to make decisions about their lives. In the following sub-sections an attempt is made to illuminate some terms and concepts related to poverty, participation, research and development in relation to the current project.

3.1 Poverty, participation, research and development

The international target of reducing the proportion of people living in absolute poverty by 50% by 2015, proposed by the Development Assistance Committee of the OECD, has been widely adopted. This has focused sharply international attention on poverty and poverty reduction (targets). The definition of poverty is key to determining necessary interventions as well as mode of operation and measurement of achievement. Thirty years ago, the definition of poverty was commonly reduced to the consideration of level of income, with macro-level interventions and macro-economic indicators. Since then the consideration of relative deprivation, of powerlessness and isolation, vulnerability to shocks, the role of social relations, the environment and sustainability, has led to a broadening of the concept of poverty. "Lack of income" (as implicitly defined by the current World Bank definition of absolute poverty of <$US 1 per day), though measurable, fails to incorporate the non-monitory aspects of poverty related to inclusion, opportunity and dignity. As Amartya Sen emphasised, income is only valuable in so far as it increases the capabilities of individuals and thereby permits "functionings" in society. Such a view of poverty implies interventions in support of sustainable livelihoods at a micro-level, participating with poor people, with an emphasis on how people evaluate their own situation.

The broad aim of participation is to increase the involvement of socially and economically marginalized people in the decision making over their own lives (Guijt and Shah, 1998). Participatory research represents a component of this process though not necessarily a discrete element. Research *per se* describes a process of systematic investigation leading to an increase in the sum knowledge, it is based on the collection and analysis of data which are processed to create knowledge. The subsequent application of knowledge to effect a desirable outcome is the process of development. However, especially where research is funded by development agencies (such as DFID), *research for development* and *the application of knowledge* for development are necessarily linked. The 1997 White Paper, which guides current U.K. development policy, reaffirms the need to ensure the relevance and capacity of current research efforts to result in direct economic benefits to end-users of research products and especially to poor sectors of the community. Indeed the assessment of achievement of some discrete research projects funded by DFID has recently been measured against development implementation indicators including adoption and replication by target institutions, adoption and behavioural change amongst end-users and resulting benefit (along the so-called A-H scale) (Cambridge Resource Economics, 1998).

Where research is carried out with end-users (with commitment to value equally the contribution of all partners) in the context of a collegiate relationship (cf. Biggs (1987) typology of approaches to on-farm research), then the generation and application of knowledge are inseparable. Whilst this provides for research and development outcomes desired by DFID, the closeness of the link between participatory research and development remains controversial, in relation to the application of research and development budgets. The new challenges set by the White Paper, including the adoption of a *sustainable livelihoods* approach, suggest that there will be more need for (policy) research in this area (Scoones, 1998). This will be likely to focus on interdisciplinarity as well as links between research and development.

The White Paper describes various principles to be incorporated into future research orientation and techniques, especially: shared knowledge, applying local solutions to local problems and adaptation of existing techniques. The research orientation of this project, which began in 1995, remains consistent with these principles.

3.2 The project approach

The overall goal of the project is to increase sustainable yields from small-scale semi-intensive aquaculture systems through improved management, specifically fish production in rice fields in Laos. The project selected a participatory research approach in attempting to achieve this goal. An explanation of the participatory paradigm and the guiding principles used in this project are described in Box 1. The project approach comprises seven project stages, which are shown in Figure 1. The activities relating to each stage are described in the following sections.

Box 1: The participatory paradigm and guiding principle for the research

The development paradigms of the 1960's and 1970's derived from the legacy of colonial rule, especially the planning systems of the late 1930's and the period after 1945. The methods were bureaucratic and target driven. The conception was top-down, development was something that governments did for people (Rennie and Singh, 1996). The apparent failure of development to improve the lives of poor people is now believed to be related to the absence of stakeholder involvement of those "undergoing" development. In the early 1980's Robert Chambers argued for a new professionalism to reverse the top-down approach (Chambers, 1984). Many of the practitioners developing new approaches and methods at the end of the 1980's came together at a workshop on "Farmers and agricultural research: Complementary methods (1987)" at the Institute of Development Studies (IDS), University of Sussex. The proceedings were developed into a book entitled *Farmer First* (1989) which distinguished the approach from the conventional paradigm of "transfer of technology". It presented evidence that new research methods and approaches could serve as a powerful tool for meeting farmers needs and could serve especially well, those who manage complex, diverse and risk prone agriculture. After five years the Sustainable Agriculture Programme of the Institute for Environment and Development (IIED) and IDS examined how far the concept of participation had developed and evolved. With regard to participatory approaches to this research, three sets of insights defined by Scoones and Thompson (1994) are especially relevant. These are

1 Power and the pluralism of knowledge

Systems of knowledge are many, though modern science is especially powerful and widespread. Some types of knowledge (and research agendas) are monopolised whilst the weaker, more dispersed and isolated are marginalised. Scientific establishments link together most easily with and local elite's (male, less poor, *progressive*) within rural communities. Thus we must take special care to:

'? Hear and act upon the knowledge and needs of diverse groups varying in gender, age, socio-economic status and capability.

'? To find ways in which the poor, vulnerable, female, excluded can be strengthened in their endeavours to enhance their own knowledge (and influence the research agendas of formal support services).

2 Changes in behaviour, interaction and methods

Evolving from the process, which emerged to transfer technology to farmers, to one based on participation requires behavioural changes from all the key social actors, the development and application of new methods, and types of interaction (reflecting changed power relations). New methods (to model, map, rank, estimate, and experiment) and new roles must be established:

'? Farmers (from recipients) to observers, analysts, experimenters, monitors and evaluators

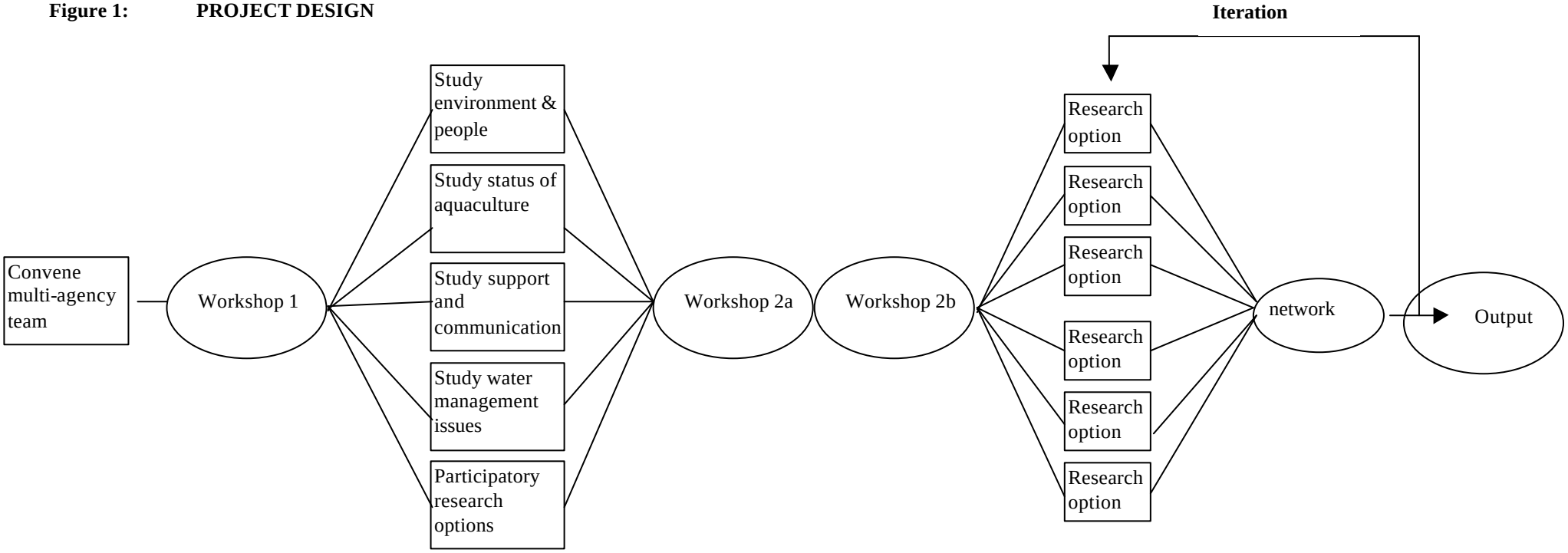
'? Extension workers (from conveyers) to convenors, facilitators, catalysts and consultants

'? Formal researchers (from definer of problem and solution) to recipient, facilitator, consultant and co-researcher

3 Procedures style and culture of organisations

Development organisations (farmers' organisations, local government, government departments, NGO's, research departments) have lines of authority, communication, personal attitudes and behaviour, which can facilitate or hinder participation. To change institutions from hinderance to facilitation requires reversals from top-down hierarchies with supply-driven orders, targets and supervision, to bottom-up articulation of needs with demand drawn search and supply with lateral sharing. Such sharing may involve networks alliances lateral links, interactive learning environments and organisational strategies, which permit scaling up, and spread.

Figure 1: PROJECT DESIGN



Stage 1:	Stage 2:	Stage 3:	Stage 4:	Stage 5:	Stage 6:	Stage 7:
Scope project Preparation Concept Procedure	Research methodologies workshop Situation analysis planning Site selection	Site studies Participatory data collection Problem identification Knowledge reviews Management visits	2a Trial planning framework with target institutions: Planning implementation & monitoring 2b Village-based workshop & farm walks. Feedback & discussion of situation analysis with villages Research participants self-selected. Farmer problem identification	Farmer research, data collection and participatory monitoring and evaluation	Farmers network facilitation Knowledge sharing amongst stakeholders Analyse applicability of products and process to a broader audience	Iterative farmer research-knowledge sharing-outputs production system instituted by target organisations

3.2.1 Stage 1: Defining the project scope, concept and procedure

An inception visit was made to Laos Peoples Democratic Republic (PDR) in January 1996 with the purpose of planning the first stage of the Lao Rice-Fish Culture project. In particular to conduct project activities 1.1 and 1.2 regarding planning and management and begin exploring specific and contextual issues relating to rice-fish farming, activity 1.3 (see the project logical framework).

Laos is the only landlocked country in Indochina, to the east, it borders North and South Vietnam, to the west, Thailand and to the north, China. Burma is located to the northwest of Laos and to the south, Cambodia (see figure 2).

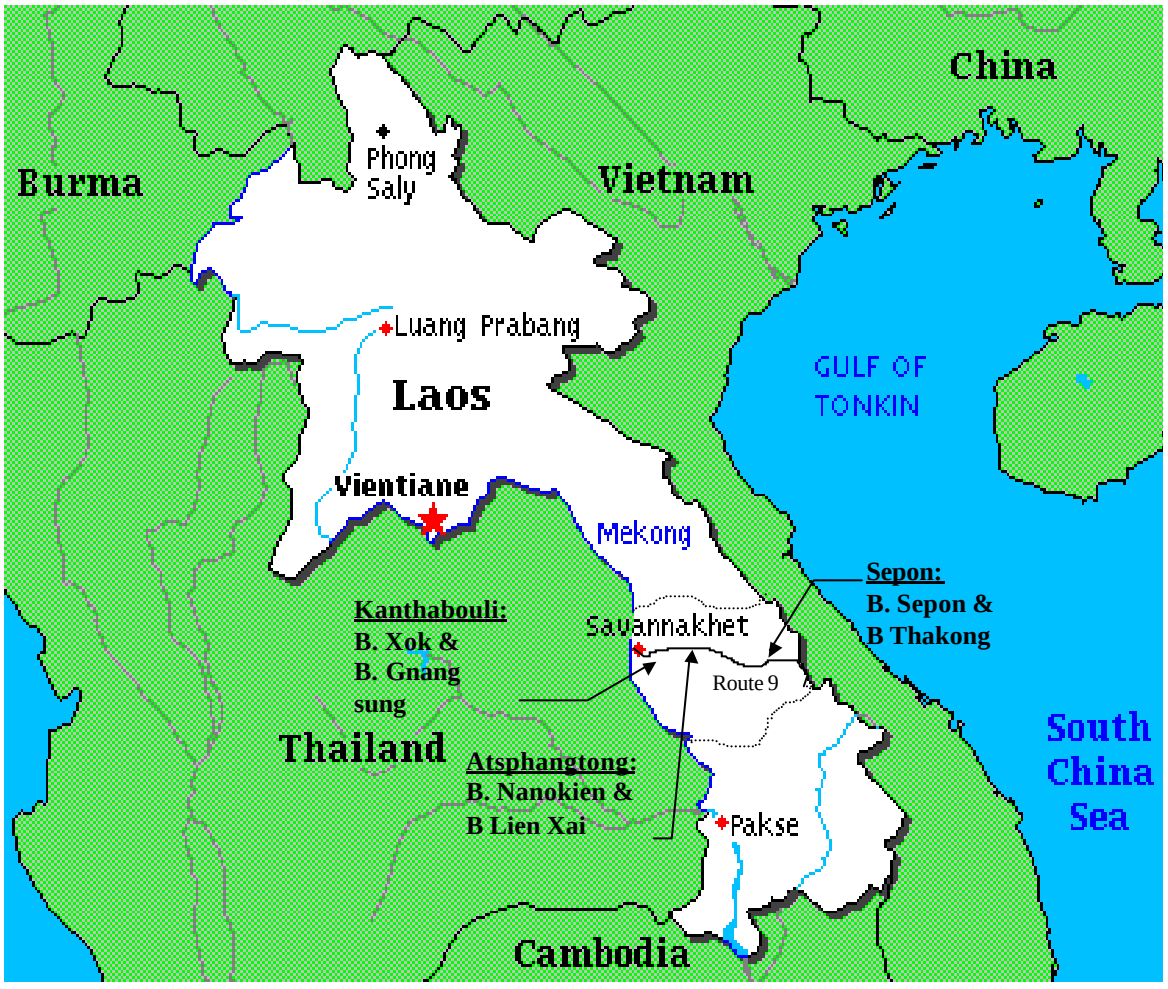


Figure 2: Laos showing the location of the districts and villages in which the project has worked (adapted from Microsoft 1994)

Planning was undertaken and a research framework adopted. The inception visit strongly confirmed the demand (identified during the long project development phase) for increased understanding of the role for rice-fish culture in addressing fish supply problems. An overview of Laos in relation to the project was reported from information collected from semi-structured interviews with farmers and other key informants as well as a great deal of written information. Information regarding options for fish culture appeared to be a major constraint to aquaculture development. Particularly good opportunities still existed in Laos to develop approaches consistent with the judicious use of chemical pest control options, given the lack of pesticide use in some.

Fish represented an important part of the local diet and the supply of fish from wild sources was becoming increasingly scarce. A survey conducted by the Department of Livestock and Forestry (DLF) in 1995 provides a base line for protein consumption and outlines consumption targets for 2000. The results are presented in table 1.

Table 1: Protein consumption in Lao PDR (kg/percap/y)

	1995		2000 target
Rural	fish	7.0	8.0
	pig	5.0	5.0
	poultry	5.0	5.0
	egg	1.5	2.0
	buffalo	1.8	1.2
	cattle	1.2	1.8
	other	1.5	1.0
	Total	**22.0**	**24.0**
Urban	fish	8.0	10.0
	pig	8.0	8.0
	egg	6.0	6.0
	poultry	4.5	5.0
	cattle	3.8	3.0
	buffalo	3.0	3.0
	Total	**33.0**	**35.0**

Source: Department of Livestock and Forestry, GoL (1995)

These illustrate the discrepancy between rural and urban communities, the importance of fish as a protein source and the importance attached to increasing fish availability to promote increased animal protein intake amongst rural and urban communities. It was recognised that cultured fish could help to solve supply problems but not equity problems. It would be important to plan with the whole community to minimise the tendency to help the wealthier farmers, and also to ensure that the natural fish resources were conserved. Ponds and paddies are not separate systems in Laos and there are broad ranging opportunities for integrated rice-fish culture. In lowland and rolling upland areas, especially where road construction was taking place, many new ponds were being constructed for on-farm water storage and fish culture. In upland areas towards the Vietnamese border, the many bomb craters (resulting from heavy US bombing during the war in Indochina in the 60s and early 70s) in or close to rice fields represent a useful potential resource for fish production.

The infrastructure for the distribution of inputs for aquaculture was becoming established in parts of Savannakhet Province through the AIT Outreach Lao programme of support to the activities of the Livestock and Fisheries Section. The social structure of Lao society and the systems operated by the collaborating institutions seemed well suited to the approach of farmer participatory research. Working with women was not a cultural problem in Laos, but would require a conscious attempt by researchers to seek them out and incorporate their priorities. Fish supplies nearer to the home may be particularly important to them. Farmers' knowledge would be invaluable in devising strategies for conserving the wild fish populations (which are appreciated by the community) as well as stocking and raising fish in rice fields. The use of Participatory Rural Appraisal (PRA) methods for the diagnostic stage of the research appeared appropriate. However as with all PRA care would have be taken to emphasise the need for real participation in decision-making. At the same time this would have to be balanced with elements of the project with a pre-set agenda, particularly the project focus on women and equity, and the potential for assistance specifically in the field of aquaculture.

3.2.2 Stage 2: Research methodologies workshop

A research methods workshop was held in June 1996 in Savannakhet Province. The workshop related to activities 1.3 and 2.2 in the project logical framework. Participatory methods were introduced to participants at the Livestock and Fisheries Section HQ in Savannakhet and practised in the field in 3 districts in the province. The workshop introduced the collaborating provincial and district LFS staff, as well as staff of the Loa Womens' Union, to some aspects of participatory rural appraisal (PRA) techniques. In particular the concept of a participation approach to understanding issues within and characteristics of local communities and their farming systems as well as the opportunities for and constraints to integrated rice and fish production.

The workshop reinforced the concept of forward planning and work breakdown structures. In particular the workshop was successful in enabling district teams to produce a detailed six-month plan to conduct participatory research in two villages in each of three districts. It reinforced team working, in particular amongst the district teams. It is unusual to disaggregate the PRA process and plan the components in such detail, but appeared to be the only way to introduce it to district staff used to target-oriented plans. Equal numbers of female and male researchers would ensure the gender focus of the research because the plan incorporated research, with equal numbers of men and women respondents. However institutional problems with the involvement of the LWU at district level were not fully resolved by the end of the workshop and required continued support.

The method of 'learning from experience' would continue - district teams having the opportunity to use different methods with a range of farmers, and to reflect on their findings in the next workshop in January. The workshop contributed to a process within the Livestock and Fisheries Section of empowerment and decentralisation. Planning and feedback were not valued as highly as fieldwork during the workshop, by either provincial or district staff, because the processes of analysis are much more difficult to integrate into a system where data is usually collected for use elsewhere.

The workshop was held to initiate the project in the country, and to capacitate district and provincial staff to conduct the diagnostic stage of the research over the next six months. I.e. to understand the dynamics of the systems and identify opportunities and constraints for fish culture in ricefields in Savannakhet Province. This is the largest and most low-lying province and is responsible for over one fifth of the country's rice production. Its 22,000 km^2 cuts across different agro-ecosystems which can be broadly split into three categories. The project determined to work in two villages in each of three districts chosen to be representative of the three types of agro-ecosystem. These were:

- ?? Khantabouly: The Savannakhet plain bordering the Mekong
- ?? Atsaphangtong: Rolling upland
- ?? Sepon: Upland valleys

The project selected 2 villages in each of the 3 districts in which to work. Guidelines had been provided to the research teams in English prior to the workshop in the form of factors, which might be considered that affect farming systems and the role of fish in those systems. The guidelines also suggested avoiding unique sites and considered the issue of raising expectations at the research sites. The principal concern of the provincial staff reflected in their guidance to district officials had been the institutional constraint of ensuring year round access in order to successfully carry out the research.

The district research teams comprised district officials of the LWU and LFS some of who were residents of the villages in which the research was to take place discussed and selected villages then each team presented the following description of the villages they had chosen.

Atsphangtong District	Sepon District	Khanthabouly District
Nanokien Village	**Thakong village**	**Xokkong village**
?? 200 yrs old ?? some places have irrigation ?? doesn't flood ?? 3 km off main Rd.	?? On road 9 ?? has market ?? big village ?? large area of paddy ?? beside Xebang River ?? people are interested in fish culture	?? beside big forest (to the North) ?? beside rice fields (to the South and West) ?? On Road 11 ?? has spring water (can get two crops of rice each year) ?? never floods
Liensai village	**Sepone village**	**Yangsuang village**
?? 11 yrs old ?? built in a cleared section of forest (site for food gathering) ?? On road 9 ?? No irrigation	?? beside Sepon River ?? 2 km off Road 9 ?? no market ?? interested in fish culture	?? surrounded by rice paddy ?? near to the Kho River (a small one) ?? 1 km off Road 11 ?? doesn't flood

A procedure for documenting and reporting the process has been established. It remained to be seen whether this would be used to full benefit including reflection on the value of findings, but it was based on the structure of feedback sessions throughout the workshop and participants were familiar with the sort of basic analysis it required. Flexibility in planning had not yet been integrated at district level though would be essential to a truly participatory mode of research, but it was hoped this might follow from the work in January.

Participants understood that they would use the results together with farmers to plan experiments - this was a departure from their usual extractive mode of data collection and, it was hoped, provided a stronger incentive for valid representative information. There was still a tendency for researchers to seek out ideal rice-fish farmers or those with ponds; everybody was more enthusiastic about identifying opportunities than constraints. This perhaps reflected the fact that district officers still expect the project to provide a 'transferable technology'.

A farmer participatory approach to research was entirely new and it would have been unrealistic to expect immediate acceptance of the concept. The importance of experimenting locally to overcome constraints could only be fully conveyed when trials were planned and implemented in 1997. The workshop was ambitious and demanding - language problems meant that we had to reduce our goals and participants lost opportunities to test their innovativeness and flexibility. However we finished the workshop with a clear understanding of where teams were going for the next six months, and the learning process would continue with further project inputs.

3.2.3 Stage 3: Participatory data collection

A Situation Analysis based on the six communities was conducted by research teams across Savannakhet Province, comprising equal numbers of male and female district staff and co-ordinated by the provincial LFS and the UK researchers.

The projects participatory data collection process was strongly dependent on some of the tools which have been developed for PRA (participatory mapping, transects, matrices, historical

diagrams and seasonal calendars). However it was necessary to complement PRA with other more conventional methods (Abbot and Guijt, 1997) - which gave PRA a specific niche in a range of methods used to complete the case study. The basic approach used for the situation analysis was that of a multiple case study, depending almost entirely on qualitative data collection methods. In case studies, standard procedures are followed for ensuring that the data collected through case studies, whether quantitative or qualitative, and / or participatory data, are useful. The principles of such data collection are summarised in Box 2 after Yin (1994).

Box 2: The principles of collecting the data (after Yin, 1994)

Construct validity: establishing correct operational measures for the concepts being studied; to fulfil this criterion we need to be sure that measures of change do reflect that change. Construct validity can be enhanced

?? using multiple sources of evidence (often referred to as *triangulation* by PRA practitioners);
?? establishing a chain of evidence, in other words providing sufficient information to allow the reader to follow the linkages from cause to effect;
?? reviewing the output with key informants.

Internal validity (for explanatory studies only): establishing a causal relationship, whereby certain conditions are shown to lead to other conditions; this is not relevant to these descriptive case studies.

External validity: establishing the domain to which a study's findings can be generalised; external validity is enhanced by

?? generalising to a theory, not to a description;
?? using multiple case studies.

Reliability: demonstrating that the operations of a study - such as the data collection procedures - can be repeated, with the same results; reliability is enhanced by

?? documenting the procedures followed;
?? establishing a case study database so that the data can be accessed and re-interpreted by others.

Triangulation itself is achieved in a variety of ways; Yin (1994) again elaborates on these:
?? multiple data sources (data triangulation)
?? multiple researchers (investigator triangulation)
?? multiple perspectives on the same data set (theory triangulation)
?? multiple methods (methodological triangulation).

The project approach to data triangulation is documented in box 3.

In this study, validity was promoted through repeated review of the findings, and by the use of multiple sources of information. As a result, both district staff and external researchers have been able to overcome their lack of familiarity with either the methods or location, by sharing a process of iteration and triangulation. This process has been quite the opposite of a blueprint approach to research design; it developed in response to the learning process achieved by the project team, and adapted to the specific social, institutional and geographic conditions of Savannakhet Province.

Box 3: Data triangulation for the situation analysis

1. reconnaissance visit by external project staff, January 1996;
2. review of published and 'grey' literature, Jan - June 1996;
3. discussions with key informants (project staff) to identify range of agro-ecological zones and villages for study;
4. two-week training workshop for district staff, in data collection methods and appropriate PRA tools; most of this workshop was field based and allowed the researchers to collect further information by:
5. semi-structured interviews
6. direct observation
7. group discussions
8. observation of trainees ability to use the methods
9. review of conclusions by trainees
10. six months of planned data collection by district research teams, during which a range of socioeconomic groups were interviewed, and a range of topics explored;
11. review of data by provincial staff during the report writing phase, December 1996;
12. review and analysis of data during presentations and feedback at workshop, February 1997, by both provincial and district staff;
13. identification of information gaps by UK, provincial and district staff at the same workshop: principally inadequate or superficial information on gender-division of work and attitudes; and lack of detail on individual farming systems;
14. development of specific research tools to address these gaps, with project staff;
15. focused group discussions with women (see below for more detail), February 1997;
16. systems diagrams drawn by selected farmers to describe their farming systems;
17. targeted interviews with key informants (oldest villagers) to strengthen information on change;
18. a series of 22 farm walks throughout Ban Xok, Ban Gnang soung, Ban Nanokien and Ban Lien xai cross-checking with key informants (village leaders, project staff, researchers) to seek an explanation of data patterns.

The situation analysis dealt with the national context including pending national and international developments (especially dam projects on the Mekong) as well as the local context including the social structure of rural communities, land tenure, the local economy and agriculture and aquaculture information systems (See LPR 1 & 3 for details).

3.2.4 Stage 4: Research planning and identification of constraints and opportunities

Workshop 2a: Trial planning framework with target institutions: Planning implementation & monitoring

Following the feedback & discussion of the situation analysis with the LWU and the Provincial and District LFS staff a trial planning framework was discussed with these target institutions in order to implement and monitor a research process. This was a significant moment in the research project. A key output of the project was to be the development of a sustainable local resource-use strategy for rice-fish systems of small-scale, poverty-focused aquaculture, emphasising the role of women achieved via on-farm research and through participatory technology development. Yet workshop 2a began with a large list of negatives and a smaller list of positives in relation to developing a sustainable resource-use strategy and little collective concept of how to proceed. (See Box 4).

Rather than to create a new system it was decided with the Head of the LFS and through discussions with the Provincial LFS staff, facilitated by Aqua Outreach Lao, to build on the systems in existence, no matter how rudimentary. It was the role of district staff to make recommendations including those involving *fish in rice* and this was thought to be occurring, though in an unstructured way. The first step would therefore be to formally record recommendations. Recording recommendations would encourage people to consider the origin of the information and how well it was tested. If the recommendation was a new one or had not been tested before, the second step would be to record this formally as a trial and monitor the outcome. Draft forms were drawn up for development with the district staff.

Box 4: Deciding on a research framework

The down side:

Traditional roles were inappropriate:

?? The traditional role for researchers is the production of finished recommendations to extension workers, who in turn, are viewed as field level teachers. The Training and Visit extension system provides a mechanism for passing to the farmers a finished non-adjustable package.

?? Research and extension organisations tend to centralise and standardise information in order to provide simple all-inclusive solutions or technical recommendations (Okali *et al*., 1994).

?? There is commonly little role for farmers in the development of the research agenda, who often appear to be viewed as passive recipients of packaged solutions.

?? These traditional roles do not lend themselves well to the development of recommendations in support of families who manage diverse, risk prone rain-fed farming systems. The heterogeneity amongst such small-scale farm families and the flexible management strategies they employ represent very complex systems, which it is difficult for outsiders to conceptualise and to research.

The institutional situation was unsatisfactory because:

?? The fisheries extension services, with responsibility for providing recommendations regarding fisheries and aquaculture development in Laos, is devolved to the Provincial Livestock and Fisheries Section of the Department for Agriculture and at the outset of the project in late 1995 institutional capacity was at a very basic level.

1. Government institutions in Laos have a specific history of extractive data collection, for analysis by centralised staff. Extension has generally taken the form of training, not learning from farmers.
2. There was no RNR-based poverty reduction strategies for the peripheral poor, targeting the needs of small and marginal farmers.
3. There were no formal procedures for formulating, recording, monitoring or upgrading government fisheries recommendations, nor links to research stations.
4. Farm families were never involved in the definition of the research agenda and the development of recommendations.
5. Approaches were not based around the flexible livelihood strategies employed by farm families in rain-fed areas.

Traditional research had failed to target systems accessible to the poor or failed to quantify potential:

?? Although, 97% of rice production in Laos is rain-fed the only available recommendation for fish in rice production was an FAO technology that was only suitable for irrigated rice systems.

?? Traditional research approaches by IRRI with fish-in-rice trials had failed to produce data to quantify and clearly demonstrate potential (although collaborating farmers had taken steps to expand their own programmes outside the scope of the research.

Seed supply was very limited:

?? A key source of seed was the government hatchery supply was poor

The up side:

?? It was clear from the situation analysis that the systems operated by farmers, the opportunities available to them and the constraints they faced were characterised by diversity but farmers perceived opportunities.

?? The extension staff perceived the shortcomings of available recommendations and perceived a need to improve their system.

?? A DFID funded bilateral development project (AquaOutreach Lao) was available and willing to facilitate capacity building within the LFS.

?? Conducting a participatory situation analysis had built rapport and a team structure already existed involving the LFS staff at provincial and district level and the LWU.

?? The time spent working with farmers during the situation analysis had (almost completely) broken down pre-conceptions about outsiders having answers and giving away resources.

?? A nursing network being established by LFS had potential to improve seed supply.

District staff and LWU teams from 3 districts were asked to characterise a typical rice field system from their districts, which might be suitable for fish production, either through enhanced wild fish collection or aquaculture. Each team were provided with clay and rice straw to build a model of the system which was then discussed. Recommendations regarding the introduction of fish to the system, which were considered suitable by the staff, were recorded on the draft forms. Where appropriate recommendations were considered as trials with discussions about what might be expected to change as a result of the trial and what to measure. As a result of the process draft forms were worked up into prototypes with the district LFS and LWU staff. For details see Livestock and Fisheries Section, Savannakhet/Aquaculture Systems Group, Institute of Aquaculture (1998).

All involved in the process acknowledged that in complex systems such as rainfed rice agro-ecosystems operated by poor farmers, many things might be expected to change as a result of introducing fish into the livelihood system. To find out about such changes the LWU and LFS district staff developed prototype forms for monitoring *fish-in-rice* trials with women and men from farm family recipients of recommendations. Two Participatory monitoring and evaluation forms were developed with district staff brainstorming and finally agreeing on a list of things that might change as a result of adding fish to the system. The first form asked the farmer to rank the importance of each topic before and then again after each trial. The second form asked farmers to look back after the trial and assess by how much each factor had changed as a result of the trial. The LWU staff would facilitate the form filling for women farmers and the LFS for men farmers.

The key points relating to the research framework were:

?? It would include farmers and those most familiar with the constraints faced by farm families (in this case district staff) in the development of the research agenda.
?? The research would be conducted within the socio-economic and agro-ecological context for which emergent recommendations would be appropriate as part of a collegiate research relationship.
?? The role for field extension staff would be changed from teacher and intermediate user of researcher output, to one of situation analyser and facilitator of farmer research.
?? The researchers would become both recipients of information and advisors, research facilitator and catalyst to information flow.
?? The process would encourage sustainability by developing the capacity to transform and disseminate rice-fish research products via local institutional mechanisms and provide ownership of the research process and products to local institutions.

See Livestock and Fisheries Section, Savannakhet/Aquaculture Systems Group, Institute of Aquaculture (1998) Fish Production in Rice Fields - Developing new recommendations through partnership trials with farmers" ISBN 1-85769 057 5.

The development and management of this partnership between researchers, extension workers and farmers would continue throughout the project and hopefully beyond. The next project activity would be village-based workshops to decide on the specifics of the research agenda.

Workshop 2b: Village-based workshop and farm walks

Following the presentation (by the district teams) of the results of the situation analysis back to the villagers with whom it was collected, the research teams undertook farm walks with all villagers who wished to collaborate with the project. Farmers and the specialist continued to share information about the potential of different agro-ecosystems to incorporate fish. This is discussed more fully in the next section.

3.2.5 Stage 5: Farmer research

The approach taken to research with farmers was to develop a *collegiate research relationship* (see Biggs typology, *ibid*.), building on the relationship developed during the participatory data collection and feedback phases of the project. Participants were not selected but interested farmers were encouraged to approach the District L & F office and to participate in the research. Although almost the whole community had participated in the preceding stages of the project a much smaller proportion wished to become involved in action research. However, the inclusive earlier stages of the project ensured that the community knew of the trials and the farmers involved, and actively observed the outcomes. The participating farmers decided on the specific problem they wanted to research through the process of seeking recommendations together with the extension staff (as described in stage 4). Farmers managed the trials, which were monitored by farmers and extension staff (based on research agreements entered into by the 2 groups). No material incentives were provided and no production enhancing inputs or fish seed were given to farmers.

The availability of fish seed is however a key development constraint in the region, which is currently being addressed via the establishment of nursing networks throughout Savannakhet province (by L & F section facilitated by Outreach Lao). Therefore, after discussions with the L & F section, it was agreed that the cost of seed production for project participants would be underwritten by the project and that seed supplied from the L & F section hatchery at Bak Bor, would be provided on credit to farmers (repayable on harvest). The seed costs repaid by farmers to the district L & F extension staff contributed to the district office, operating budget (effectively supporting the consumables cost of project monitoring at the district level).

Farmers chose the approach and level of investment that they could accommodate. The key research question at this early stage in the process of farmers deciding to add fish production objectives to their livelihood strategies was, "given the resources which farmers felt they could allocate and the paddy agro-ecosystems which they managed, would adding fish to the system benefit their livelihoods". Farmers had little or no experience of fish production, little or no control over species availability, numbers and date of availability and few production enhancing inputs. Therefore research questions involving these specifics were not relevant to farmers.

Farmers participated in monitoring and evaluating the changes that occurred as a result of adding fish to their systems. This systematic PME was facilitated by the LWU and the L & F section (as described in stage 4), whilst regular interviews with farmers complimented the process. Researchers and the extension staff monitored inputs, outputs and progress.

3.2.7 Stage 6 & 7: Developing and instituting an iterative farmer research-knowledge sharing-outputs production system

Stage six of the research process involved the project facilitating the L & F section to support networking amongst farmers, knowledge sharing amongst stakeholders and an analyse of the applicability of products and process arising out of the research to a broader audience.

As many of the communities involved in the early stages of the project were interested in the trials it was necessary to identify a mechanism for sharing the results emerging from trials. Also, as the trials were dispersed across 3 districts within Savannakhet it was agreed with farmers and district staff, that a workshop held after the completion of trials would help to share information and experiences gained amongst the action researchers and the district extension staff. Farmers and district staff would assess the applicability of the outcome of the trials and develop recommendations to share with other farmers.

The workshop took place over 1.5 days at the beginning of in May in Savannakhet. Farmers explained their approaches and shared their experiences in facilitated group discussions. The constraints identified by farmers and also by district staff, were brainstormed as a group and then ranked individually by the participants. Finally, in discussion groups, and then in plenary, farmers and district staff discussed and formulated recommendations. These were developed as an extension leaflet for distribution by the district.

4 Outputs

4.1 Understanding resource and communication systems and identifying constraints

Some key points from the situation analysis are summarized below.

Ethnic groups

Of the three broad ethnic groups in Laos (see LPR 1) the project has worked in communities which are almost entirely lowland Lao. It is worth noting the factors which led to this and which make fish production in rice paddies a management system, which is less likely to be adopted by the upland Lao groups. In general the upland Lao have fewer material possessions, and less access to good land or irrigated valley bottoms.

Labour exchange

The villages in Laos are characterised by a strongly integrated social structure, with a well-defined sense of mutual responsibility and care for the less well off. Labour exchange systems in lowland villages not only provide economic security but also village solidarity, and the ideal of a unified village is still accepted despite political and economic changes. However, labour exchange systems are being abandoned in favour of waged labour, so that an economic situation more similar to that in northeast Thailand is evolving.

Position of women

The household is also an important decision-making unit since land is owned and controlled by the family, not by the community. Women' social position is relatively high in Laos, based on men's and women's mutual dependence for production in subsistence farming, and particularly on women's traditional economic role as purse-keeper and vendor in the marketplace. Lowland Lao women have higher status than the highland groups, and usually stay in the village of their birth, their husband moving into the matrifocal family. Our gender analysis showed a clear pattern of joint decision-making by husband and wife (although the male role is more conspicuous and the husband is designated 'head of household' by Lao officials unless the woman is widowed). Almost all group and individual discussions indicated that women and men clearly see themselves working together interdependently, and that both would be affected by the implications of a decision so both should consider it beforehand. Men tend to initiate decisions affecting farming and aquaculture, while women tend to initiate decisions concerning horticulture and marketing, but this is not universal. The village studies showed that many villages have more women than men, which is largely attributable to losses during the war, rather than out-migration of men in search of work. The differences are small but reflect a general trend across Laos, whose population consists of 52% women. As a result, all the study villages have a small number of female-headed households, although widows tend to remarry within a few years.

Perceptions of poverty

Wealth is widely perceived (by government officials at least) to be the consequence of hard work, poverty the reward of laziness, but in fact wealth is inherited (see section on tenure LPR 3). Examples of wealth distribution for project villages in shown in table 2.

Table 2: Distribution of wealth categories as perceived by village headmen

Village	% poor families	% middle families	% rich families
Xok Kang	15	64	21
Nyang Soung	55	39	7
Thakhong	50	30	29
Sepone	61	39	0

Perceptions of wealth depend on proximity to roads and markets - in both Kantabouli and Sepone districts, the communities with the higher proportions of rich families are those which are situated on main roads and near to towns.

Tenure

In principle, all land is owned by the state, and farmers pay taxes for the rights to cultivate that land. In effect, because the system is stable and such rights are hereditary, rice fields are individually owned. Usually, the only common land is that containing the temple, cemetery and school. Forest tenure is more variable, reflecting population density. In the west, in Kantabouli, the grazing land in the forest is divided between the families of the village who have hereditary rights to it; this system is also recognised in parts of Atsaphangtong but in the newly settled villages such as Lianxai the forest is open-access. Anyone can forage there, but it can be claimed and improved, by converting it to rice fields, in which case the tenure becomes private. Even on private land wild resources are common property, and anyone may catch wild fish from a private rice field. If that field is stocked with fish, however, the owner will deny access. Ponds are owned by those who dig them on their land, while irrigation reservoirs may be the property of individuals or the community.

Local economy

When discussing the pros and cons of various enterprises, farmers in this study took into account labour, cost, frequency of inputs and speed of results. Land is not yet scarce in Savannakhet - even in the most densely populated district, Kantabouli, almost no families are landless, and in Atsaphangtong and Sepone the area cultivated is limited by the amount that the family can clear and work. Labour is the more critical economic factor, along with capital. Credit is rarely available, although there are now government credit schemes targeted at the poorer rural areas.

Income tends to be generated from weaving and the sale of vegetables, bamboo poles, bamboo mats, thatch, and hired labour. Lao lao (a spirit distilled from fermented rice) made by the women, is important in the local economy of some villages. In Kantabouli, because of proximity to Savannakhet, salaried work is common. In Atsaphangtong salaries are rare; some families receive remittances from relatives living in cities and wild harvest is an important source of income. The natural resources are significance of for income. There are few opportunities for non-agricultural income generation and few cash crops. Farmers sell within the village. General patterns of income are shown in table 3. Few items are purchased, mainly clothes, seasoning and food. The times of greatest expenditure are December just before the harvest on food to supplement the little available just; in poorer communities this is just a period of scarcity and just before the planting season, for inputs.

Fish is an important marketed commodity, and prices vary according to which market they are sold in, the season, and whether the fish is cultivated or wild. Wild fish is considered to have better flavour, and prices also rise in the dry season due to scarcity. Smaller fish fetch lower prices - these are the ones often caught by women

Table 3: General patterns of income by gender in the three districts

	Kantabouli	**Atsaphangtong**	**Sepone**
women	Weaving sale of fish (wild and cultured), vegetables	rice labour sale of wild produce (not fish) hired labour (more than men)	marketing on border
men	Salaries	sale of large animals	
both		Sawing hired labour	sale of scrap metal

Information & communication systems

The principal role of LFS is in extension, though there is currently no formal procedure for formulating recommendations, nor links to research stations. Since 1994, each district has had at least one official trained in basic aquaculture. Information flow continues to follow more or less traditional patterns, with external information being directed at the male village elders, who pass it to community members. The LWU also has a role in information flow, having a

network of women, which reaches every village in the province. Much rural planning remains top-down. Two international organisations (IRRI and FAO) have conducted research related to fish in rice locally. IRRI studies in 1993, 1994 and 1995 were reported to be inconclusive because of lack of experience, wetter than usual conditions and severe flooding effecting fish and rice losses. In the polyculture trials were flooded and all fish lost. Growth of fish was poor. Annual technical reports are produced, however it is unclear what efforts are made to distribute these research results within Laos. FAO project (Lao/89/003) on fish culture extension was conducted between 1992-96 with the main objective of transferring fish culture technologies to rural farmers. The project produced some recommendations for irrigated rice fish production on posters as well as other output. Unfortunately 97% rice cultivation in Laos is rain-fed. Some LFS district staff were aware of the FAO information and could highlight its shortcomings for rainfed agro-ecosystems.

During this study, farmers in Kantabouli noted a lack of external information to support aquaculture, and the improvement in information flow was identified in Atsphangtong and Sepon as a factor helping them to start aquaculture. There are important informal networks through which aquaculture information is channelled (farmer-to-farmer). Information to guide the development of recommendations for fish production from rice fields remains an important constraint. In particular extension approaches are needed which can begin to address the needs of poor farm families and which take account of the diverse agro-ecosystems, which they manage.

In Laos generally, livelihoods are based on four components: food production systems, the collection of wild food resources, other income generating activities and other essential activities. The production of rice dominates most of Laos agriculture, although non-rice products often include many species of fish, frogs, insects, vegetables, etc. The management of the rainfed rice-based agro-ecosystems is summarised in Figure 3.

Based on the situation analysis a conceptual framework of potential fish production options was drawn up depending on the agro-ecosystems, which farmers operate, their circumstances and wishes (see table 4).

Table 4: Conceptual framework of fish production options in rice-based agro-ecosystems in Savannakhet

Option	**Likely investment**	**variable labour requirement**	**production**	**likely suitable agro-ecosystem ***
rice field fishery	Fishing	fishing often daily in wet season peak wild fish harvest October	10's of kg from common land holdings varies widely with location	2,3,4,5,6,7,8
Enhanced rice field fishery (see table 4.8 LPR3)	Important labour cost for refuge digging	fishing often daily in wet season, protection from theft after rice harvest	10's of kg may be up to 40 kg varies widely with location	2,3,4,5,6,7,8
Extensive fish culture in rice field	Seed and seed acquisition cost	fishing often daily in paddy/ final fish harvest	around 30 kg/ha	1,2,3,4,5,6,7,8
Semi-intensive fish culture in rice field	Possible modification to infrastructure, seed, feed	feeding, security, fishing often daily in paddy/ final fish harvest	around 250 kg/ha	1,2,3,4,5,6,7
Intensive fish culture in rice field	Possible modification to infrastructure, predator control, seed, feed, labour,	feeding, security, maintenance of infrastructure, pest and disease monitoring and control, fishing often daily in paddy/ final fish harvest	around 500 kg/ha	1,2,3,4,5,6,7

*(see Box 4)

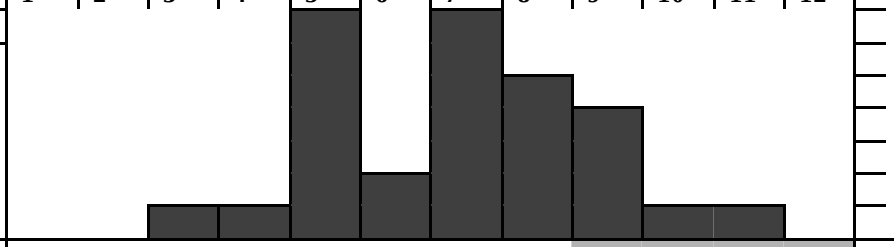
Months	1	2	3	4	5	6	7	8	9	10	11	12	
Rainfall In Savannakhet varies annually 1088 - 1710 mm with double peak													
Rice production													
1st plowing													
nursery beds													peak labour demand May
Transplanting													
general care													weeding, fertiliser, pest manage.
Harvest								E		M		L	peak labour demand Aug-Oct
Fish in paddies													
wild fish enter													
Spawning													
fish grow													
Capture													October peak wild fish harvest
Other crops													
Vegetable													
Orchard													
Livestock													
Chicken													
Ducks													
Pigs													
Wild food collection													
Vegetables, etc.													wild vegetables, frogs, bamboo
Fish													wild fish until December
Food security													
enough food													
Insufficient food													dry season; not lack of rice but everything else (no wild food)
Fertiliser management													
manure for rice													Varies with location
Chemical fertiliser													More prevent amongst poor families
wild materials													?
Other income generating activities													road construction, work in neighbouring urban areas,
Weaving													
outside labour													helping with rice farming
Cash flow													
main income													sell wild vegetables from the forest, frogs; domestic animals are sold; Make Laolao.
main expenses													paying for rice labour
other essential activities													
roof thatching													
house building													
HRM													
rice production													
fish capture													
Busiest													rice planting and harvest

Figure 3: Management of rice-based agro-ecosystems in Savannakhet Province, Laos

From the situation analysis the financial benefit from different systems can be estimated as shown in table 5.

Table 5: Estimated gross margins in Savannakhet fish in rice production systems: Fish raised in late maturing (June -November) improved rice (Financial prices 1997) (Kip/ha)

Cost and income estimates [1]	"extensive"	"semi-intensive"	"intensive"
Gross income			
Fish Yield (kg/ha)[2]	30	250	563
value (Kip/kg)[3]	2500	2500	2500
Gross income (/10^6)	**0.075**	**0.625**	**2.499**
Variable costs			
seed (@ 5kip each)	5,000 (1000/ha)	13,400 (2680/ha)	62,500 (12,500/ha)
organic fertilizer*	-	-	-
inorganic fertilizer*	-	-	-
feed (vegetable waste, termites (both must be collected 24 days @1800kip/day), rice bran average 5kg/week @ 100kip/kg)	-	18,400	55,200
maintenance (24 days @1800kip)			432,000
Total	**5,000**	**31,800**	**723,400**
Gross margin (/10^6)[4]	**0.07**	**0.5932**	**1.7756**
Capital costs			
earthworks (raising bunds/trench building @ 200,000kip per rai on flat land (1600m^2)[5].	Up to 800,000[8]	584,112	1,250,000
netting (@80,850/ha)[6] and posts (@133,333/ha)[7] (for fence)			214,183
labour 144 x (quarters of man days)			64800
Total Capital Cost (/10^6)	**0.8**	**0.58**	**1.53**
kip/man day	1800	1800	1800

* Depending on the rice production system fertiliser is sometimes used for rice (see Project Report 3 Tab. 4.4)

Notes on table 5

1 Cost and income estimates are based on information provided by farmers from their direct experience.

2 Actual reported yield under farm conditions (in excess of family consumption)

3 The value of fish depends on source and availability/season. Most producers sell locally. Cultured fish ranges in value from 1500-2500kip (wet season) to 3000kip (dry season)

4 Gross margin represents a contribution to capital costs and labour (excl. maintenance and wild feed collection already included as variable costs).

5 "semi-intensive" involves 400 m of bunds per ha, "intensive" involves 160 m of bunds per 1 rai (1600 m^2) on flat land. Some paddy in gently slopping valleys is only bunded on one side (like a dam) thus reducing this capital cost substantially. Capital cost is therefore very site specific. Labour and tractor hire costs are very similar for this work. N.B. The cost of earth moving is reduced by about 33% if laterite is provided to nearby road building contractors in part exchange for carrying out earthworks. Using ones own labour with some help can reduce the cost by 66%.

6 netting comes from Thailand 400 m^2 encloses 1ha i.e.14 rolls @150 Bht per 30 m role (38.5 kip = 1 Bht)

7 posts every 1..5 m for 400 m @ 500 kip each locally.

8 specific example of cost for barrage type paddy bunds where fish stocking is practised (B. Xok)

The likely opportunities and constraints related to the incorporation of fish into the identified rice-based systems discussed between farmers and researchers is summarised in figures 4 and 5 for Kantabouli and Atsphangtong respectively.

months	1	2	3	4	5	6	7	8	9	10	11	12	
Agroecosystems KANTABOULI Ban Xok													**opportunities/ constraints**
Som Phoy dry season irrigation scheme		Add seed			Area floods during wet season ← →								Nursing fry for stocking in May (tilapia, common carp and Bighead carp can be spawned in February)
Stream-fed bunded paddy in forested valley					Flowing water through paddy ← →					Add seed			Raising fish from October. The bunds remain open until October to prevent flooding, EUS risk, mrigal not recommended as they tend to migrate
spring fed irrigated rice paddies		Add seed			Add seed →								Double cropping option for rice and fish, EUS risk, seed production opportunity (?), some risk of flooding
Stream irrigated paddy													Double cropping option for rice and fish, EUS risk, seed production opportunity (?), risk of flooding
Ban Gnangsoung													
paddy that dries out if there is a break in the rains							Add seed						Opportunity to develop water storage/ fish refuge/ trap pond to encourage and collect wild fish instead of culture. High risk of loss of stocked fish.
Natural depression/ low lying paddy										Add seed			Raising fish from October stocking after flooding risk. Risk of flooding, EUS risk
Permanent water body (ox-bow lakes)		Add seed											double cropping option for rice and fish, EUS risk, seed production opportunity (?), floating rice as fish feed
Paddy is drained to harvest rice							Add seed						Opportunity to stock fish at low density, fast growing *puntius*/common carp options. short HYV rice less compatible with *puntius*

FIGURE 4 OPPORTUNITIES AND CONSTRAINTS IN KANTABOULI
(shading represents period of water availability, Add seed = proposed timing of fish seed introduction)

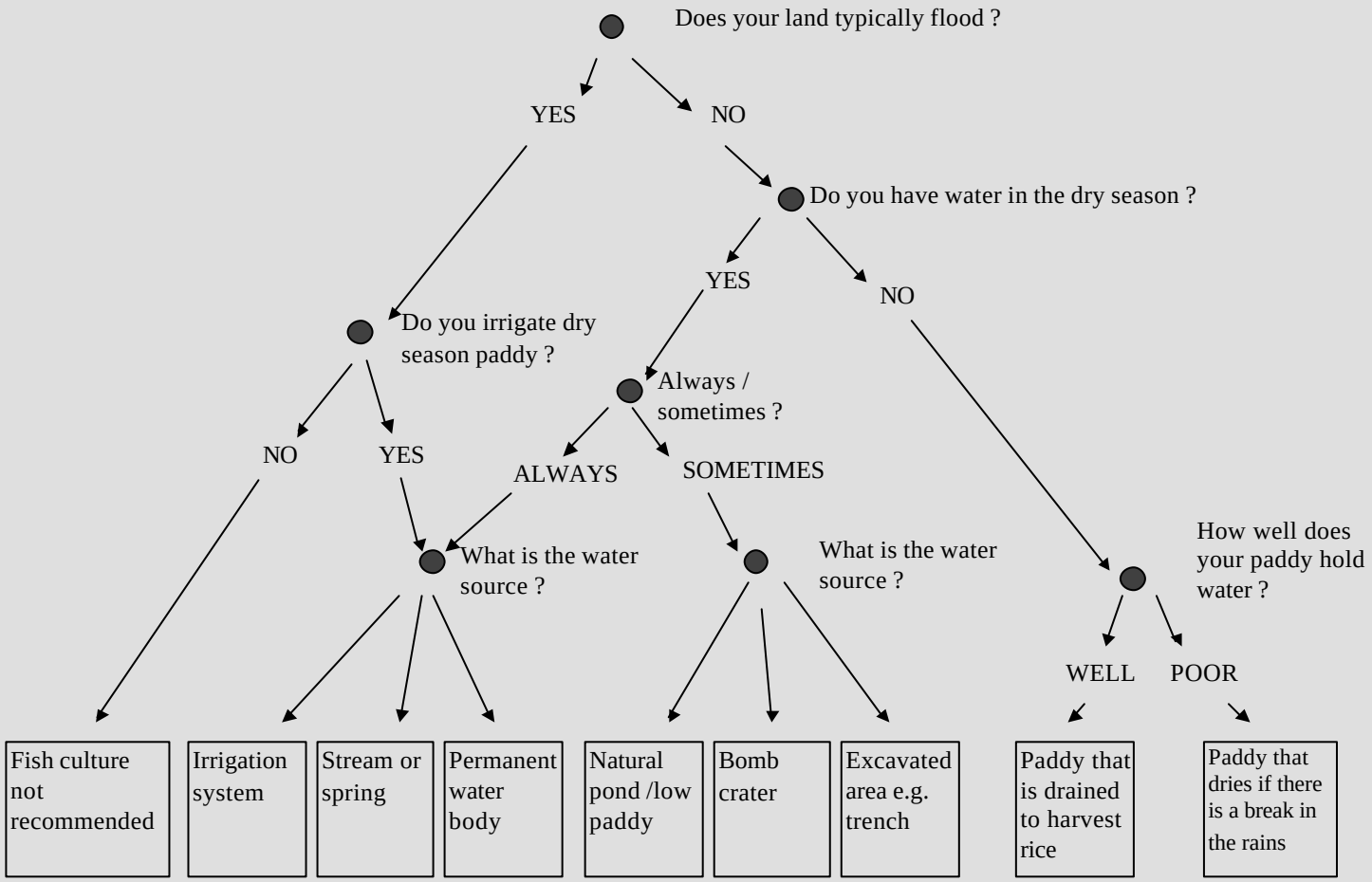
months	1	2	3	4	5	6	7	8	9	10	11	12	
Agroecosystems													
ATSPHANTONG **Ban Nanokien**													**opportunities/ constraints**
Paddy that is drained to harvest rice							Add seed						Opportunity for stocking at low density, fast growing *puntius*/common carp options. dwarf HYV rice less compatible with *puntius*
Low paddy area										Add seed			Opportunity to stock fish in October following flooding, EUS risk, risk of flooding
Bomb craters in paddies					Add seed								Opportunity for early season nursing in hapa in crater opportunity for holding in bomb crater after rice harvest, EUS risk.
Stream-fed bunded paddy										Add seed			bunds open until October to prevent flooding, opportunity to stock fish in October following flooding, EUS risk, Mrigal not recommended as they tend to migrate
Ban Lien Xai													
Natural depression - paddy area shrinks to a central pond in dry season	water In pond →					Add seed					←		Opportunity to stock fish though risk of drought from July so low stocking density recommended, risk of poor water quality and theft from pond
Permanent pond & paddy, drained to harvest rice	water In pond Add seed →											↔	Opportunity to nurse fry in pond before wild fish arrive June - July opportunity for holding in pond after rice harvest, risk of poor water quality and EUS risk

FIGURE 5 OPPORTUNITIES AND CONSTRAINTS IN ATSPHANGTONG
(shading represents period of water availability, Add seed = proposed timing of fish seed introduction)

This process identified a range of rice-based agro-ecosystems close to each village that might incorporate fish. Based on the systems identified in individual villages a more general system for the classification of different agro-ecosystems throughout Savannakhet was developed into a decision tree matrix by Provincial support staff and researchers which might be used by district LFS to classify different agro-ecosystems in future (see Box 4).

The classification distinguishes 8 separate agro-ecosystems in Savannakhet. Each of these systems has different characteristics. Of particular relevance is the time during the year for which each holds water. This is shown in figure 6.

Box 4: Decision tree matrix for categorising paddy agro-ecosystems suitable for fish production



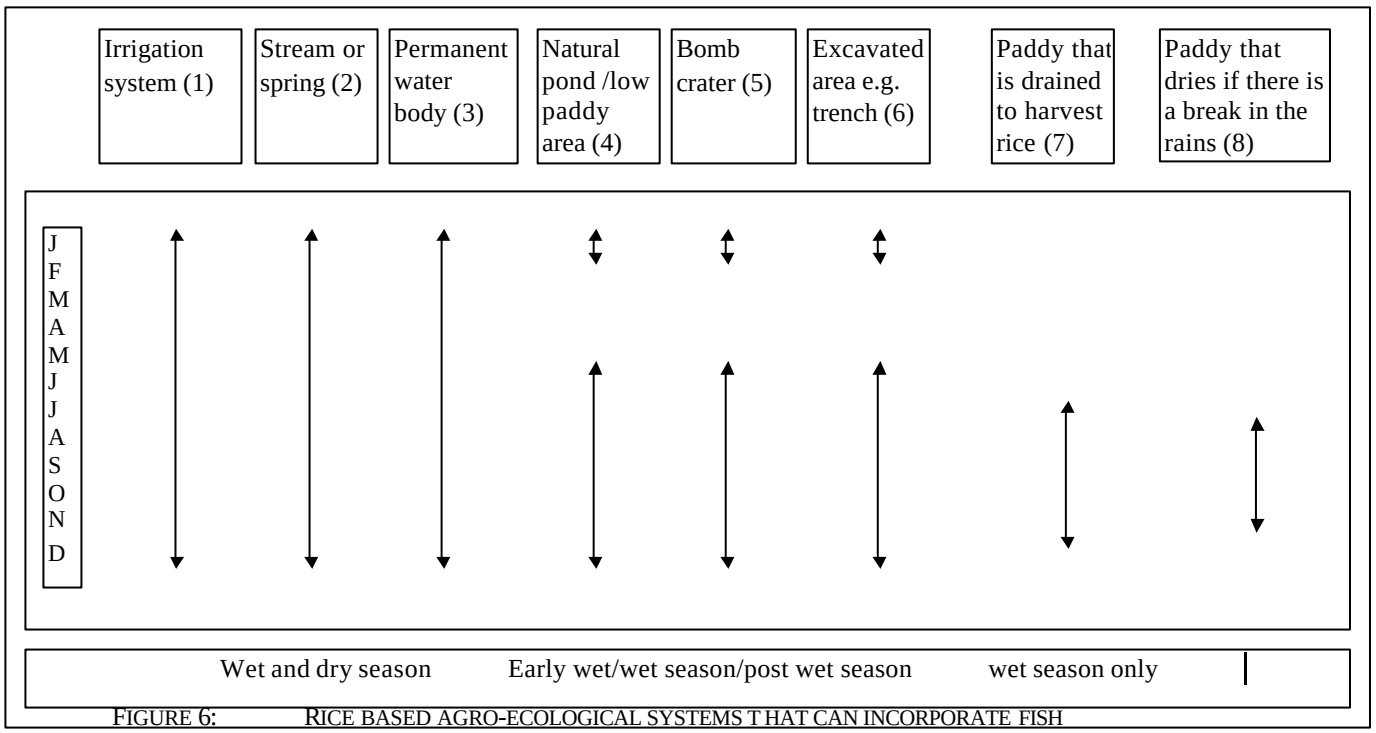


FIGURE 6: RICE BASED AGRO-ECOLOGICAL SYSTEMS THAT CAN INCORPORATE FISH

(The boxes represent the 8 agro-ecosystems identified, the arrows indicate the seasons of water availability'. The bottom line refer to the season in which an agro-ecosystem can best accommodate fish)

Generally, from left to right across the figure the environment for fish production becomes more marginal with decreasing periods of water availability, increasing aridity and dependence upon rain water and (far right) areas with reduced water holding capacity.

4.2 Developing sustainable local resource use strategies

4.2.1 Farmer trials

The trials undertaken and the results of monitoring are presented in appendix 1. A wealth ranking of farmers participating in the research is given in appendix 2 and the variation in fish prices over the period is shown in appendix 3.

The level of investment by farmers

The level of investment in producing fish by rice farmers (composed of their labour, credit and cash) was typically below 50,000kip in 1987 see figure 7

Over half the farmers attending the research workshop after the 1998 trials ranked "coming up with funds and inputs" as their most serious constraint. Farmers' own labour was most often substituted for financial capital. In 13 of 15 cases labour was the principal component of the investment, usually contributing more than 50% (over 80% in the case of the poorest farmers). In 6 of the 15 cases, no cash was invested, whilst in other cases, cash usually comprised less than 20% of the total investment. In the absence of formal credit, the only credit available was the fish seed provided by the project. Two cases were unusual. One farmer investigated nursing of fish fry in spring fed paddies during the dry season, for sale and on-growing in paddies during the rainy season, involving a much larger investment in fish seed (a thus a larger credit component). Another farmer (in the surplus wealth category whose son has a salaried job in the Provincial capital) made a significant capital investment in earthworks and topsoil reconditioning prior to fish stocking.

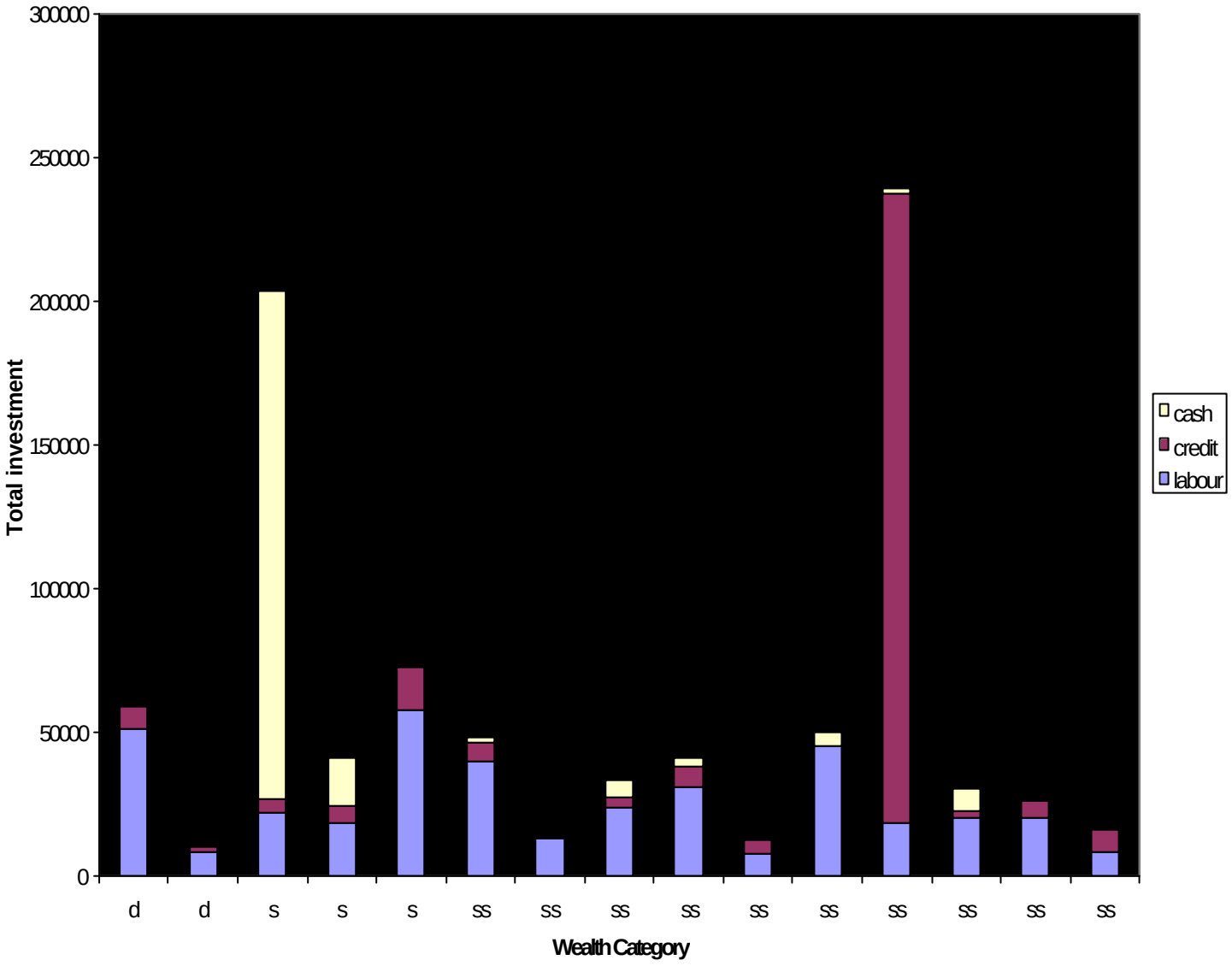


Figure7: Investment by Lao rice farmers investigating fish production in their paddy systems in 1997 trials (d= deficit; ss = self-sufficient; s= surplus see appendix 2)

In 1998, with many costs and prices inflated by 250% over the previous year (related to macro-economic issues in the region), the typical investment of participating farmers was approximately double, labour was still the key component of the rice farmers investment (see figure 8). However, with increased confidence in the venture (and revenue), five farmers producing fish for a second year also invested between 33-84,000 kip each in cash. The increased investment was for increased levels production enhancing inputs and for excavating/deepening natural depressions in increase the duration for which water is available. As before the only credit available was in the form of fish seed from the project.

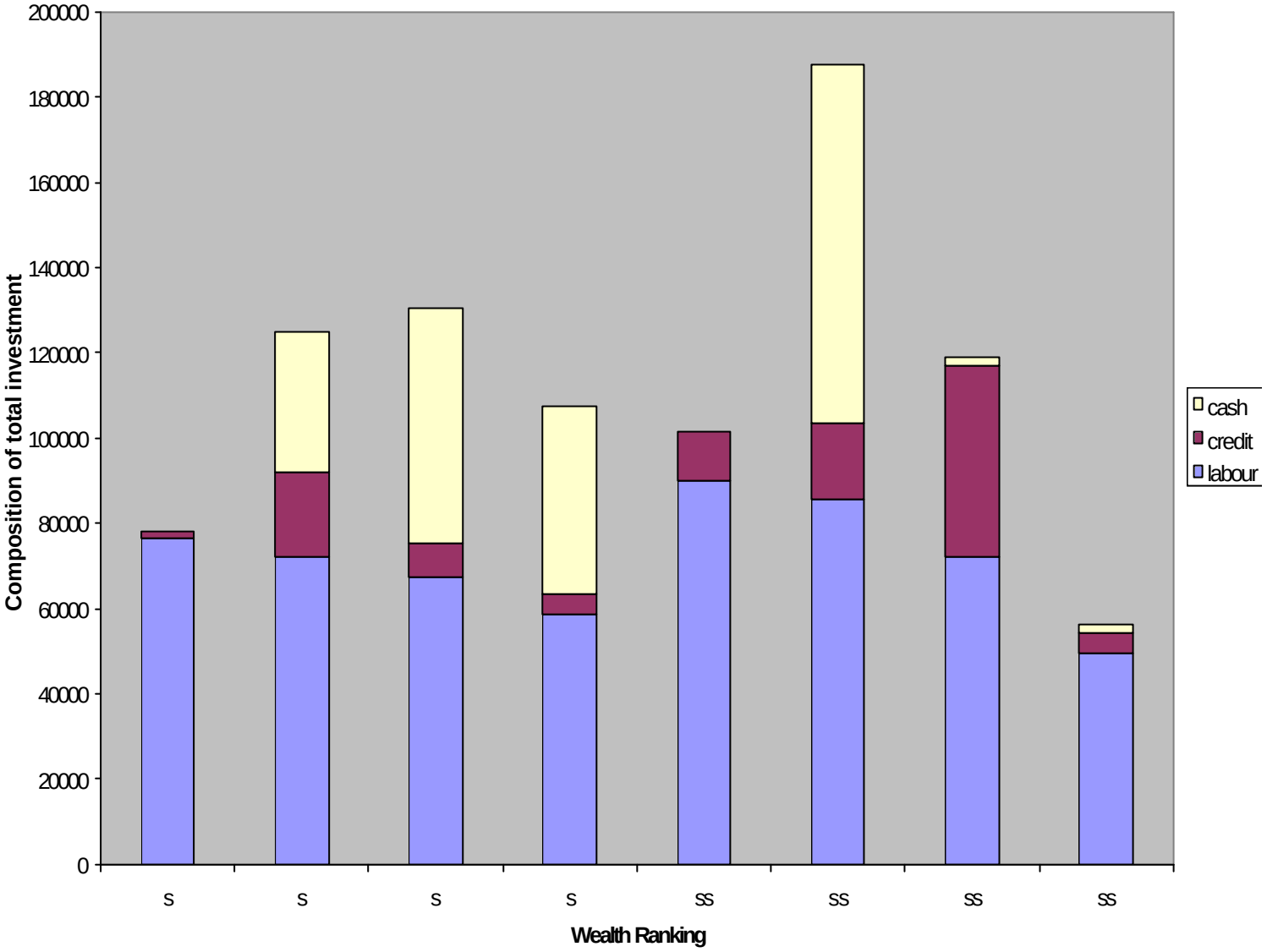


Figure 8: Investment by Lao rice farmers investigating fish production in their paddy systems in 1998 trials

Effects of adding fish to paddies

Two key indicators of the effect of adding fish to the system are the return-to-labour invested in fish production and the production of fish and/or income from the system. Figure 9 shows the gross margin from fish production in rice agro-ecosystems in relation to return to labour. To add meaning to these values, return-to-labour can be compared to the labour rate in villages in rural Laos (1800 kip/day in 1987). Similarly, fish production can be related to the government target for increased fish production (1 kg/capita/yr by 2000) which implies a target increase in fish production per household of about 7kg/yr, or at 1997 fish prices a gross margin of 28,000 kip. All fish production trials in the top right-hand sector of figure 9 may be considered successful compared to waged labour opportunities and also exceed government targets related to fish production. (In spite of objectives to the contrary, these figures appear to be an under-estimate as most farmers reported that their own consumption of fish was not recorded as production).

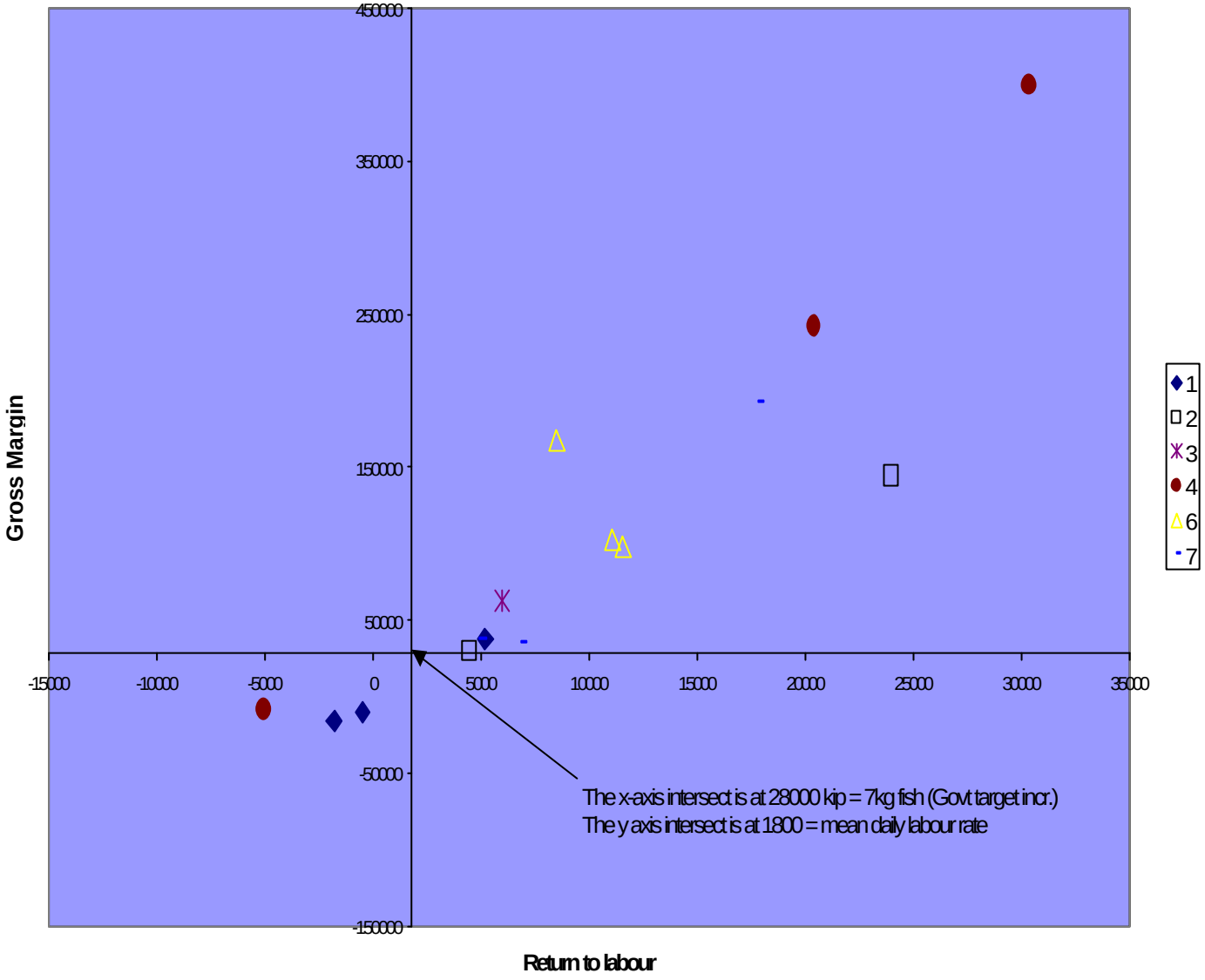


Figure 9: The gross margin from fish production in rice agro-ecosystems in relation to return to labour (legend numbers refer to agro-ecosystem types)

One trial involved a farmer trapping wild fish in his pond-paddy system (eco-system 3) which proved successful. However fish culture in the same system (see 1998results) resulted in a 10-fold increase in return-to-labour. The system selected by the farmer incurred a 4-fold increase in variable costs for a 13-fold increase in gross margin.

Three trials were unsuccessful with families incurring losses of between 9-16000 kip. In each case the loss was due to poor site selection with all fish lost due to flood or drought early in the trial. By 1998, the local labour rate had risen to 4500kip/day and the value of 7 kg of fish rose to 49,000kip. Loss making farmers from 1997 withdrew from the project in view of the unsuitable location of the paddies. A number of other farm families suffered ill health or bereavement or migrated. Figure 10 shows gross margin from fish production in rice agro-ecosystems in relation to return to labour for those farmers who participated in 1998.

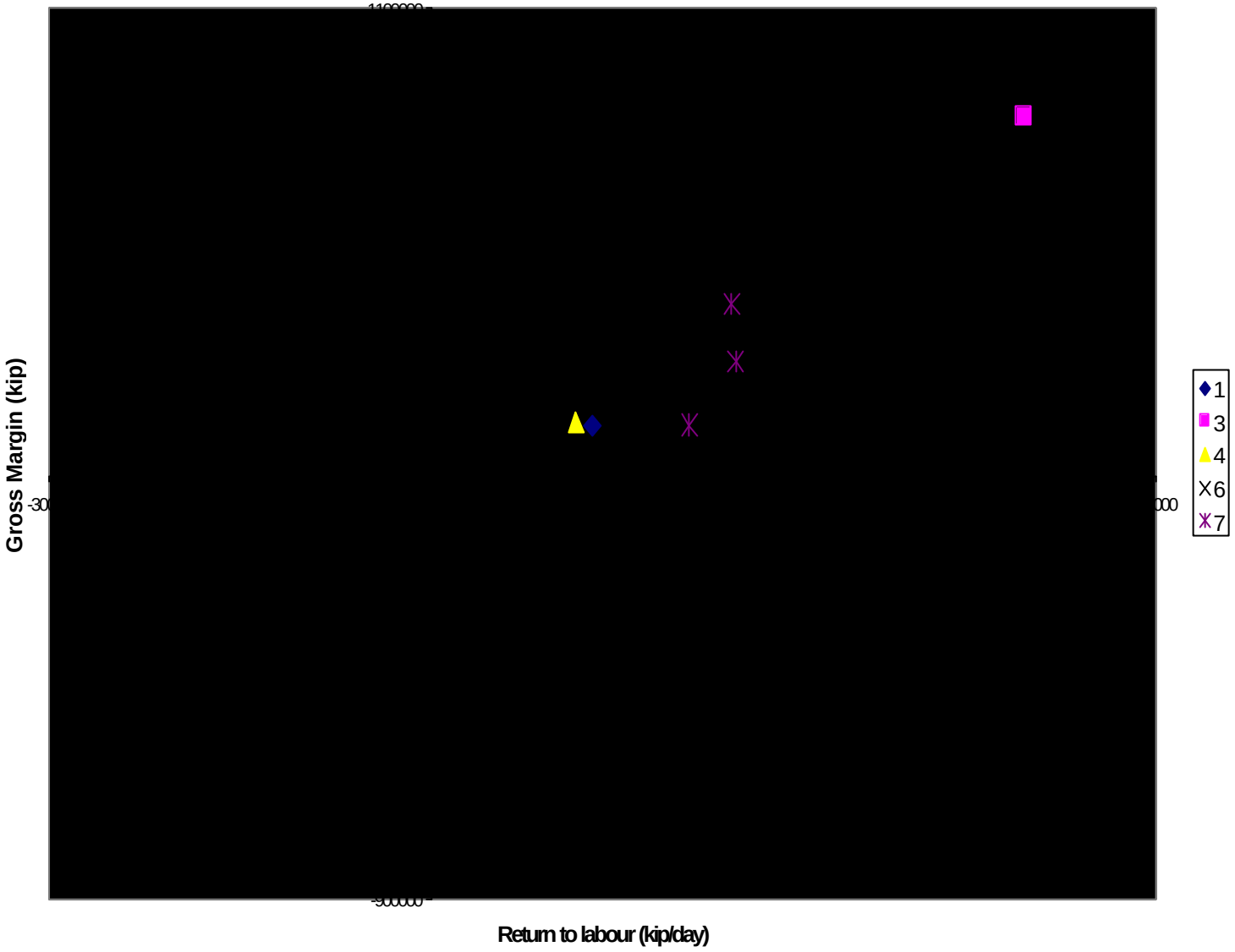


Figure 10: Gross margin from fish production in rice agro-ecosystems in relation to return to labour for project participants in 1998 (legend numbers refer to agro-ecosystem types)

All farmers in trials in 1998 produce fish successfully according to return-to-labour and gross margin indicators. Agro-ecosystem 3 (where a permanent water body is available in conjunction with a paddy system) proved particularly remunerative because fish could be held to take advantage of peak prices in the dry season and especially at Lao New Year. As highlighted above, cash and labour investments in excavation of water bodies to increase water holding were undertaken by farmers in agro-ecosystems 4,6 and 7 prior to the 1998 rains. However, below average rain fall in 1998 has meant that farmers are yet to realise the potential benefits of these investments.

Farmers indicators of the effect of adding fish to their paddy systems

None of the farmers in the trials keep records of the financial indicators above. Although many farmers suffered flooding, drought and theft during their trials with fish, farmers considered 20 out of 23 cases successful. Indicators of success were variable. Most farmers reported that fish production took less time, less labour and less financial investment than they expected. All farmers saw themselves as rice farmers and saw fish production as a

secondary activity. Many compared fish production favourably to another secondary activity, vegetable growing, and considered fish production a much less time consuming option. Farmers reported that the availability of fish provided them with a range of benefits, these are listed below:

- ?? Fish were used to fulfil social obligations (which otherwise can represent "shocks" to livelihoods), such as to support to wedding feasts. Culturing fish therefore helped to reduce vulnerability of livelihoods resulting from culturally dictated asset use patterns.
- ?? Fish were used directly to hire labour, or in part-exchange for labour at a cheaper rate, making activities requiring off-farm labour possible, building assets which otherwise might not have been possible.
- ?? Many farmers valued fish availability during labour bottlenecks such as the rice harvest when there is no time for wild food collection for consumption. Where building natural capital assets through the culture and holding of fish, allows these to be substituted for human capital during seasons when e.g. labour is limiting.
- ?? Many farmers reported increased rice yields in rice fields where fish were produced and believed this to be due to a number of different causes. These included better care of water management, increased fertility due to inputs for fish, reduced weed cover (with Common carp considered especially valuable in this regard, and especially weed clearance around rice hills), and reduced insect pests (with Silver barb considered especially useful against stem borers and leaf rollers).
- ?? Adding fish to a paddy eco-system prevented its use as an open-access fishery, which had a number of important benefits for the rice farmers[1]. The harvest of wild fish available to farmers sometimes increased, frog harvest (an important food resource from paddy ecosystems) increased substantially and, as a result the frogs better controlled the paddy crab population (which attach rice stems, burrow into bunds and disrupt water management).

Farmers were less concerned with maximising production than with balancing production in relation to investment, in the context of the risk of total loss of production. They tended to take an incremental approach to investment and balanced the use of labour and other inputs for fish against other activities. Rice was not perceived to be an exchangeable component of their livelihood systems though other activities including vegetables, fish and maize production were. Women tended to be more cautious then men in investment decisions, which were shared (negotiated).

In semi-structured interviews farmers responded to questions about fish production in paddies reducing access to aquatic resources for poorer members of their community. Most commonly farmers reported that their own aquatic resource needs were increasingly satisfied by their own rice fields, leaving all other common access aquatic resources less heavily exploited.

The performance of fish species in farmers paddies

In the farmers paddy environment Common carp achieved a higher mean growth rate than other species but growth performance was variable and there were no significant differences in growth rate between species overall (see figure 11).The specific growth rate[2] (SGR) amongst fish species in the different agro-ecosystems, ranged from just over 0.8 to just below 1.4 cm/day.

[1] The benefits to farmers in this case are at the expense of those who may have otherwise had access to the fisheries e.g. the landless

[2] [Ln (final length) – Ln (initial length)/days] x 100 where Ln = natural logarithm

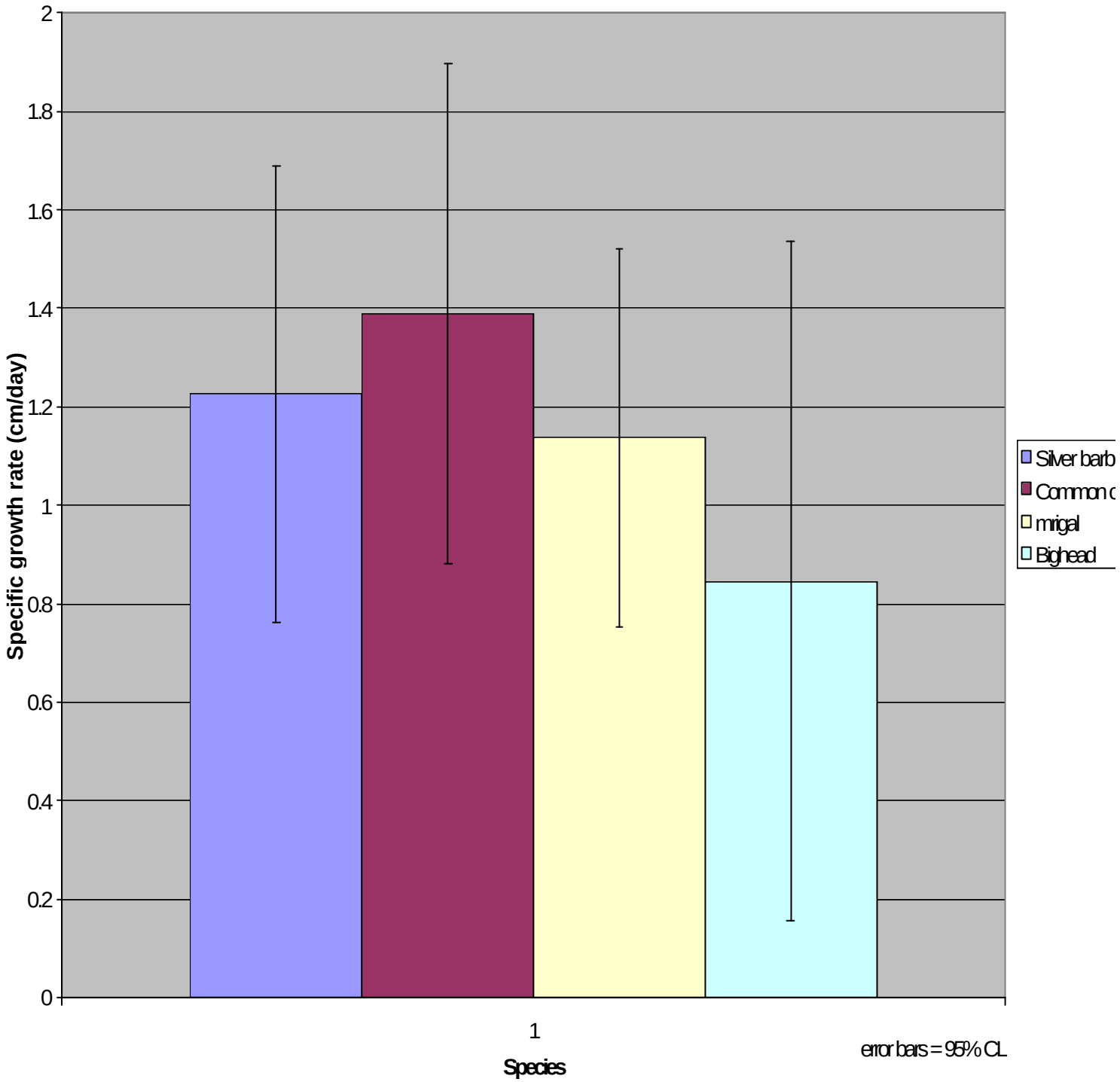


Figure 11: Specific growth rate of fish species grown in paddy agro-ecosystems by farmers

The survival of the four main species cultured under farmers' paddy field conditions varied from 13-100% in individual environments. Species differed significantly in their survival (see figure 12). Bighead carp survived the paddy environment particularly well (mean survival

98.4%) and significantly better than all other species. Mrigal survived significantly better than Common carp.

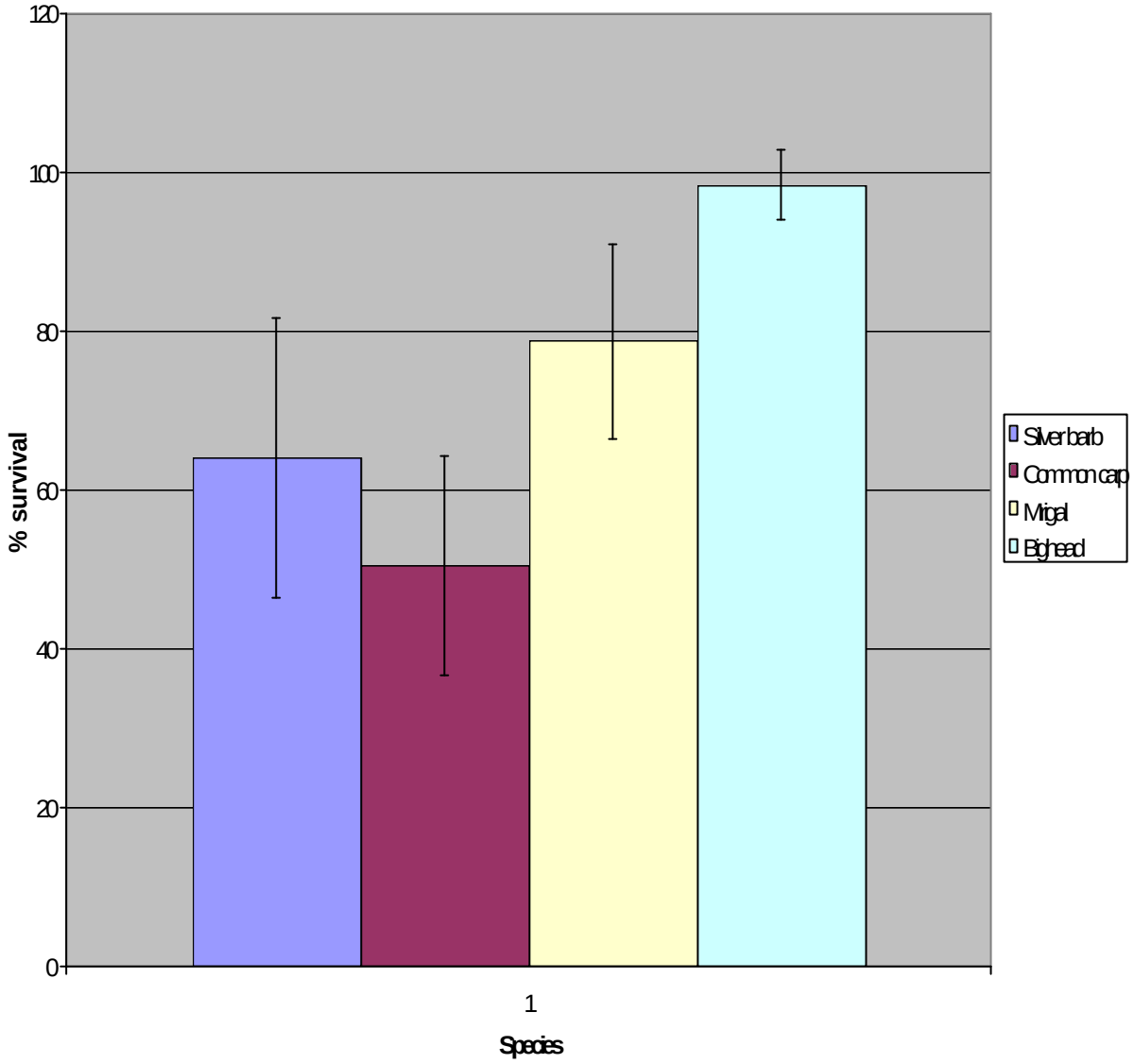


Figure12: % survival of fish species growth in paddy agro-ecosystems by farmers

In the highly variable environment of the rain fed rice field, the commonly used units of stocking and production in terms of unit area are less meaningful than in more controlled aquaculture environments. Variations in stocking density between 0.5 and 1 fish m^2 had no discernible effect on fish growth rate or survival. Income from fish production in many paddy systems is highly dependent on manipulations to the environment such as bund repair, water management and water storage and these activities in turn depend on investments especially labour. The measurement of production in terms of labour may therefore be more appropriate. These are shown in figures 13 and 14 for 1997 and 1998 respectively.

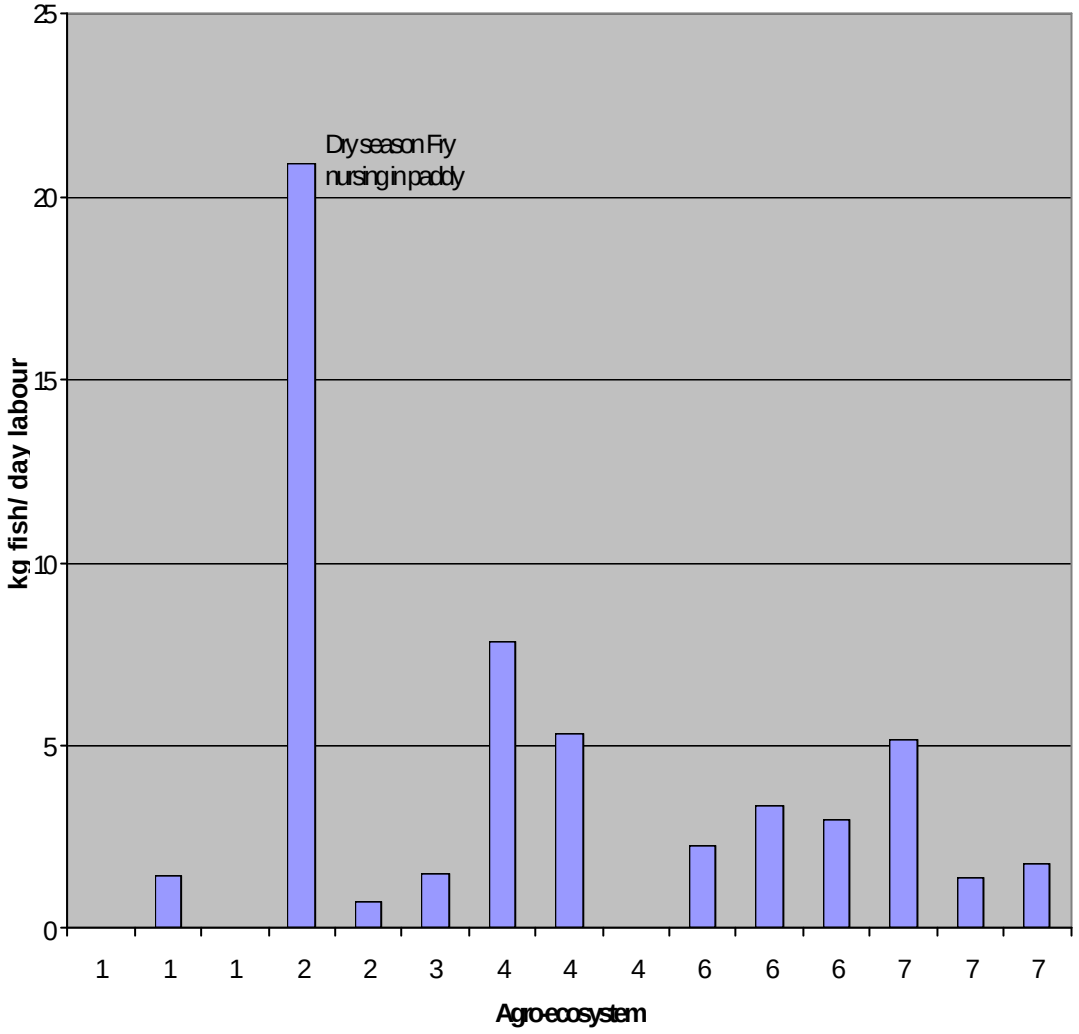


Figure 13: Fish productivity in return to labour input (1997)

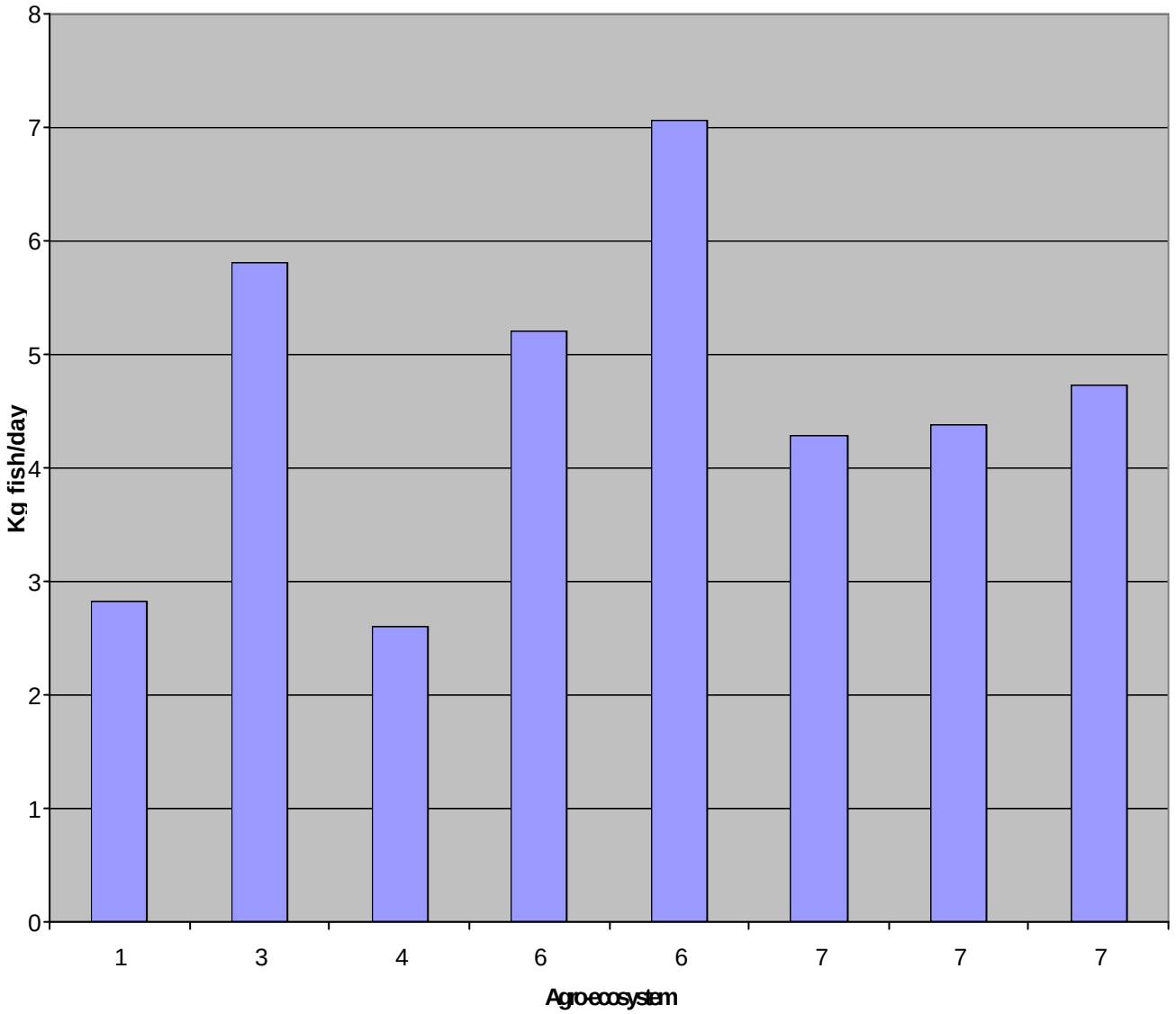


Figure 14: Fish productivity in return to labour input (1997)

4.2.2 Developing the process and the outputs

The constraints identified by farmers and also by district staff, were brainstormed as a group and then ranked individually by the participants. Finally, in discussion groups, and then in plenary, farmers and district staff discussed and formulated recommendations. These were developed as an extension leaflet for distribution by the district.

Problems identified through brainstorming at farmer workshop:

A	Flooding and drought
B	Fingerlings too small and available too late
C	Funds – "coming up with the inputs"
D	Fish predators
E	Feed availability
F	Finding a suitable site

Problem ranking

Farmer	Somsi	Kak	Pome	Wiene	Ang	Luang
Problem						
A	5	2	4	2	1	1
B	2	4	2	4	2	2
C	1	1	1	3	3	3
D	3	3	5	6	6	6
E	4	6	3	5	4	5
F	6	5	6	1	5	4

Ranks	1	2	3	4	5	6	Total ranks	Sum of ranks
A	2	2	0	1	1	0	6	15
B	0	4	0	2	0	0	6	16
C	3	0	3	0	0	0	6	12
D	0	0	2	0	1	3	6	29
E	0	0	1	2	2	1	6	27
F	1	0	0	1	2	2	6	27

From the sum of ranks it is apparent that investment costs are a key constraint, as is the availability of fingerlings at the right size and time and flooding and drought. This emphasises the importance of identifying what benefit can be obtained from the (low) level of investment available to farmers. In addition it re-emphasises the key development constraint of fingerling supply and the need for an improved nursing network and innovative nursing options. It also reinforces the importance of risk of total stock loss in paddy eco-systems.

Problems brainstormed by district staff

A	Fingerlings delivered too late
B	Information collected in nursing trial unclear
C	Fingerlings that were stocked were too small
D	The workload of district staff is already large
E	Expenses were slow to come
F	The *perdiem* was too small
G	Not enough time was spent in the field
H	There were problems with information gathering from participants
I	No experience of this type of work

Ranking

District staff (gender)	Kantabouli (M)	Kantabouli (F)	Atsphangtong (M)	Atsphangtong (F)	Xepon (M)
Problem					
A	2	9	1	1	5
B	9	7	8	9	2
C	3	5	2	2	1
D	7	8	9	6	3
E	4	2	4	8	8
F	5	1	5	3	6
G	6	6	3	5	4
H	8	4	7	7	9
I	1	3	6	4	7

Ranks	1	2	3	4	5	6	7	8	9	Total ranks	Sum of ranks
A	2	1	0	0	1	0	0	0	1	5	18
B	0	1	0	0	0	0	1	1	2	5	35
C	1	2	1	0	1	0	0	0	0	5	13
D	0	0	1	0	0	1	1	1	1	5	33
E	0	1	0	2	0	0	0	2	0	5	26
F	1	0	1	0	2	1	0	0	0	5	20
G	0	0	1	1	1	2	0	0	0	5	24
H	0	0	0	1	0	0	2	1	1	5	35
I	1	0	1	1	0	1	1	0	0	5	21

The district staff shared the farmers concerns over the way in which fish seed is currently made available (especially size and timing). They showed concern about the newness of the approach and questioned the level of remuneration for the work.

Farmers brainstormed topics for discussion regarding recommendations then split into groups to discuss what recommendations they felt could be offered at this stage to other farmers.
Topics for discussion

?? Fertilisation
?? Stocking
?? Feeds
?? Water
?? Location
?? Care-taking
?? Season/timing
?? Money (investment)
?? Expertise

Following discussions in groups, trial farmers developed in plenary a series of recommendations (see table 6). These were developed into an extension leaflet for distribution by the district staff. Copies were discussed with staff of other Provinces in southern Laos (Champasak and Koumwan) through the RDC. In one of the trial villages, Ban Xok more than 40% of households now grow fish in rice (Mr Somboon, *Pers. Com.* Head of Khantabouli District Extension service). The current L & F section policy is to await the outcome of the 2nd workshop in May, 1999 before initiating wider distribution of recommendations. So far Mr Somboon has had enquiries from 50 families in Khantabouli (including: B Xok kang, B Xok nua, B Xok tai, B Ngangsung, B Han tai, B Han nua, B Phak Kha, B Phone soung, B Xok Vang, B Tha enghang, B Phone sin, B Ngang kham, B Pho xai, and B Nong denn).

Table 6: A Summary of Farmers Recommendations regarding fish in rice systems after one season

Fertilisation	Use of manure /Chemical fertiliser is good for rice and fish but there use is site specific (where residual fertility is good, little may be required; where water flows through systems quantity and timing may be important). If possible raise duckweed (as a fish feed).
Stocking	Stock fish 10-15 days after transplanting when rice greens up. Stock as early as possible (Jun/Jul), as large as possible (5-7 cm). If fish are smaller than 5-7 cm then nurse where this is possible. Use a polyculture of non-fish eating species. Don't invest too much in stocking if there is a risk they will be lost (to flood or drought)
Feeds	There are many potential feedstuffs: rice bran (although this is expensive and used to feed chickens and other animals), termites (if readily available – this is not sustainable but may help when you begin), vegetable waste, manure, whisky bi-products (wash first). Feed 2 x daily (to observe fish and check system), feed based on what you think the fish are eating
Location	Choose a paddy close to the house for convenience and protection from theft, with good soil that holds water well and paddy bunds that are robust which is not prone to flooding. If you don't expect to be able to hold 15 cm of water then maybe you shouldn't grow fish. Prevent over-topping with a pipe/outlet with net cover (there are many small floods). Choose a size appropriate for the labour you have, try one paddy first
Care taking	As you have time but consistently check the bunds (and repair), the water level, net screens (and unblock these), keep weeds and grass short to discourage snakes, feed regularly
Season/timing	Stock fish 10-15 days after transplanting rice. 4-6 months of culture can be worthwhile.
Investment	Invest money and time as available and appropriate

The iterative process of annual trials and post-trial workshops was instituted by the L & F section in Savannakhet, to continue until robust recommendations emerged about which district staff was confident. A summary of the opportunities and issues identified for rice-based agro-ecosystems is given in table 7.

Table 7: A summary of opportunities and issues identified by the research so far by agro-ecosystem

Agro-ecosystem	Relation to poverty focus	opportunities	Constraints (in ranked order)	Some key observations & issues
Paddy that has to drained to harvest rice (7)	Common system amongst poor farm families in lowland and rolling upland areas of Southern Laos	?? Farmers selecting to invest >$9 - $130 (comprising 50-80% labour, plus cash and/or credit) have realised returns on investment of 120%-450% over single production cycles. ?? Returns-to-labour for trial farmers exceeded local labour rates by 2.75-10 times ?? Families have typically doubled or tripled their fish production. ?? 50-100% survival rates of fish stocked at 0.4-1/m^2 ?? fish grown typically 120-140 days with medium maturing rice	?? flood or drought ?? cash for inputs ?? timely supply of fish seed ?? predators and theft	?? Stocking fish: increases frog harvest & decreases crabs (a key constraint to rice production in lowlands) ?? Common carp are effective against weeds ?? Silver barb are effective against insects ?? It is extremely valuable to have fish available for food during rice harvesting ?? Mrigal survive rice field environments very well ?? Common labour requirement 7-16 days
Paddy with excavated area (6)	Common system amongst poor farm families in lowland and rolling upland areas of Southern Laos. *N.B. Very rare in upland areas because of unexploded ordinance discouraging excavation.*	?? Farmers selecting to invest $20 - $50 (comprising 50-80% labour, plus cash and/or credit) have realised returns on investment of 330%-520% over single production cycles. ?? Returns-to-labour for trial farmers exceeded local labour rates by 4.7-11 times ?? Families have typically doubled or tripled their fish production. ?? 50-100% survival rates of fish stocked at 0.5-1/m^2 ?? fish held up to 210 days	?? cash for inputs ?? timely supply of fish seed ?? predators ?? drought or flood	?? Availability of fish provides opportunities to support wedding feasts and to hire labour, in exchange or part-exchange, for fish, which otherwise might not have been possible ?? Holding fish into dry season improves food security and potential return ?? Rice harvest improved ?? Frog harvest improved & decreases crabs ?? Short droughts better accommodated by excavation ?? Common labour requirement10-25 days
Paddy with natural pond or low-lying area (4)	Common system amongst poor farm families in rolling upland areas of Southern Laos. *This is a common ecosystem in rolling upland deforested areas where poor farmers are migrating into degraded dry dipterocarp areas and building paddys and mini-watershed (dams). These people are a key target group*	?? Farmers selecting to invest <$8 - $45 (comprising 50-80% labour, plus cash and/or credit) have realised returns on investment of 0%-670% over single production cycles. ?? Returns-to-labour for trial farmers exceeded local labour rates by 0-16 times ?? Families have typically doubled or tripled their fish production. *100% loss fish also encountered* ?? 0-86% survival rates of fish stocked at 0.5-1/m^2 ?? fish held up to 180 days	?? flood or drought ?? cash for inputs ?? timely supply of fish seed	?? Stocking fish in *low-lying areas of rainfed paddy is more risk prone* (than systems 6 & 7 above) ?? Stocking fish tended to increase wild fish harvest ?? Excavating to hold water (a fish) for longer was a key objective for farmers ?? Rice harvest improved ?? Common labour requirement 14 days
Rice paddy associated with permanent	System available amongst poor farm families in lowland and rolling	?? One middle-income family tried trapping wild fish and fish culture in successive	?? cash for inputs ?? timely supply of fish seed	?? A more stable agro-ecosystem for fish as risk of drought is

water body (3)	upland areas of Southern Laos.	years ?? Aquaculture provided a 10-fold increase in return-to-labour compared to trapping wild fish. ?? The aquaculture system selected by the farmer incurred a 4-fold increase in variable costs over trapping wild fish for a 13-fold increase in gross margin. ?? 820% return on $32 aquaculture investment realised ?? trapping wild fish and aquaculture both required 15-16 days labour ?? Fish can be held all year	?? theft ?? flood	removed. Reduced risk increased investment potential. ?? Holding fish into dry season improves food security and potential return (especially Lao New Year when fish value is commonly increased by 170-200%). This is a key advantage of this system
Stream or spring fed paddy (2)	System available amongst poor farm families in lowland and rolling upland and upland areas of Southern Laos.	?? One middle-income family tried nursing fry in paddies prior to the on-set of the rains ?? 350% return on investment (in spite of loss due to flooding) ?? 13 fold increase in return-to-labour compared to waged labour	?? flood	?? As nursing is a key development constraint well selected paddies with water in the dry season represent a huge investment opportunity and fast return ?? Other labour opportunities are limited in the dry season ?? Large fingerlings at the on-set of the rains are key for short season water resources
Paddy that is irrigated (1)	System available amongst poor farm families in lowland and rolling upland and upland areas of Southern Laos. Some of these systems are poorly designed/located/ unstable	?? Farmers selecting to invest <$6.5 - $17 (comprising 50-80% labour, plus cash and/or credit) have realised returns on investment of 0%-380% over single production cycles. *Losses of $6.5-10 were incurred.* ?? Families have typically doubled or tripled their fish production. *100% loss fish also encountered* ?? 3-4 fold increase in return-to-labour compared to waged labour	?? flood or drought (over-topping of irrigation dam and sandy soil) ?? cash for inputs ?? timely supply of fish seed	?? Although an irrigation source might imply guaranteed water supply and increased stability, many systems are poorly sized for their catchment and command area and service land with poor water holding characteristics and therefore *risk-prone systems.*

5 Contribution of outputs

The outputs of the project contribute to the DFID development goal of *a sustainable increase in yields from small-scale semi-intensive and extensive aquaculture systems through improved management* via products to improve productivity and influence policy.

Improved productivity

Yield increments of 200-300% have been observed on farms and the impacts of technology express themselves in income changes, which have been identified and measured for households. Access to technology for the poorest (a small number of whom volunteered for the trials along with self-sufficient and surplus wealth-category farmers), who do not have access to savings, was possible by substituting their labour for financial investments.

Through the conduct of trials, farmers and extension institutions have developed experience in participatory research and the capacity to work in concert with each other and with research and development institutions (both local and remote). The development of communications channels between farmers and institutions reduces farmers' transaction costs in the adoption of fish production in rice fields.

Policy influence

Traditionally, research and extension institutions generate recommendations and train farmers respectively. The process is commonly unidirectional. The contribution of the outputs offered to beneficiaries by this project is embodied in a strategic approach to designing and implementing a system which takes account of the complexity and diversity in natural resources, and the risk faced by individual farm families. The system represents a unique mechanism, designed through an iterative and interactive research process in which farmers and local institutions are collaborative partners. Outsiders supporting community-based natural resource management systems have a limited capacity to understand the constraints and issues, which they seek to address. The project defines roles for key players devolving the research and development to farmers and field workers. It values local knowledge whilst acknowledging roles for outsiders. Sustainable impact is attempted through the instigation of an iterative process, which leads towards the refinement of the existing system of research and development at a rate consistent with local capacity. The Regional Development Committee (RDC) of Southern Laos has incorporated this iterative process developed with the Lao Government into Regional Government Policy. The first outputs of the process have been developed into extension materials by the Livestock and Fisheries Section and a video and extension media have been developed from the research output in conjunction with FAO in Laos. These media require to be pre-tested before distribution.

The specific *a priori* emphasis on the involvement of a women's organisation with a wide geographic influence and institutional cohesion (the Loa Women's Union) as a key target group in natural resources research is an effective method to support the active participation of women.

Project publications

Written output relating to stage 1:

Haylor, G and Lawrence A (1997) Identification of technical, social and economic constraints to rearing of fish in rice fields in Lao PDR: Country overview and proposed project structure. Project Report Volume 1. January 1996

Written output relating to stage 2:

Lawrence A and Haylor, G (1997) Identification of technical, social and economic constraints to rearing of fish in rice fields in Lao PDR: Research methods workshop. Project Report Volume 2. July 1996

Livestock and Fisheries Section (1996) Information collection, research methods and research planning. Published by Livestock and Fisheries Section, Division of Agriculture and Forestry, Government of Laos48p (IN LAO)

Written output relating to stage 3:

Haylor G (1997) Aquaculture Systems Research: Participatory research projects involving fish production in agro-ecosystems in Asia. Aquaculture News 23 p 18-20. ISSN 1357 1117.

Livestock and Fisheries Section (1996) Information collection, research methods and research planning. Published by Livestock and Fisheries Section, Division of Agriculture and Forestry, Government of Laos48p (IN LAO)

Haylor, G Lawrence A and Meusch E (1997) Identification of technical, social and economic constraints to rearing of fish in rice fields in Lao PDR: Resource management and information systems - A situation analysis. Project Report Volume 3. July 1997

Written output relating to stage 4-7:

Anna Lawrence, Graham Haylor, Carlos Barahona and Eric Meusch (1999) "Using participatory indicators to understand systems change through farmer-managed trials in Bolivia and Laos." In: Learning from Change. Issues and Experiences in Participatory Monitoring and Evaluation.

Authors: Marisol Estrella with Jutta Blauert, Dindo Campilan, John Gaventa, Julian Gonsalves, Irene Guijt, Debra Johnson, and Roger Ricafort (eds).

New Frontiers of 'Participation': Lessons and Experiences in Participatory Monitoring & Evaluation (edited by Institute for Development Studies in association with IIED and IIRR) published by Intermediate Technology (*in press*).

Haylor, G & Lawrence, A (1998) Laos: Participatory research and extension. Rural Extension Bulletin. October 1998.ISSN 0969 6350.

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Lawrence A, Haylor, G and Meusch E (1997) Participatory monitoring of systems change in integrated aquaculture. Aquaculture News 24, p 25-27. ISSN 1357-1117

Haylor G (1997) Aquaculture Systems Research: Participatory research projects involving fish production in agro-ecosystems in Asia. Aquaculture News 23 p 18-20. ISSN 1357 1117.

Livestock and Fisheries Section (1996) Information collection, research methods and research planning. Published by Livestock and Fisheries Section, Division of Agriculture and Forestry, Government of Laos 48p (IN LAO)

Haylor, G Lawrence A and Meusch E (1997) Identification of technical, social and economic constraints to rearing of fish in rice fields in Lao PDR: Resource management and information systems - A situation analysis. Project Report Volume 3. July 1997

The project was reviewed in 1998 and judged to have progressed from methodological development to research product delivery within the duration of the project (Cambridge Resource Economics, 1998). The FAO project LAO/97/007 wish to fund the production of extension materials (leaflets and video) to carry the products of the research to a wider audience in Laos. The RDC in southern Laos together with the project co-ordinator are seeking support to continue the refinement of the research and development process. The 2nd

post trial workshop will take place in May 1999 and will be co-ordinated and funded entirely by the RDC. A number of technical publications aimed at peer-review journals are *in prep*.

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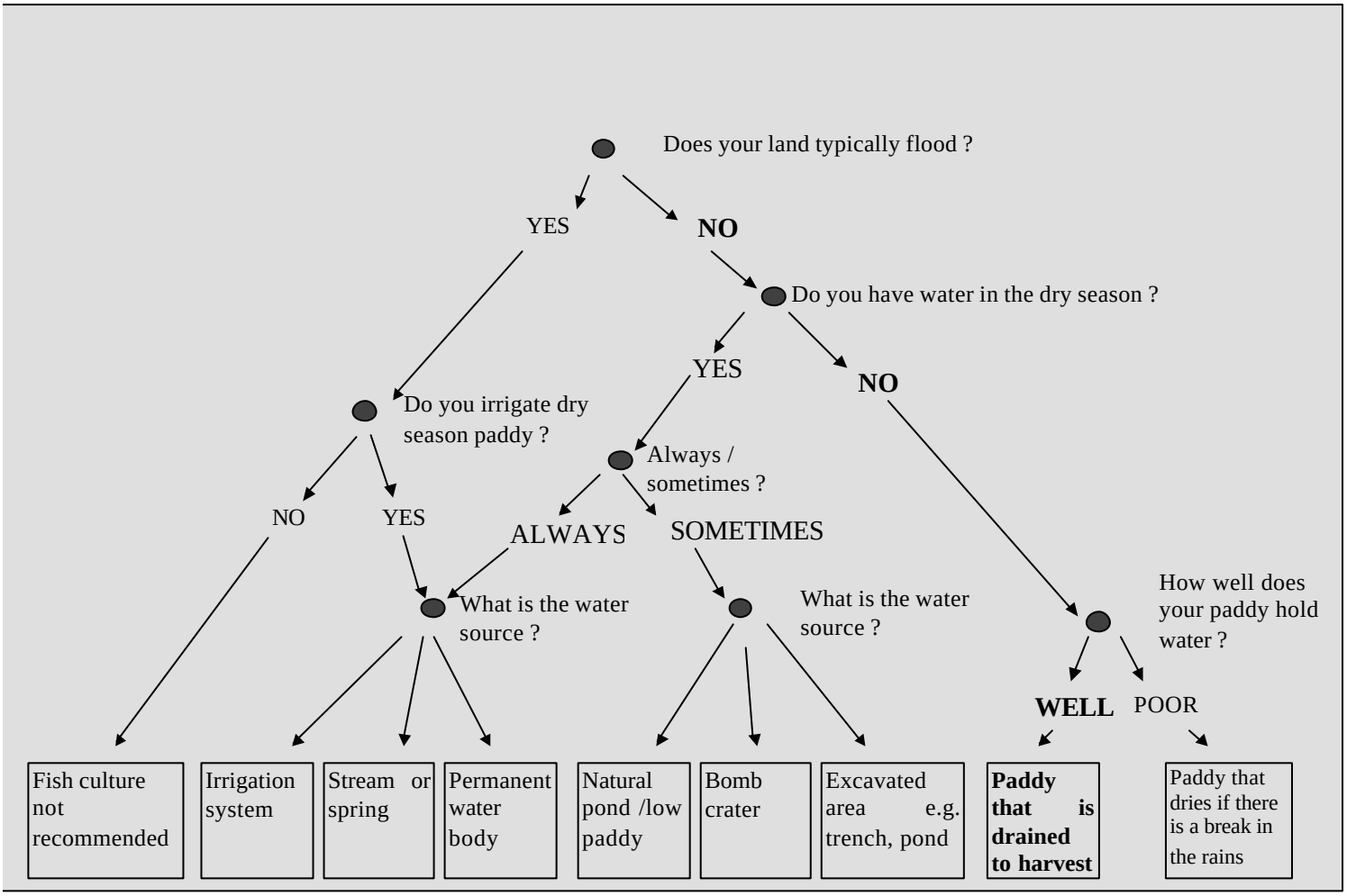
Appendix I: Trial results

1.1 Agro-ecosystem 7: Paddy that is drained to harvest rice

1 Classification



2 Summary of Rice-fish system in paddy agro-ecosystem that is drained to harvest

(All tasks are completed by family labour)

Water in paddy												
Activity / month	1	2	3	4	5	6	7	8	9	10	11	12
Nursery rice beds (up to 45days)												
first ploughing Transplanting rice General care of rice Harvest rice								GK10				
Prepare fish nursery **Nursing fry (5 weeks)** **Releasing fingerlings (14DAT)** fish feed in the paddies **Harvest fish**												
wild fish enter paddies Spawning Capturing wild fish												

3 Adding fish in agro-ecosystem 7

Farmers	System selected by family
Supome (1997)	**Preparatory work**: 4 paddys into 1 with tractor (120,000kip) plus 2t buffalo manure to recondition scraped off top-soil **Nursing**: Nursed 6 weeks in Mr Newgains pond, 10 kg rice bran **Inputs**: Seed cost (5000kip on credit); rice bran (2kg/week) (5000kip); 2 buckets manure 4 times weekly **Labour**: (nursing 42days 30min/day; feeding 107 days 30min/day; seed acquisition 2days; harvesting 2days) 13 days
(1998)	**Preparatory work**: added extra 300 kg manure **Nursing**: 6 weeks in Newgains pond, 10 kg rice bran **Inputs**: Seed (20,000kip on credit); Rice bran (125kg total) **Labour**: (42 days 30min/day; feeding 125 days 30min/day; termite collection 30 hrs, seed acquisition 2days; harvesting 4 days) 16 days
Siya (1997)	**Preparatory work**: raised paddy bunds slightly leaving small trench (10 days own labour) **Nursing:** nursed fish in a hapa in his pond 6 weeks **Inputs:** Seed (6500kip on credit) No feeding; fertiliser for rice as usual (after transplanting, at flowering), **Labour**: (nursing 40 x 30 min, check outflow screen daily 84 x 30min, seed acquisition 2days; harvesting 2days) =12 days plus 10 days prep.
(1998)	**Preparatory work:** Improved paddy bunds again (10 days own labour) **Nursing:** nursed fish in a hapa in his pond 6 weeks **Inputs:** Seed (11500kip on credit); Fed 20 termite balls **Labour:** (nursing 40 x 30 min, termite collection (total 12hrs), check outflow screen daily 53 x 30min, seed acquisition 2days; harvesting 2days) =11 days plus 10 days prep.
Luan(1997)	**Preparatory work:** none **Nursing:** nursed fish in a hapa in his pond 6 weeks **Inputs:** Seed (1100kip on credit); no feeding **Labour:** (nursing 40 x 30 min, seed acquisition 2days; harvesting 2days) = 7days
Nouna (1998)	**Preparatory work:** none **Nursing:** nursed fish in a hapa in his pond 6 weeks **Inputs:** Seed (15000kip on credit); no feeding **Labour:** (nursing 40 x 30 min, seed acquisition 2days; harvesting 2days) = 7days

4 Evaluation of fish production

Farmers	plan	Stocking	Sp	no	Size (cm)	Density/m^2	Harvest	no	size	Wt (kg)	Surv.%	SGRcm/dy
Siya and **Nechan** (1997)	1300m2, 1300 sb,Cc+til @ 1/m2	18/7/97	Sb Cc Mr Bh	212+600 10 431 12	4.3+2-3 3 5.8 9.5	1	10/10/97 (84days)	495 5 300 11	9.6 16 11 11	5.5 0.5 5 1 5 (wild)	61 50 70 92	1.38 2 0.76 0.18
(1998)	1300m2 1300 Cc,Sb,Mr @1/m2	1/8/98	Sb Cc Mr	350 350 450	2-4 3-5 4-7	1	23/9/99 (53days)	300 200 350	10-13 8-11 15-17	Total 50 2 (wild)	86 57 78	2.54 1.63 2.02
Supoom and **Pokong** (1997)	2000m2 800 sb,cc,t Sc@ 0.4/m2	18/7/97	Sb Mr Bh	607 400 5	3 5.5 9.3	0.5	2/11/98 (107days)	462 343 5	11.8 15.6 29.8	15.4 22.8 4 20(wild)	76 86 100	1.28 0.97 1.09
(1998)	2000m2 800 sb,cc,t Sc@ 0.4/m2	30/6/98	Sb Mr Til	400 450 56	3-5 2-5 4-7	0.45	5/8/98 (850 4-10cm) harvested to pond 5/8 due to drought					
		12/8/98	Restocked paddy from pond				16/11/98	344 61 0	13-19 18-20	70kg total	86* 14*	
Luan and **Sithong** (1997)	500m2 Sb @0.4m2	4/8/97	Sb	200	7	0.4	7/10/97 (95days)	67	15	4.8 7.5 (wild)	40	0.8
Somboon and **Nouna** (1998)	3000m2 3000 cc @ 1/m2	12/6/98	Cc	3000	2-3	1	Theft from paddy			10kg 20kg		

N.B. Plan and actual stocking sometimes differ reflecting the lack of control over choice in species and numbers
Sb = silver barb, Cc = common carp, Mr = mrigal, Til = tilapia, Sc = Silver carp

Agro-ecosystem	7	7	7	7	7	7
Cost and income estimates	Supome 97	Supome 98	Siya 97	Siya 98	Lunag 97	Nouna 98
Gross income						
Fish Yield (kg)	62.2	70	17	52	12.3	30
value (Kip/kg)[1] this varies seasonally and annually see figure??	4000	8000	4000	7000	4000	7000
Gross income	**248800**	**560000**	**68000**	**364000**	**49200**	**210000**
Variable costs						
seed	5000	20000	6500	11500	1100	15000
organic fertilizer	24000	6000				
inorganic fertilizer						
feed	6000	27000	2000			
labour (nursing, feeding, feed collection, maintenance)	21600	72000	21600	45000	12600	31500
Total	**56600**	**125000**	**30100**	**56500**	**13700**	**46500**
Gross margin	**192200**	**435000**	**37900**	**307500**	**35500**	**163500**
Capital costs						
earthworks (raising bunds/trench building ect.)	120000+26667		18000	45000		31500
Total Capital Cost	**146667**	**0**	**18000**	**45000**	**0**	**31500**
labour (days)	12	16	12	11	7	7
Return to labour gross income – (variable cost – labour)/labour (kip/day)	17817	31688	4958	32046	6871	27857
Productivity of labour	5.18	4.38	1.42	4.73	1.76	4.29

Farmers evaluation

Indicator	**Before trial**		**After 6 month**		**after one year**		**after 18 month**		**Comments**
Siya and **Nechan** (Ngang sung, Khantabouli)	M	F	M	F	M	F	M	F	11 most important, 1 least important (in second year Nechan used tied ranks)
time spent	5	**2**	1	**1**	1	**5**	1	**4.5**	much less time needed to care for fish than for growing vegetables the routine work load shifted from Siya to Nechan as Siya spent time collecting termites (see labour also)
money invested	3	**1**	5	**5**	2	**7.5**	3	**1.5**	surprised by low investment cost (but money a big issue for Nechan, Siya minimised investment by collecting termites rather than buying rice bran which impressed his wife and changed her view about the investment cost)
labour	2	**4**	8	**4**	3	**7.5**	2	**4.5**	Nechan was surprised by low requirement for labour (Siya and Nechan are the only source of labour (no children or other labour source). Siya complained about the termite collection after the first attempt to culture fish, his wife suggested stopping but he was very keen to continue
location	1	**3**	6	**7**	5	**10.5**	4	**8.5**	During second attempt the paddy dried completely by September (el nino drought) Nechan was therefore concerned about location Siya was less worried about appropriate location as he had saved the fish into a pond (cf Supoom and Pokong)
rice production	6	**7**	9	**6**	9	**7.5**	7	**8.5**	rice production is the central tenant of the farming system
wild fish	7	**5**	3	**2**	4	**7.5**	5	**1.5**	the importance of wild fish has declined as cultured fish has become available
tech knowledge	4	**6**	2	**3**	6	**1**	6	**8.5**	feels more confident about technology after a loss of confidence by Nechan at the start of the second season.
cultured fish production	8	**8**	10	**8**	8	**3**	8	**8.5**	Nechan had some doubts at the onset of the second season but both are now committed to fish as part of their farming system in their words “for ever”
household expenses	9	**10**	7	**9**	7**3**		9**3**		the change in Nechan’s ranking here could not be explained!
household income	10	**11**	4	**11**	10	**3**	10	**8.5**	income is a key issue
consumption	11	**9**	11	**10**	11	**10.5**	11	**8.5**	food security is the key issue

Farmers, men and women separately, were asked to rank the importance of a list of indicators drawn up at the project outset by a workshop involving farmers and District Government staff. Ranking was carried out before and after each trial was undertaken and the resulting matrix was then discussed with farmers. Principal male householder is shown in light type and principal female householder in **bold** type.

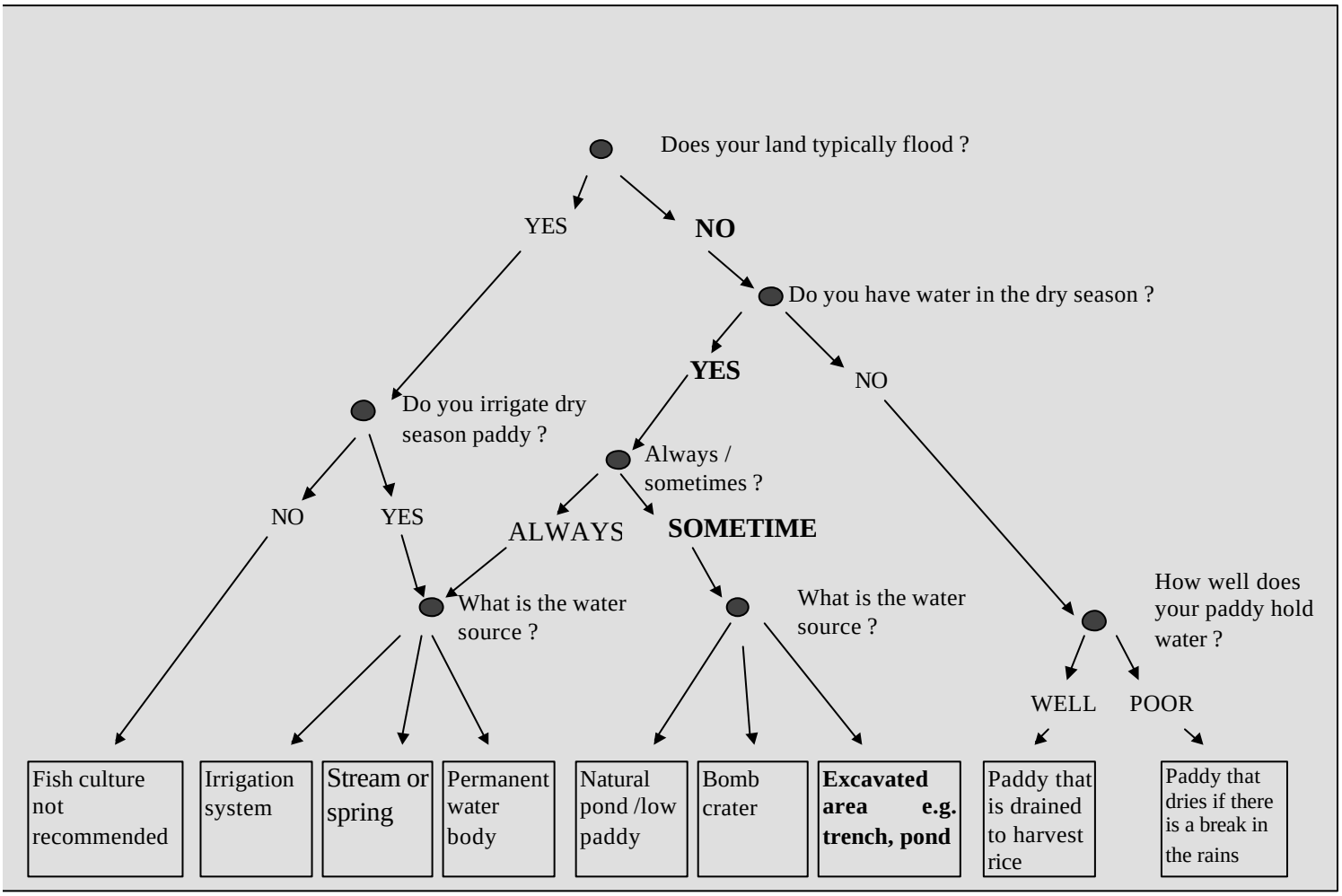
Indicator	**before trial**		**after 6 month**		**after one year**		**after 18 month**		**Comments**
Supoom and **Pokong** (Ngang sung, Khantabouli)	M	F	M	F	M	F	M	F	11 most important, 1 least important (in second year Pokong (with Mrs Nouna used tied ranks)
time spent	4	**4**	1	**1**	1	**8**	2	**2.5**	The couple said much less time needed to care for fish than for growing vegetables. The routine work load shifted from Supoom to Pokang in the second season as Supoom spent time with new maize crop they were trying as maize price was high.
money invested	2	**1**	7	**7**	2	**10**	1	**5**	Supoom converted 5 smaller paddies into 2 larger ones for rice fish in the first season. Pokang (asked about high response in column 3) is referring to overall investment in a house for her son - 40 kg of fish from the paddy supported the labour cost of the building.
labour	5	**2**	4	**4**	4	**10**	3	**2.5**	labour for fish is considered much lower than for vegetables. Pokang is referring to overall labour for a house for her son
location	3	**3**	2	**2**	3	**10**	4	**7.5**	During second attempt the paddy dried completely by August (el nino drought conditions) fish were caught and put into pond Pokang is concerned about appropriate location (Supoom thinks that location is good next to pond for this reason)
rice production	6	**6**	3	**3**	7	**6.5**	8	**10**	Supoom sees himself as first and formost a rice farmer, they produced 2t/ha first year with fish and 2.5t the second year
wild fish	7	**7**	6	**6**	5	**5**	5	**6**	the importance of wild fish for Supoom and Pokang has declined as cultured fish has become available
tech knowledge	1	**5**	8	**8**	6	**2.5**	6	**7.5**	feels more confident about technology after a loss of confidence by Pokang at the start of the second season.
cultured fish production	8	**8**	9	**9**	9	**2.5**	7	**10**	Pokang had some doubts at the onset of the second season due to poor rains but both are now committed to fish as part of their farming system.
household expenses	9	**10**	10	**10**	8	**2.5**	9	**2.5**	Supoom reflects on a very expensive period, Pokang when asked about her low resposes said she is seeking to minimise expenditure after the wedding.
household income	11	**11**	11	**11**	10	**2.5**	10	**10**	income is a key issue low point re wedding
consumption	10	**9**	5	**5**	11	**6.5**	11	**2.5**	food security is the key issue

Indicator	**before trial**	**after 6 month**	**Comments**
Somboon and **Nouna** (Ngang sung, Khantabouli)			11 most important, 1 least important (in second year Nechan used tied ranks)
time spent	**11**	**4**	much less time needed to care for fish
money invested	**3**	**3**	low investment cost
labour	**10**	**7**	Less labour than expected but little time to give to new venture
location	**2**	**6**	All fish stolen from location remote from house in b. Xok
rice production	**9**	**1**	rice production a key issue in June finished in December
wild fish	**6**	**5**	the importance of wild fish has declined as cultured fish has become available
tech knowledge	**8**	**8**	Valued highly
cultured fish production	**7**	**11**	Mrs Nouna has been closely involved with managing the trials, believes fish culture increasingly important
household expenses	**4**	**10**	Expenses increased (especially felt because fish stolen)
household income	**5**	**9**	income has increased
Consumption	**1**	**2**	food security is not a key issue for this surplus family

Indicator	**before trial**		**After 6 month**		**Comments**
Luan and **Sithong** (Nanokien, Atsphangtong)					11 most important, 1 least important (in second year Nechan used tied ranks)
time spent	9	**8**	3	**4**	much less time needed to care for fish than expected
money invested	8	**7**	4	**5**	lower investment cost than expected
labour	10	**9**	6	**1**	Less labour than expected
location	7	**6**	7	**6**	
rice production	3	**3**	11	**7**	rice production a key issue at time of second ranking
wild fish	1	**1**	2	**3**	Wild fish are common in their paddy (unclear why they scored them so low)
tech knowledge	11	**10**	10	**8**	Valued highly
cultured fish production	2	**2**	9	**9**	Now they have cultured fish big rise in importance
household expenses	6	**5**	1	**2**	?
household income	5	**4**	5	**11**	Income has increased
consumption	4	**11**	8	**10**	?

1.2 **Agro-ecosystem 6: Excavated area in paddy**

1 Classification



2 **Summary of Rice-fish system in paddy agro-ecosystem with excavated area**

All tasks are completed by family labour.

GK10 used as irrigated crop (120days) and in rainy season a short variety (120mm) Puntius jump up and eat rice.

Water in excavated area												
Water in paddy												
activity / month	1	2	3	4	5	6	7	8	9	10	11	12
first ploughing												
nursery rice beds												
transplanting rice							GK10					
general care of rice												
harvest rice												
prepare fish nursery												
nursing fry												
releasing fingerlings												
fish feed in the paddies												
harvest fish												
Fish in excavated area												
wild fish enter paddies												
Spawning												
capturing wild fish												

farmers	System selected by family
KAK & LAN (1997)	**Preparatory work**: no work on paddy bunds **Nursing**: Nursed 6 weeks in hapa in bomb crater; hapa rental 5000kip **Inputs**: Seed cost (6000kip on credit); fed rice bran (2kg total), no feeding, initially in paddy, fed last 2 mo. 2kg/day (11600 rice bran), **Labour**: (nursing 42days 30min/day; feeding 40 days 30min/day; seed acquisition=2days; harvesting=2days) 10 days
KAK & LAN (1998)	Preparatory work: no work **Nursing**: Nursed direct in paddy. **Inputs**: Seed (8000kip on credit); fed rice bran fed 2 kg/day (54800kip rice bran) **Labour**: 40days 30min/day nursing plus 137days 30min/day feeding; seed acquisition=2days; harvesting=2days)
TONGDEE AND SEO (1997)	**Preparatory work**: **Nursing:** Nursed in pond added 15 buckets manure during nursing (200x15=3000). **Inputs:** Seed (7500kip on credit) Fed 200-300 termite balls; manure 3000kip **Labour**: 9x1800=16200; (collects 20-30 in 0.5 day i.e. 10 days labour) fed twice daily feeding 30 min/day 137 days (8.56days).
POOM AND SONG (1997)	**Preparatory work** Spent 2 days on paddy prep. for fish, bund repair and water regulation. **Nursing:** Nursed in pond (gets water June) stocked fish small after transplanting rice **Inputs:** Seed (4000kip on credit)added 25 buckets buffalo manure(5000); fed 10kg rice bran (1000); 25 termite balls **Labour:** (collection time2hrs=3-4balls total time 15hr), fed 1-2 times weekly (total time 2.5 days) total labour 2+2+2.5=6.5x1800=11700,
POOM AND SONG (1998)	**Preparatory work:** **Nursing:** Nursed in pond. Stocked in 3 paddys total 3600m^2. **Inputs:** Seed (18000kip). Drought 6.8.98 paddy dried out caught fish added to pond restocked from pond plus 500 sb (4-5cm @ 10kip ea.=5000kip) ; Rice bran daily on dry days (50kg bran 10,000kip); 200 kg manure (40,000kip); urea 50 kg total @ 34000kip, 20 termite balls **Labour:** labour nursing 40 x 30min plus 100 x 30 min feeding, rescue and reseeding (2 days) termite collection (total 20 hrs@4500kip/h=11250kip); seed acquisition 2days; harvesting 2 days

farmers	plan	Stocking	sp	no	Size (cm)	Density/m^2	Harvest	no	size	Wt (kg)	Surv. %	SGRcm/dy	Benift-costs
KAK & LAN	1600m2, 800 sb @0.5/m2	4/8/97	Sb Cc Bh mr	300 600 3 297	11.5 4.75 3 5.5	0.8	28/12/97 (146days)	181 310 3 178	13.4 10.8 30 14.7	9 15.5 2.7 6.13	60 52 100 60	0.11 0.56 1.6 0.67	82500-(11600+ 6000+11025) = 53,875
	3000m2 1500 fish @0.5/m2	12/6/98	Sb Cc Mr til	786 76 64 673	3-6 3-5 4-7 2-7	0.5	19/12/99 (137days)	720 50 56 580	14-15 13-14 16-17 11-12	Total 78	92 66 88 86	0.85 0.89 0.8 0.69	468000- (8000+50000+54800) =355,200
TONGDEE AND SEO	2000m2 2000 sb&cc @ 1/m2	18/7/97	Sb Cc Bh Mr others	200 600 4 166 +500	4 3(+2-3) 7 3.8	0.5(0.8)	2/12/97 (137days)	140 325 160 580	16-20 10-12 10-16 10-15	4.5 13 7 24 8.1(wild)	70 54 100* 100*	1.1 0.95 0.45 0.87	141500-(44700)= 96,800
POOM AND SONG	1600m2 1600 sb,cc,til @1/m2	18/7/97	Sb Cc Bh mr	407 242 5 135	3.7 3 8.1 4.5	0.5	2/12/97 (137days)	365 148 5 123	10-12 10-12 29-30 16-17	12 5 3 12	90 60 100 90	0.84 0.95 0.91 0.95	80000-(21700)= 58,300
	3600m2 3600 sb,cc,til	12.6.98	Sb Cc mr	500 2600 500	1.5-3 2-3 1.5-3	1	16/11/98	451 195 147	12 12 14	Total 120			720000-158250 = 561,750

Agro-ecosystem	6	6	6	6	6
Cost and income estimates	KAK & LAN 97	KAK & LAN 98	TONGDEE AND SEO 97	POOM AND SONG 97	POOM AND SONG 98
Gross income					
Fish Yield (kg)	33.33	78	56.6	33	120
value (Kip/kg)	4000	8000	4000	4000	8000
Gross income	**133320**	**624000**	**226400**	**132000**	**960000**
Variable costs					
seed	6000	8000	7500	4000	18000
organic fertilizer			6000	5000	40000
inorganic fertilizer					34000
feed	11600	54800		1000	10000
labour (nursing, feeding, feed collection, maintenance)	18000	67500	45000	19800	76500
Total	**35600**	**130300**	**58500**	**29800**	**178500**
Gross margin	**97720**	**493700**	**167900**	**102200**	**781500**
Capital costs					
earthworks (raising bunds/trench building ect.)	5000			3600	9000
Total Capital Cost	**5000**	**0**	**0**	**3600**	**9000**
labour (days)	10	15	25	11	17
Return to labour gross income – (variable cost – labour)/labour (kip/day)	11572	37413	8516	11091	50471
Productivity of labour	3.33	5.2	2.26	3	7.06

5 Farmers evaluation

Indicator	**before trial**		**after 6 month**		**after one year**		**after 18 month**		**Comments**
Kak and **Lan** (Xok kang, Khantabouli)	M	F	M	F	M	F	M	F	11 most important, 1 least important (in second year Nechan insisted on tied ranks)
time spent	6	**3**	9	**4**	2	**9.5**	1	**2.5**	much less time needed to care for fish than expected
money invested	1	**7**	8	**2**	1	**9.5**	2	**2.5**	
labour	7	**4**	3	**8**	3	**9.5**	3	**5.5**	labour for fish is considered much lower than for vegetables. Pokang is referring to overall labour for a house for her son
location	11	**2**	7	**6**	10	**6.5**	10	**4**	During second attempt the paddy dried completely by August fish were caught and put into pond Pokang is concerned about appropriate location (Supoom thinks that location is good next to pond for this reason)
rice production	4	**8**	4	**5**	9	**6.5**	9	**10**	Supoom sees himself as first and formost a rice farmer, they produced 2t/ha first year with fish and 2.5t the second year
wild fish	10	**6**	6	**1**	11	**9.5**	11	**1**	the importance of wild fish for Supoom and Pokang has declined as cultured fish has become available
tech knowledge	5	**1**	1	**9**	4	**2**	4	**7.5**	feels more confident about technology after a loss of confidence by Pokang at the start of the second season.
cultured fish production	8	**9**	2	**10**	8	**2**	8	**10**	Pokang had some doubts at the onset of the second season due to poor rains but both are now committed to fish as part of their farming system.
household expenses	3	**5**	5	**7**	7	**5**	7	**8**	Supoom reflects on a very expensive period, Pokang is seeking to minimise expenditure
household income	9	**11**	10	**3**	6	**2**	6	**7.5**	income is a key issue
consumption	2	**10**	11	**11**	5	**4**	5	**10**	food security is the key issue

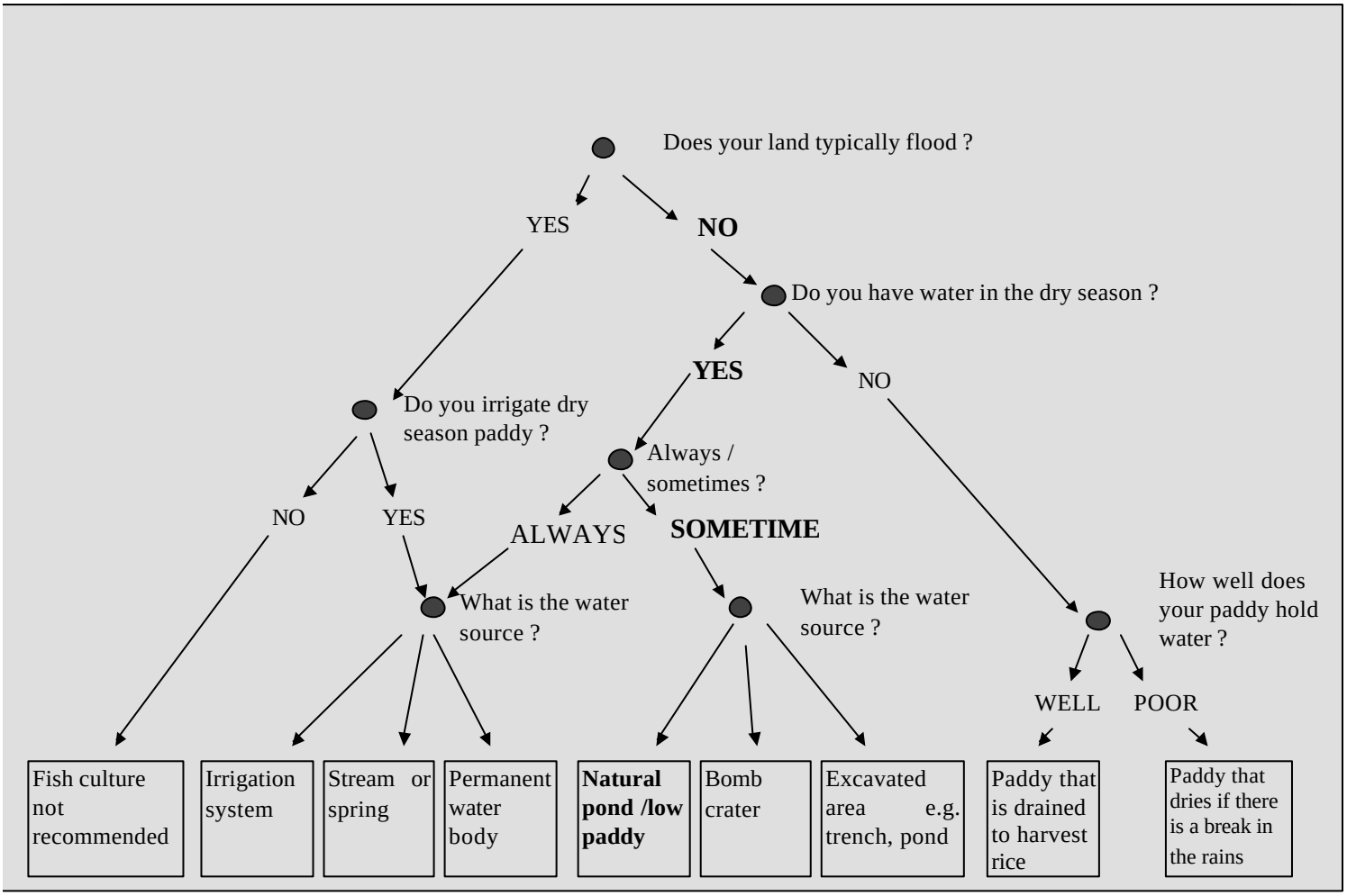
Indicator	**before trial**		**after 6 month**		**Comments**
Tongdee and **Seo** (Ngang sung, Khantabouli)					11 most important, 1 least important (in second year Nechan insisted on tied ranks)
time spent	2	**2**	1	**1**	Had little time, required less time to care for fish than expected
money invested	1	**1**	4	**7**	Tongdee and Seo had no money for inputs. The fish were purchased on credit. Their investment 'after the trial' represents the money paid back at harvest for the fish seed bought on credit.
labour	3	**3**	7	**9**	Labour for fish is considered much lower than for vegetables by the couple. However, their only possible input, termite collection was very time consuming and increased the work load of Tongdee and Seo.
location	4	**4**	11	**8**	Togdee and Seo came to realise the importance of the proximity of pond and paddy for success. They stayed by the stocked paddy. A neighbouring plot (Mrs Nuonar who lived in the Xoh village had all her fish stolen)
rice production	6	**6**	6	**3**	Tongdee and Seo harvested 1.5t/ha rice from their 0.2ha plot
wild fish	7	**7**	3	**4**	the importance (collection - fishing time) of wild fish for Tongdee and Seo has declined as cultured fish has become available.
tech knowledge	5	**5**	2	**2**	both said they feel more confident about technology.
cultured fish production	9	**8**	5	**5**	Transplanting/harveting rice conflicts with time for searching for food cultured fish very important at this time (i.e. prior to the trial)
household expenses	8	**9**	8	**6**	Seo deals with household expenses. (The pre-trial period happens to be a difficult time of the year)
household income	11	**11**	9	**10**	income is a key issue Tongdee and Sea are perhaps the poorest farmers associated with the project.
consumption	10	**10**	10	**11**	food security is the key issue

*Tongdee and Seo migrated to a larger rice plot inherited from Tongdee's father and left the trial, they planned to continue with fish in rice , Tongdee felt that the termites were a poor source of food for fish but he saw no other entry point in the near term.

Indicator	**before trial**		**after 6 month**		**after one year**		**after 18 month**		**Comments**
Poom and **Song** (Ngang sung, Khantabouli)	M	F	M	F	M	F	M	F	11 most important, 1 least important (in second year Song used tied ranks)
time spent	3	**4**	1	**1**	4	**7.5**	1	**3.5**	little time needed to care for fish. Family have attempted maize during second season the routine work load for fish has shifted to Song. Time has become more short due to attention to maize crop.
money invested	2	**1**	4	**5**	2	**7.5**	2	**1**	surprised by low investment cost (investment in yr 2 a bigger issue for Song cf. Most other cases!)
labour	4	**2**	11	**9**	3	**7.5**	4	**3.5**	Poom and Song dug a pond in their paddy at the end of first season. They will have 6 persons now daughter and son-in-law are moving back in - more labour more food needs.
location	1	**3**	6	**8**	1	**10.5**	3	**9**	During second attempt the paddy dried completely by August (el nino) (Songs rank reflects concerned about appropriate location/ Poom feels he has no more worries about location now he has a pond in his paddy)
rice production	6	**5**	5	**6**	7	**7.5**	7	**9**	rice production is the central tenant of the farming system adding fish to the system has improved rice production says Poom (1.4t/ha up from 0.99-1.24t/ha)
wild fish	7	**7**	3	**3**	6	**10.5**	5	**3.5**	the importance of wild fish has declined as cultured fish has become available. Song was relying on wild fish when their family size increased to 6 at beginning of this season before cultured fish were available at the right size.
tech knowledge	5	**6**	2	**2**	5	**1**	8	**7.5**	Poom and Song are very interested in fish habits and take a lot of note about the rice field environment they feel their technical knowledge has grown.
cultured fish production	8	**8**	7	**5**	8	**2**	8	**7.5**	Song had problems at the onset of the second season getting fish to eat but both are now committed to fish as part of their farming system. This family see fish as for their own consumption not for sale. The pond in the paddy is related to a strategy for holding fish for consumption during rice transplanting and the difficulty of getting food at this time especially time for collection.
household expenses	10	**9**	9	**7**	10	**3.5**	9	**3.5**	Song explained that expenses, income and consumption were all low at the start of this season.
household income	11	**11**	8	**10**	9	**5**	10	**9**	income is a key issue
consumption	9	**10**	10	**11**	11	**3.5**	11	**6**	food security is the key issue. Song had problems providing food for all at the start of this season. This is now improved due to cultured fish (fish are grown by Poom and Song just for consumption not sale.

1.4 Agro-ecosystem 4: Natural low-lying area in paddy

1 Classification



2 Summary of Rice-fish system in paddy agro-ecosystem with excavated area

Water in lowlying area												
Water in paddy												
Activity / month	1	2	3	4	5	6	7	8	9	10	11	12
first ploughing Nursery rice beds (up to 45days) Transplanting rice General care of rice Harvest rice								TDK				
Prepare fish nursery **Nursing fry (5 weeks)** **Releasing fingerlings (14DAT)** fish feed in the paddies **Harvest fish** **Fish in lowlying area**												
wild fish enter paddies Spawning Capturing wild fish												

All tasks are completed by family labour.
GK10 used as irrigated crop (120days) and in rainy season a short variety (120mm) Puntius jump up and eat rice.

Farmers	System selected by family
Nuang(1997)	**Preparatory work**: converted 8 small paddys into one and raised 300 m of outer paddy bunds from 20 to 40 cm creating a 30cm wide 30 cm deep trench next to bund . Used family labour 6 people x 3 days. **Nursing**: Nursed 3 weeks in depression in paddy, 10 kg rice bran **Inputs**: Seed cost (15000kip on credit); 25 termite balls (urea application 21 DAT as always for rice) **Labour**: (Preparation 18 days; nursing 21days 30min/day; termite collection 20hrs; feeding 92 days 30min/day; seed acquisition 2days; harvesting 2days) 32 days
(1998)	**Preparatory work**: deepened depression with a back hoe 33m^3 (40,000kip) **Nursing**: 3 weeks in depresion in paddy, 10 kg rice bran **Inputs**: Seed (5000kip); Rice bran 10kg;; 35 termite balls **Labour**: (21 days 30min/day; feeding 56 days 30min/day; termite collection 30 hrs, seed acquisition 2days; harvesting 2days) 13days
Neuporn	**Preparatory work**: **Nursing:** Nursed in hapa in Nuangs paddy depression after 1st rains **Inputs:** Seed (7500kip on credit) Fed 20-30 termite balls; manure 3000kip, 2 kg rice bran 1st week only. **Labour**: (Nursing 21 x 30 min; feeding 128 x 30min; termite collection 30hrs seed acquisition 2days; harvesting 2days) 13days
Sukjalern	**Preparatory work:** Improved paddy bunds **Nursing:** seed lost 9 days after stocking **Inputs:** Seed (5000kip on credit) **Labour:**

4 Evaluation of fish production

Farmers	plan	Stocking	sp	no	Size (cm)	Density/m^2	Harvest	no	size	Wt (kg)	Surv.%	SGRcm/dy	Benift-costs
NUANG AND KAMSAI	3000m2, 3000 sb+Cc @ 1/m2	4/8/97	Sb Cc	2000 1000	7 7	1	24/11/97 (92days)	196 306	16 20	24 51 35 (wild)	10 31	0.9 1.14	
	3000m2 1000 fish @0.3/m2	1/9/98	Sb Mr	200 800	4-5 4-5	0.3	25/10/99 (54days)	171 667	15-17 12-13	Total 32 2 (wild)	86 83	2.35 1.9	
NEUPON AND DOWAN	3000m2 2500 sb,cc,t Sc@ 0.8/m2	9/8/97	Sb Cc Sc	1000 1000 500	7 7 7	0.8	15/12/98 (128days)	225 230 189	14 15 17	23 25 21	23 23 38	0.54 0.6 0.7	
SUKJELEM AND	2000m2 1000 sb&cc @ 0.5/m2	6/897	Sb Cc	700 300	7 7	0.5	Paddy flooded 15.8.97				0		

Agro-ecosystem	4	4	4	4
Cost and income estimates	NUANG & KAMSAI 97	NUANG & KAMSAI 98	NEUPON AND DOWAN 97	SUKJALERN 97
Gross income				
Fish Yield (kg)	110	34	69	0
Value (Kip/kg)	4000	7000	4000	
Gross income	**440000**	**238000**	**276000**	**0**
Variable costs				
Seed	15000	5000	7500	5000
Organic fertilizer			3000	
Inorganic fertilizer				
Feed		4000		
Labour (nursing, feeding, feed collection, maintenance)	25200	58500	23400	3600
Total	**40200**	**67500**	**33900**	**8600**
Gross margin	**399800**	**170500**	**242100**	**-8600**
Capital costs				
Earthworks (raising bunds/trench building ect.)	32400	40000	7200	3600
Total Capital Cost	**32400**	**40000**	**7200**	**3600**
Labour (days)	14	13	13	
Return to labour gross income – (variable cost – labour)/labour (kip/day)	30357	17615	20426	-5000
Productivity of labour	7.86	2.6	5.3	0

5 Farmers evaluation

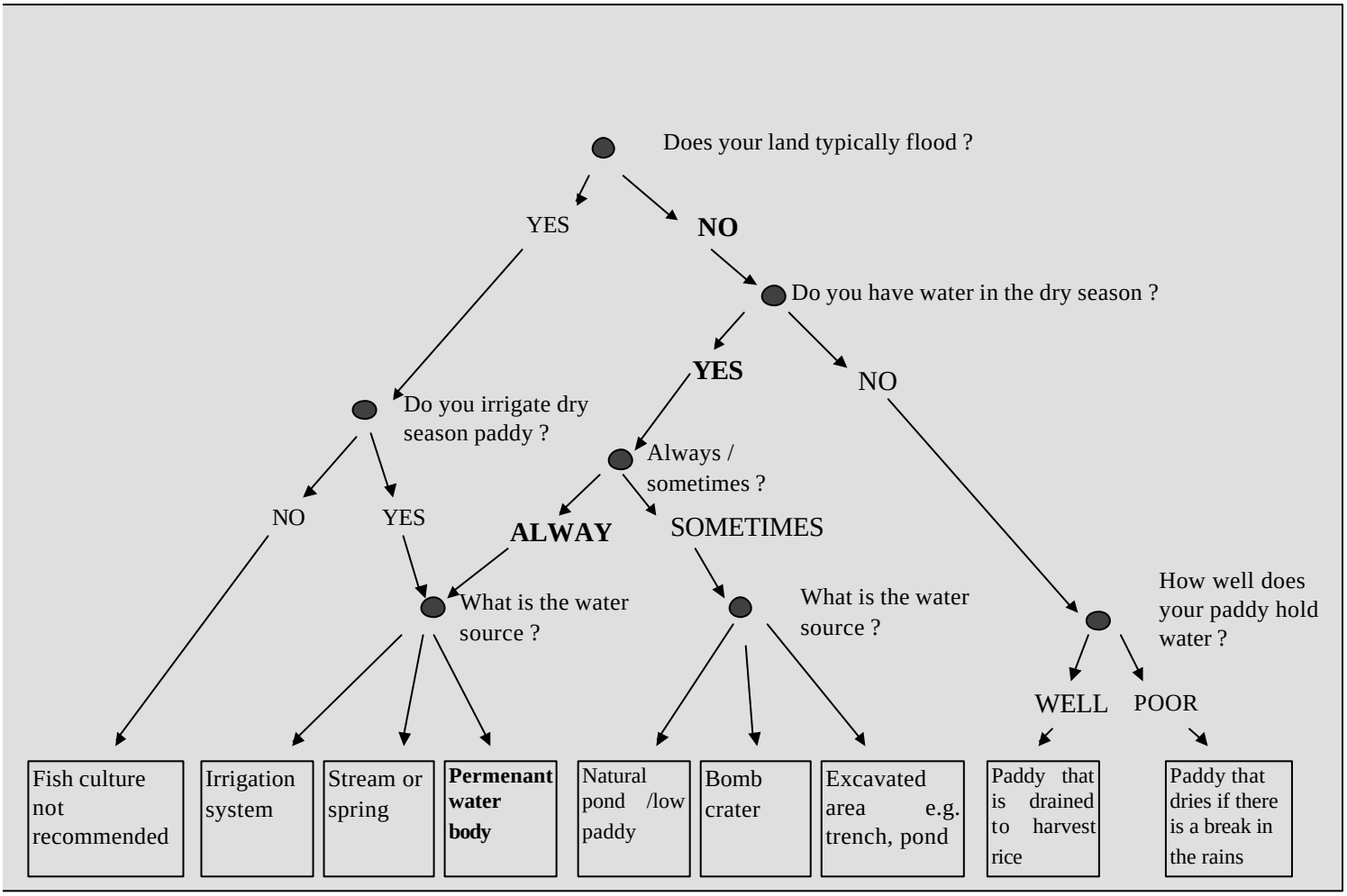
Indicator	**before trial**		**after 6 month**		**Comments**
NEUPON AND **DOWAN** (Lienxai, Atsphangtong)					11 most important, 1 least important
time spent	8	**7**	1	**2**	much less time needed to care for fish than expected
money invested	10	**8**	6	**4**	Lower investment then expected
labour	7	**9**	3	**3**	labour for fish is much lower than expected. Dowan nursed the fish
location	9	**1**	4	**5**	Location was a concern for Neupon but his choice proved well made. Dowan didn't chose the location.
rice production	2	**2**	11	**9**	Rice harvest is at the time of the 2nd evaluation!
wild fish	1	**3**	1	**6**	The importance of wild fish is low for Neupon they do not infiltrate their paddy. Dowan purchases wild fish sometimes
tech knowledge	11	**10**	7	**1**	Technical knowledge was a key concern before the trial
cultured fish production	6	**6**	10	**8**	The importance of cultured fish has increased
household expenses	5	**4**	8	**7**	Household expenditure has increased
household income	4	**5**	9	**11**	Household income has increased
consumption	3	**11**	2	**10**	food security is the key issue for Dowan

The family did not add fish to their system in the second year. Mr Neupon became very ill and the family has suffered greatly by this setback. No fish could be nursed in the second year.

Indicator	**before trial**		**after 6 month**		**after one year**		**After 18 month**		**Comments**
NUANG AND **KAMSAI** (Lienxai, Atsphangtong)									11 most important, 1 least important (in second year Song used tied ranks)
time spent	7	**7**	2	**2**	1	**3**	2	**2**	little time needed to care for fish. If can't stock by August then wouldn't do it (Nuang). Used more time got more production but didn't stop them doing anything else (Kamsai)
money invested	10	**11**	4	**4**	2	**4**	4	**3**	surprised by low investment cost
labour	9	**9**	1	**1**	3	**2**	1	**1**	Nuang and Kamsia spent a lot of effort on paddy preparation.Very little day-to-day attention needed.
location	8	**8**	5	**5**	4	**5**	5	**4**	Nuang and Kamsia prepared the paddy very well for adding fish they also dug a pond in their paddy at the end of first season (a key improvement)During second attempt the growing season was reduced by dry conditions
rice production	3	**3**	11	**6**	9	**6**	10	**10**	rice production has improved the best production is the paddys with fish. Nuang says (2.25t/ha up from 1.5t/ha)
wild fish	2	**4**	6	**7**	6	**1**	3	**5**	the importance of wild fish has declined as cultured fish has become available.
tech knowledge	11	**10**	7	**11**	7	**7**	6	**11**	As "pioneers" setting up a new village Kamsai and Nuang value knowledge about all else in decision making.
cultured fish production	4	**5**	10	**10**	5	**8**	7	**8**	Nuang and Kamsia were very successful in year 1 in year 2 less seed was available and less water.
household expenses	1	**1**	3	**3**	10	**9**	9	**6**	Both suggested expenses have increased as they develop their system
household income	6	**6**	9	**9**	11	**11**	8	**7**	income has increased as rice production has increased and fish has been added
consumption	5	**2**	8	**8**	8	**10**	11	**9**	food security is the key issue. Rice and fish production has impacted on this.

1.5 Agro-ecosystem 3: Paddy with permanent water resource

1 Classification



2 Summary of Rice-fish system in paddy agro-ecosystem with permanent water body

Water in permanent pond												
Water in paddy												
Activity / month	1	2	3	4	5	6	7	8	9	10	11	12
Nursery rice beds (up to 45days)												
first ploughing Transplanting rice General care of rice Harvest rice							GK 100					
Prepare fish nursery **Nursing fry (5 weeks)** **Releasing fingerlings (14DAT)** fish feed in the paddies **Fish in pond** **Harvest fish**												
wild fish enter paddies Spawning wild fish leave paddy												

All tasks are completed by family labour.
GK100 used as water can be quite deep

3 Experiments with fish in agro-ecosystem 3

Farmers	System selected by family
Somsi and **Koan** (1997)	**Preparatory work**: surround paddy with blue fine mesh netting 10 man days in August **Inputs**: Rented netting 5 sections at 1000kip/section to surround 1600m2 paddy, cut bamboo, caught fish in stream 3 times in rainy season 1.5-2kg each time for food for wild fish **Labour**: (12 days maintenance 3 days fishing small feed fish) 15 days
(1998)	**Preparatory work**: not much rain no flooding no particular prep. **Nursing**: 6 weeks in pond, 10 kg rice bran **Inputs**: Seed (45,000kip on credit); site below village so fertile no feed or fert. added **Labour**: (nursing 42 days 30min/day; checking 150 days 30min/day; seed acquisition 2days; harvesting 2days) 16 days

* Fishing sold to trader for 90,000

4 Evaluation of fish production

Farmers	plan	Stocking	Sp	no	Size (cm)	Density/m^2	Harvest	no	Size (cm)	Wt (kg)	Surv.%	SGRcm/dy	Benift-costs
Somsi and **Koan**	Trap wild fish												90,000
(1998)	1300m2 1000 Cc,Sb,Mr @<1/m2	12/6/98	Sb Cc Mr	300 1000 300	1.5-3 2-3 1.5-3	1	8/9/98 20/9/98 15/10/98 2/3/99		 17 75 73	9 10 9 5 10 10 40 (wild)		 0.75 1.26 1.3	651,000 (so far)

Agro-ecosystem	3	3
Cost and income estimates	Somsi and Koan 97	Somsi and Koan 98
Gross income		
Fish Yield (kg)		19 (9.98) 9 (10.98) 65 (3.99) total 93
value (Kip/kg)		7000(9.98) 7000 (910.98) 12000 (3.99)
Gross income *	**90000**	**976000**
Variable costs		
seed		45000
organic fertilizer		
inorganic fertilizer		
feed		2000
labour (nursing, feeding, feed collection, maintenance)	27000	72000
Total	**27000**	**119000**
Gross margin	**63000**	**857000**
Capital costs		
Hiring netting cutting bamboo, constructing fence	18000+5000	
Total Capital Cost	**23000**	**0**
labour (days)	15	16
Return to labour gross income – (variable cost – labour)/labour (kip/day)	6000	58063
Productivity of labour	-	5.81

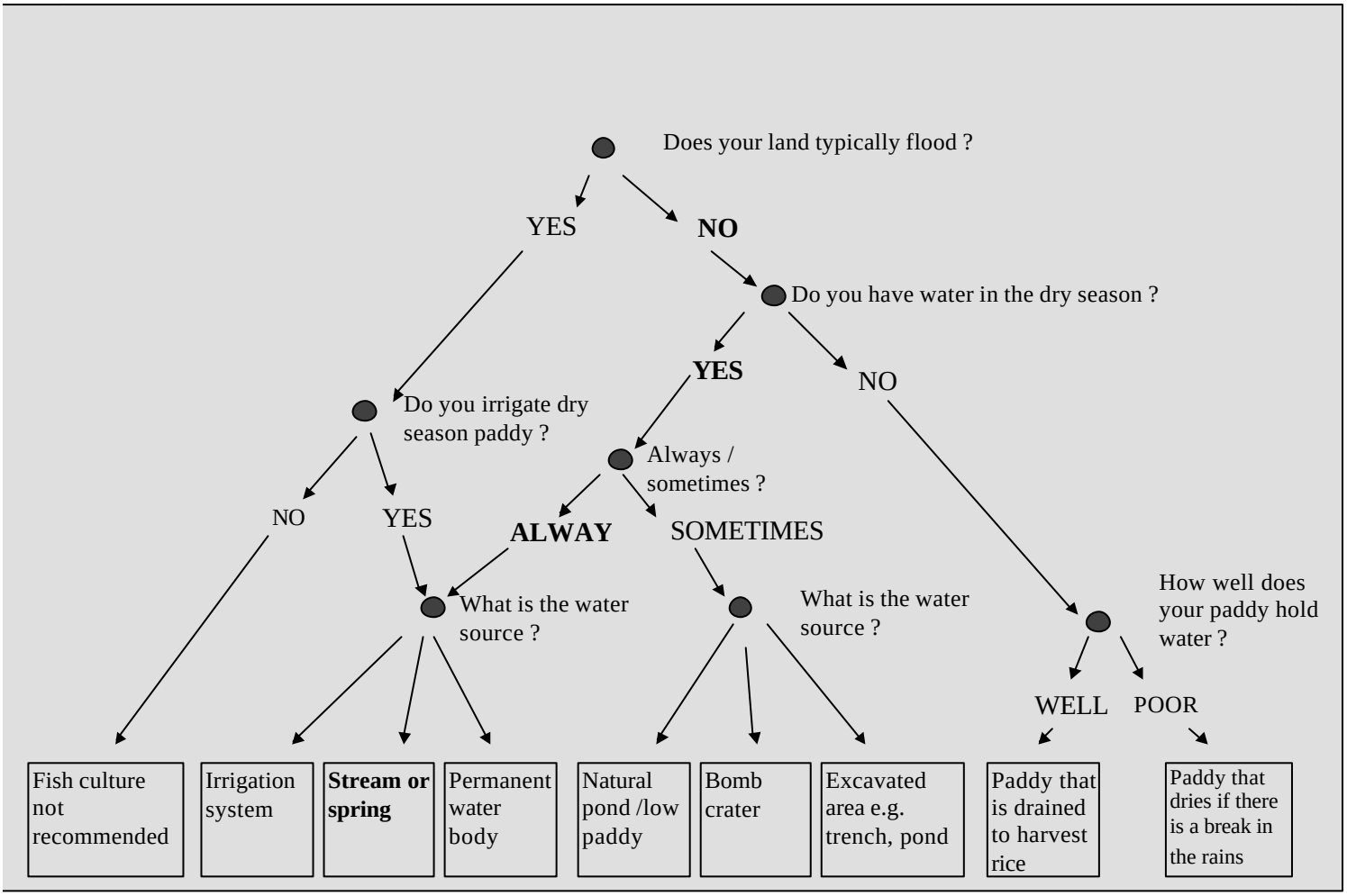
* sold fishing to trader for 90,000kip

Farmers evaluation

Indicator	**before trial**		**after 6 month**		**after one year**		**after 18 month**		**Comments**
Somsi and **Koan** (Ngang sung, Khantabouli)	M	F	M	F	M	F	M	F	11 most important, 1 least important (in second year Song used tied ranks)
time spent	4	**4**	1	**1**	1	**10**	1	**3**	Koan perceives a lot of time needed for culture of fish, Somsi believes the opposite. This is related to the length of time Somsi is away from the small retail outlet the couple operate at their house (highlighted by Koan) compared to the length of time it actually take Somsi to tend the fish each a.m. and p.m. (he chats and doesn't hurry back !)
money invested	2	**2**	3	**3**	2	**10**	6	**3**	Koan perceives low investment cost for wildfish capture system, higher for culture system Somsi disagrees. Koan was resistant to investment in culture in yr 2 in terms of time and money required before but changed her view when it became clear that the investment in cash was not so high.
labour	3	**3**	6	**6**	4	**10**	2	**9**	Koan perceives the culture system to be much more labour intensive than wildfish capture system Somsi disagrees. (Somsi could spend less time at the paddy)
location	1	**1**	4	**4**	3	**4.5**	5	**3**	Somsi and Koan have a good pond-paddy system in a fertile location below the village. They therefore pay little attention to location
rice production	7	**7**	7	**7**	8	**4.5**	8	**9**	
wild fish	6	**8**	5	**5**	6	**8**	3	**1**	the importance of wild fish has declined as cultured fish has become available.
tech knowledge	5	**5**	2	**2**	5	**2**	4	**9**	Somsi new there were wild fish in his paddy/pond and elected to fence them in and feed. They employed a fisherman to fish the paddy/pond and agreed a price in advance which proved a good deal for the couple. After harvesting all last year they then stocked fish. Koan highlights the increased knowledge requirement related to culture vs capture.
cultured fish production	9	**9**	8	**8**	9	**2**	9	**9**	Koan had problems at the onset of the second season getting fish to eat (as availability was low and the paddy/pond was empty of big fish) but both say they are now committed to fish as part of their farming system. (Men and women in general appear to have perceived this differently, men had faith that the fish were growing, women had no fish to feed people!)
household expenses	8	**6**	11	**11**	9	**4.5**	9	**5**	Koan and Somsai explained that rains were delayed expenses, income and consumption were all low at the start of the second season. This appeared to impact especially on Koan.
household income	11	**11**	10	**10**	10	**2**	10	**6**	income is a key issue. Before the second trial, without rains household income was very low. (Koan and Somsi sell goods and now fish in a small retail outlet at the base of their house).
consumption	10	**10**	9	**9**	11	**4.5**	11	**9**	food security is the key issue. Koan had problems providing food before the rains. (Koan and Somsi provided 25kg of fish from their paddy for their nephews wedding)

1.5 Agro-ecosystem 2: Paddy that is irrigated by spring

1 Classification



2 Summary of Rice-fish system in paddy agro-ecosystem that is irrigated by spring

Water in paddy												
Activity / month	1	2	3	4	5	6	7	8	9	10	11	12
Nursery rice beds												
Transplanting rice General care of rice Harvest rice	GK10							GK10				
Prepare fish nursery **Nursing fry (between rice crops)** fish feed in the paddies **Harvest fish**												

All tasks are completed by family labour.
GK10 wet season and used as irrigated crop. Fish seed available for dry season nursing in paddy between rice crop.

Farmers	System selected by family
Pome and **Chan** (1997)	**Preparatory work**: 2 days **Nursing**: in paddy as trial **Inputs**: Seed (22060 fry) ; feeding rice bran (A & D) 20 kg rice bran (2000kip) **Labour**: Feeding 29 x 30 min; seed acquisition 2 days; harvesting 2 days
	Preparatory work: 2 days **Nursing**: in paddy as trial **Inputs**: Seed (11900 fry); no feeding (B & C) **Labour**: checking 30 min x 29 days; seed acquisition 2 days; harvesting 2 days
summary	
(1997)	**Preparatory work**: none **Nursing**: nursed in paddy **Inputs**: Seed (2800kip); 1 kg rice bran/day **Labour**: (Nursing 40 days x 30 min; feeding 73 x 30 min; seed collection 2 days; harvesting 2 days) 11 days

4 Evaluation of fish production

Farmers	plan	Stocking	Sp	no	Size (cm)	Density/m^2	Harvest	no	size	Wt (kg)	Surv.%	SGRcm/dy	Benift-costs
Pome and **Chan** (1997) A	450m2, 13830 sb,cc,til @ 20/m2	6/5/97	Sb Cc til	6160 6720 950	2.3 2.3 2.3	31	4/6/97 (29days)*		3.5 4.1 5.7			1.45 1.99 3.13	
B	230m2, 5510 sb,cc,til @ 20/m2	6/5/97	Sb Cc Til	2640 1920 950	2.3 2.3 2.3	24	4/6/97 (29days)*		3.8 3.4 5.3			1.73 1.35 2.88	
C	240m2, 6390 sb,cc,til @ 20/m2	6/5/97	Sb Cc til	3520 1920 950	2.3 2.3 2.3	27	4/6/97 (29days)*		4.3 3.5 5.4			2.16 1.45 2.94	
D	216m2, 8230 sb,cc,til @ 20/m2	6/5/97	Sb Cc til	4400 2880 950	2.3 2.3 2.3	38	4/6/97 (29days)*		4.0 3.4			1.9 1.35	
Nursing				43900	2.3			8366			19		119100-(219500+8900)= -109300
Pome and **Chan** (1997)	400m2	28/8/97	Sb	200	10	0.5	15/10/97 (73 days)	200	18-20	8	100	0.88	

* interim data fish sold 6.6.97 then paddy flooded out 16.6.97

Agro-ecosystem	2	2
Cost and income estimates	Pome & Chan 97	Pome & Chan 97
Gross income		
Fish Yield (kg unless otherwise indicated)	8366 fingerlings*	8
value (Kip)		4000
Gross income	**119100**	**32000**
Variable costs		
seed	219500	2800
organic fertilizer		
inorganic fertilizer		
feed	2000	7300
labour (nursing, feeding, feed collection, maintenance)	10800	19800
Total	**232300**	
Gross margin	**-113200**	**29900**
Capital costs		
Hiring netting cutting bamboo, constructing fence	3600	0
Total Capital Cost	**7200**	**0**
labour (days)	6	11
Return to labour gross income – (variable cost – labour)/labour (kip/day)	-17067	4518
Productivity of labour (unless stated otherwise)	1394 fingerlings / day	0.73

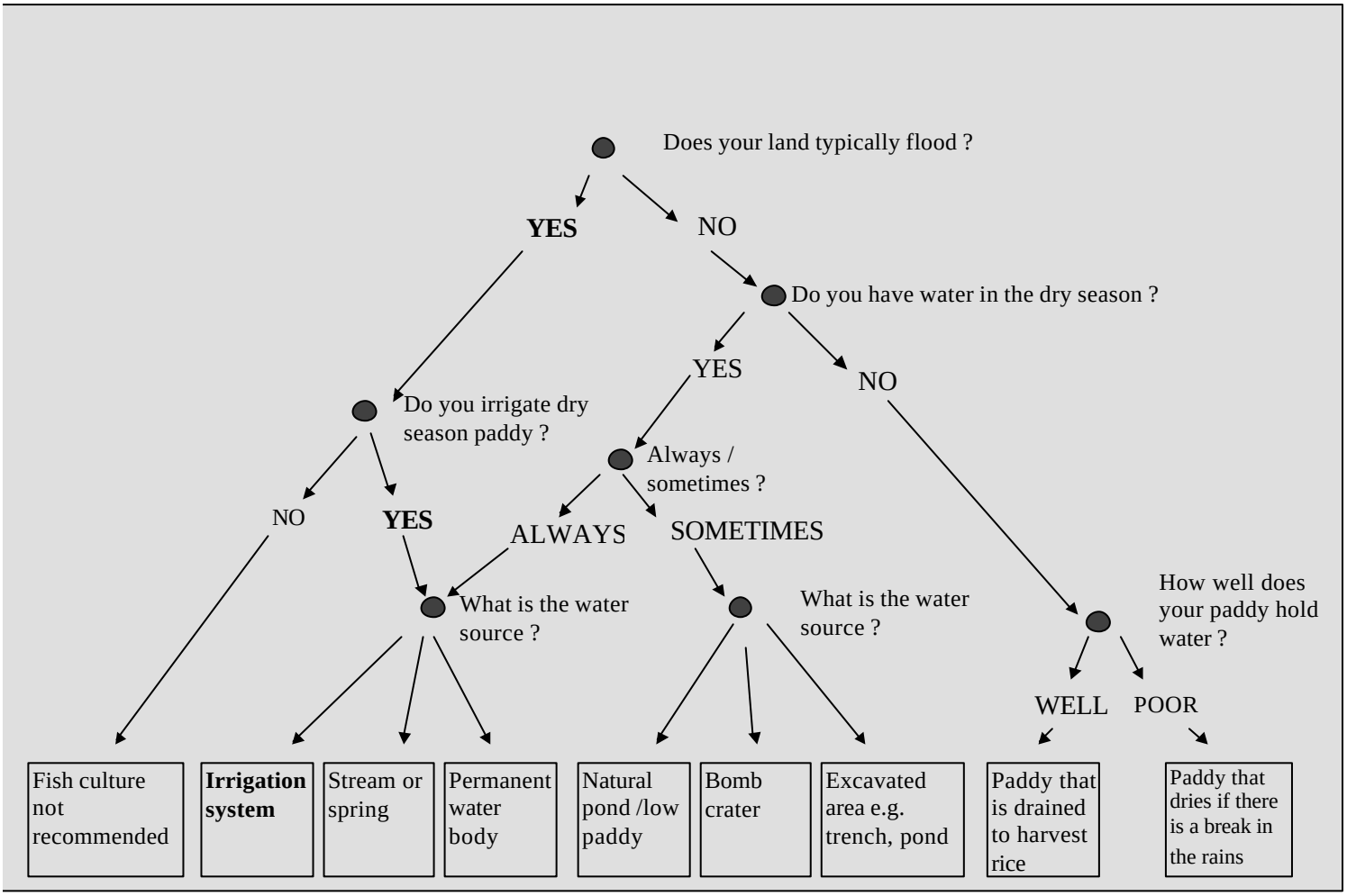
* fish lost in a flood and many sold but unrecorded (this was the first trial) M&E was poor trust between L&F staff and farmer less good

5 Farmers evaluation

Indicator	**before trial**		**after 6 month**		**Comments**
Pome and **Chan** (Xok kang, Khantabouli)					11 most important, 1 least important (in second year Nechan insisted on tied ranks)
time spent	5	**11**	1	**1**	much less time needed to care for fish than expected
money invested	2	**2**	2	**3**	
labour	3	**4**	3	**8**	acquiring fish at time of transplanting rice is difficult this is a labour bottleneck
location	1	**1**	11	**11**	Flooding was a problem in June though Pome and Chan have never known this paddy to flood before!
rice production	6	**9**	4	**9**	Rice production improved. Pome sometimes used to let paddy dry out but with fish he was more vigilant about water level.
wild fish	7	**6**	5	**8**	
tech knowledge	10	**10**	6	**6**	feels more confident about technology
cultured fish production	8	**4**	7	**5**	
household expenses	9	**7**	9	**10**	
household income	11	**8**	8	**4**	income is a key issue
consumption	4	**5**	10	**7**	food security is the key issue

1.6 Agro-ecosystem 1: Paddy that is irrigated

1 Classification



2 Summary of Rice-fish system in paddy agro-ecosystem that is irrigated

Water in paddy												
Activity / month	1	2	3	4	5	6	7	8	9	10	11	12
Nursery rice beds (up to 45days)												
first ploughing												
Transplanting rice												
General care of rice								GK10				TDK
Harvest rice												
Prepare fish nursery												
Nursing fry (in bomb crater)												
fish feed in the paddies												
Harvest fish												

All tasks are completed by family labour.
GK10 wet season TDK used as irrigated crop. Note no fish seed available for dry season rice. Fish left in bomb crater and stocked late because of dam overtopping.

Farmers	System selected by family
Boon My and **Nounta** (1997)	**Preparatory work**: none **Nursing**: in bomb crater **Inputs**: Seed (6000kip); 6 kg rice bran (200g every other day) **Labour**: (Nursing 40 days x 30 min; 20 hr termite collection; feeding 52 x 30 min; seed collection 2 days; harvesting 2 days) 11 days
(1998)	**Preparatory work**: none **Nursing**: in bomb crater **Inputs**: Seed (4900kip private supplier); 20 termite balls, 10 kg rice bran; 2 kg rice (after fermentation for Lao Lao) **Labour**: (Nursing 40 days x 30 min; 20 hr termite collection; feeding 52 x 30 min; seed collection 2 days; harvesting 2 days) 11 days
Ang and **Phong** (1997)	**Preparatory work**: none **Nursing**: in bomb crater **Inputs**: Seed (2000kip) **Labour**: : (Nursing 40 days x 30 min; seed collection 2 days) 4.5 days
Boonyoke and **Pousa** (1997)	**Preparatory work**: none **Nursing**: in bomb crater **Inputs**: Seed (8000kip) **Labour**: (Nursing 40 days x 30 min; seed collection 2 days) 4.5 days

4 Evaluation of fish production

Farmers	plan	Stocking	Sp	no	Size (cm)	Density/m^2	Harvest	no	size	Wt (kg)	Surv.%	SGRcm/dy	Benift-costs
Boon my and **Nounta**	a. 900m2, 900 sb,Cc+til @ 1/m2	8/9/97*	Sb Cc	550 650	3.5 3.5	1.3	8/11/97 (61days)	75** 85**	20 20	8 8	14 13	2.86 2.86	
	b. 1000m2 300 sb, cc, til @0.3/m2												
(1998)	490m2	1/9/98	Cc	490	4-5	1	22/10/98 (52 day)	318	15-17	31	65	2.44	
Ang and **Phong** (1997)	400m2 400 Cc,Sb@1/ m2	9/9/97	Sb Cc	200 200	3.5 3.5	1	Paddy dried up***						
Boon yoke and **Pousa** (1997)	1600m2 1600 Cc and Sb @1/m2	10/9/97	Sb Cc	900 700	3.5 3.5	1	Paddy dried up***						

*dam overtopped 5 times so could stock fish till Sept. water management a problem in Xepon a newly built US$18,000 dam blew out recently the paddys here are almost like a flow through system.
**Unexploded ordinance - so no refuge - so as paddy drained fish stranded in puddles in paddy (not flat) pole cats, snakes and rats got to fish first
*** snakes make holes in paddy banks water lost fish lost

Agro-ecosystem	1	1	1	1
Cost and income estimates	Boon My and Nounta 97	Boon My and Nounta 98	Ang and Phong 97	Boonyoke and Pousa 97
Gross income				
Fish Yield (kg)	16	31	0	0
value (Kip/kg)	4000	7000		
Gross income	**64000**	**217000**	**0**	**0**
Variable costs				
seed	6000	4900	2000	8000
organic fertilizer				
inorganic fertilizer				
feed	600	2000		
labour (nursing, feeding, feed collection, maintenance)	19800	49500	8100	8100
Total	**26400**	**56400**	**10100**	
Gross margin	**37600**	**160600**	**-10100**	**-16100**
Capital costs				
Hiring netting cutting bamboo, constructing fence	0	0	0	0
Total Capital Cost	**0**	**0**	**0**	**0**
labour (days)	11	11	4.5	4.5
Return to labour gross income – (variable cost – labour)/labour (kip/day)	5218	19100	-444	-1778
Productivity of labour	1.46	2.82	0	0

5 Farmers evaluation

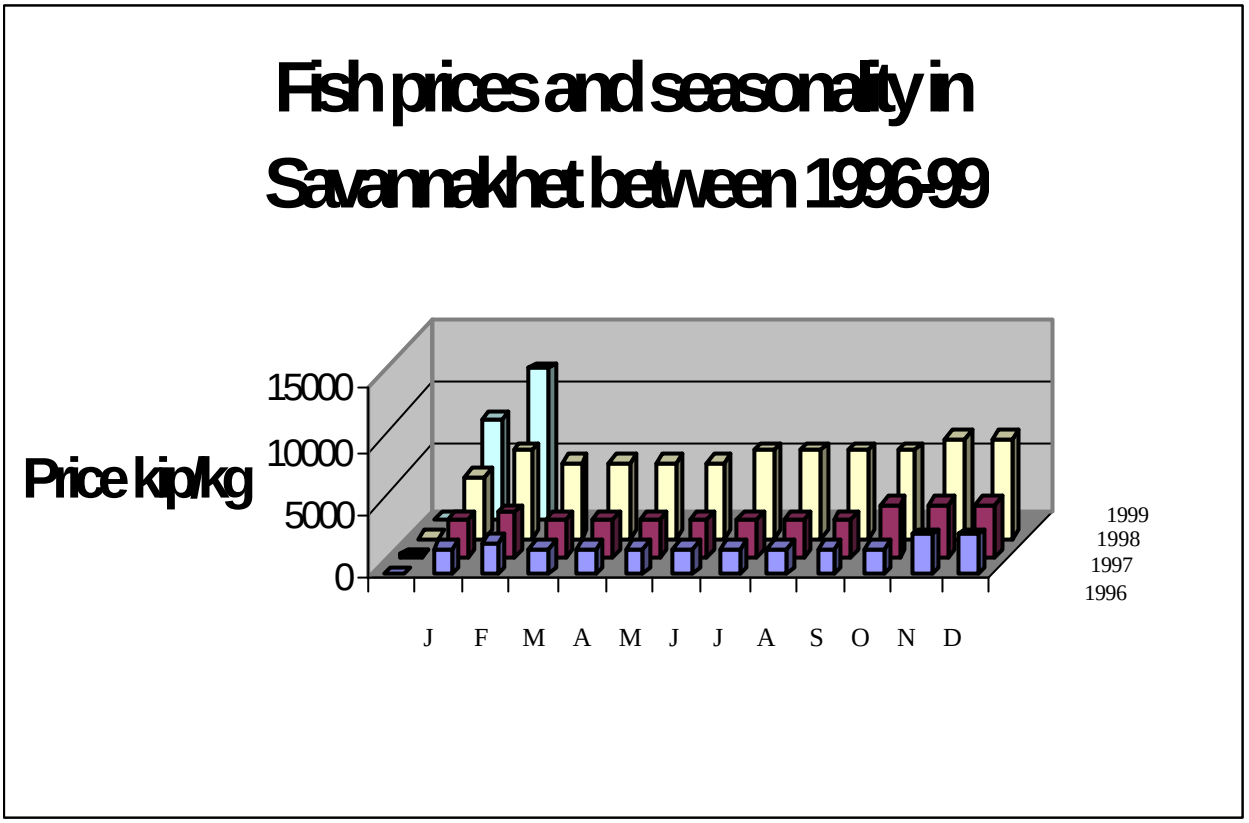
Not done

Appendix II: Wealth ranking

(d= deficit; ss = self-sufficient; s= surplus)

District Village	Farm family		Wealth ranking	
Khantabouli				
Ngang sung	Poom		ss	2 ha paddy, 4 buffalo, self-sufficient in rice
	Siya		ss	1 motor bike, middle-sized house, 2-2.5ha paddy, 4 buffalo, self-sufficient in rice, 2 small pigs
	Somsi		ss	middle-sized house, 4 buffalo; 2 cattle; 2ha paddy; small retail outlet; self-sufficient in rice
	Supome		s	Big house; 3ha paddy; motor bike; rice mill; 6 buffalo, big pig;
	Tongdee		d	Small house; 1ha paddy (moved to 2ha upland by forest inherited from father)
Xok kang	Kak		s	Big house; rice mill; hand tractor; 2ha paddy (gets US$ from wife's mothers sister $300/yr)
	Pome		ss	Motor bike; middle house; 2ha paddy; 2 buffalo; self-sufficient in rice
	Weing		s	Big house; motor bike; hand tractor; rice mill; 2ha paddy close to village; 3 fish ponds; sells coconuts; more than 20 palms; move to Xok first had best choice of land.
	Nouna		s	Small family size; no children possible nephew lives with her, big house; income from weaving; husband head of communication school (160,000gib/mo); jeep and 2 motor bike
Atsphangtong				
Lienxai	Nuang		s	Big house; hand tractor; 4ha rice field close to village, self-sufficient in rice and sells rice
	Neupon		ss	Big house; many children; 2ha poor rice land; 10 cattle, 3 buffalo, self-sufficient in rice
Nanokien	Luan		ss	Old house; 2ha rice; several buffalo, 2-3 cattle (area near forest so everyone has cattle); self-sufficient in rice
	Sukjalem		ss	middle house, 3ha paddy, buffalo and cattle; self-sufficient in rice
Xepon				
Takong	Boon my		ss	1.5ha paddy, 2 seasons of rice, middle house 6 buffalo, some cattle; irrigation reservoir
	Ang		d	Small house; 1.5 ha rice paddy 2 seasons possible but flooding problem
xepon	Boon Yok		ss	1.5ha rice 2 seasons, buffalo, cattle goats

Appendix III: Variation in fish prices and other costs



Notes on other costs

	1997	1998
Fish seed	5kip/ea.	5kip/ea.
Fish	2500kip/kg fish price at Pe mai 7,000kip/kg	6000kip/kg fish price at Pe mai 12,000kip/kg
Blue fine mesh netting	6500kip/30m section 1000kip to rent	13000kip/30m section
Rice bran	100kip/kg	200kip/kg
rice	700kip/kg	1000kip/kg
Daily labour	1800kip/day	4500kip/kg
manure	200kip/15kg	300kip/15kg
urea		34,000kip/50kg
Furadon	1500kip/kg (Thialand)	
Back hoe hire	1200kip/m3	