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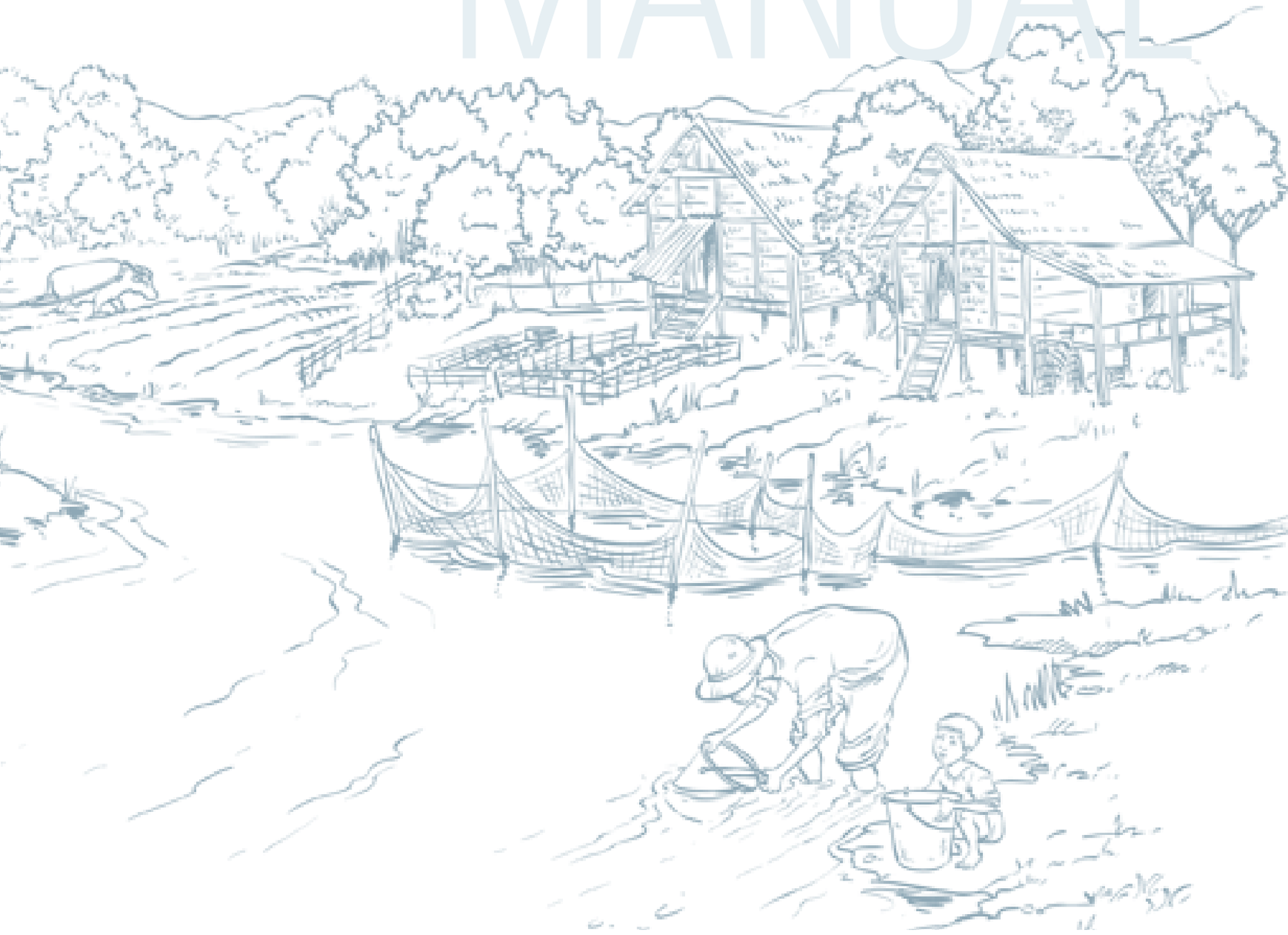
GUIDANCE MANUAL

COMMUNE AGROECOSYSTEMS ANALYSIS IN CAMBODIA



DEPARTMENT OF AGRICULTURAL EXTENSION
MINISTRY OF AGRICULTURE FORESTRY AND FISHERIES, CAMBODIA

IWMI International Water Management Institute

WorldFish CENTER

SOAS University of London

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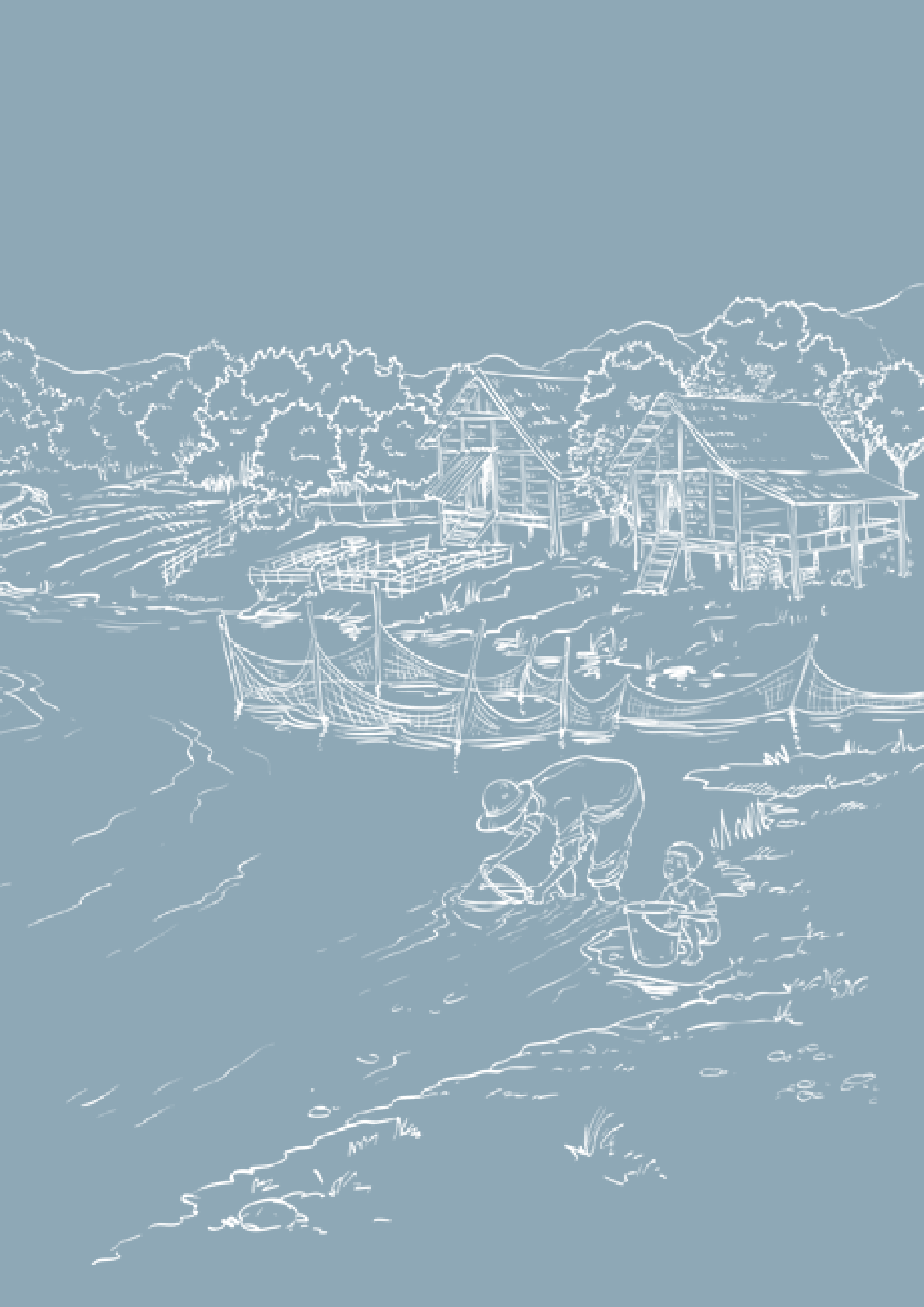

FOREWORD

Commune Agroecosystems Analysis (CAEA) is a participatory analysis methodology used by the Department of Agricultural Extension to identify and prioritize agricultural development needs at the commune level. In 2004, CAEA was officially adopted as the national policy by the Ministry of Agriculture, Forestry and Fisheries (MAFF) for producing Commune Agricultural Plans and since then has been conducted in over 500 communes nationwide. Funding support for CAEA has been provided by MAFF and the Decentralisation and Deconcentration Program (D&D), and by a range of donors including the Australian Agency for International Development (AusAID), the International Fund for Agricultural Development (IFAD), the Japan International Cooperation Agency (JICA), the Asian Development Bank (ADB), the European Commission (EC) and a number of international non-governmental organizations (NGOs).

Cambodian farmers face a number of issues as they experience the rapid transition from subsistence farming to a more market-oriented rural economy. In this context, CAEA is seen by the government as an extremely important tool to help farmers as well as provincial and district agricultural officials in improving the quality of life, ensuring food security and eradicating poverty.

Prior to 2008, CAEA mainly focused on agricultural issues, while problems of the fisheries sector, closely interlinked with agriculture in Cambodia, were not well addressed. CAEA users recognized this weakness and agreed that the water and fisheries components of the methodology needed to be strengthened. In 2008, the Challenge Program on Water and Food (CPWF) of the Consultative Group on International Agricultural Research (CGIAR) provided support for a two-year project to upgrade CAEA with regard to the issues of water and fisheries. This Guidance Manual incorporates the changes and modifications made to CAEA under the CPWF Project

The Ministry of Agriculture, Forestry and Fisheries acknowledges the kind assistance provided by the CPWF, and fully supports and endorses the use of this new Guidance Manual.

Signed and sealed by
H.E. So Khan Rithykun,
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ABBREVIATIONS & ACRONYMS

ADB	Asian Development Bank
AEA	Agroecosystems Analysis
AusAID	Australian Agency for International Development
CAAEP	Cambodia Australia Agricultural Extension Project
CAEA	Commune Agroecosystems Analysis
CAP	Commune Agricultural Plan
CARDI	Cambodian Agricultural Research and Development Institute
CC	Commune Council
CDP	Commune Development Plan
CGIAR	Consultative Group on International Agricultural Research
CIP	Commune Investment Plan
CPWF	Challenge Program on Water and Food
D&D	Decentralisation and Deconcentration Program (formerly Seila)
DAE	Department of Agricultural Extension, Cambodia
DAO	District Agriculture Office
DIW	District Integration Workshop
EC	European Commission
FSEO	Farming Systems and Economics Office [of the DAE]
FSMIS	Farming Systems [Extension] Management Information System
FWUC	Farmer Water User Community
HS	Haemorrhagic Septicaemia
IFAD	International Fund for Agricultural Development
IFReDI	Inland Fisheries Research and Development Institute, Cambodia
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
MAFF	Ministry of Agriculture Forestry and Fisheries, Cambodia
MLMUPC	Ministry of Land Management, Urban Planning and Construction, Cambodia
MOWRAM	Ministry of Water Resources and Meteorology, Cambodia
NCDD	National Committee for Decentralization and Deconcentration, Cambodia
NGO	Non Governmental Organization
NTFP	Non Timber Forest Product
OAE	[Provincial] Office of Agricultural Extension
PBC	Planning and Budgeting Committee [of the CC]
PDA	Provincial Department of Agriculture
PIF	Provincial Investment Fund
QA	Quality Assurance
RGC	Royal Government of Cambodia
RRA	Rapid Rural Appraisal
SME	Small and Medium Enterprise
SLC	Social Land Concession
SMS	Subject Matter Specialist
TIPs	Technology Implementation Procedures
TSC	Technical Suitability Criteria
UNTAC	United Nations Transitional Authority in Cambodia
WorldFish	World Fish Center

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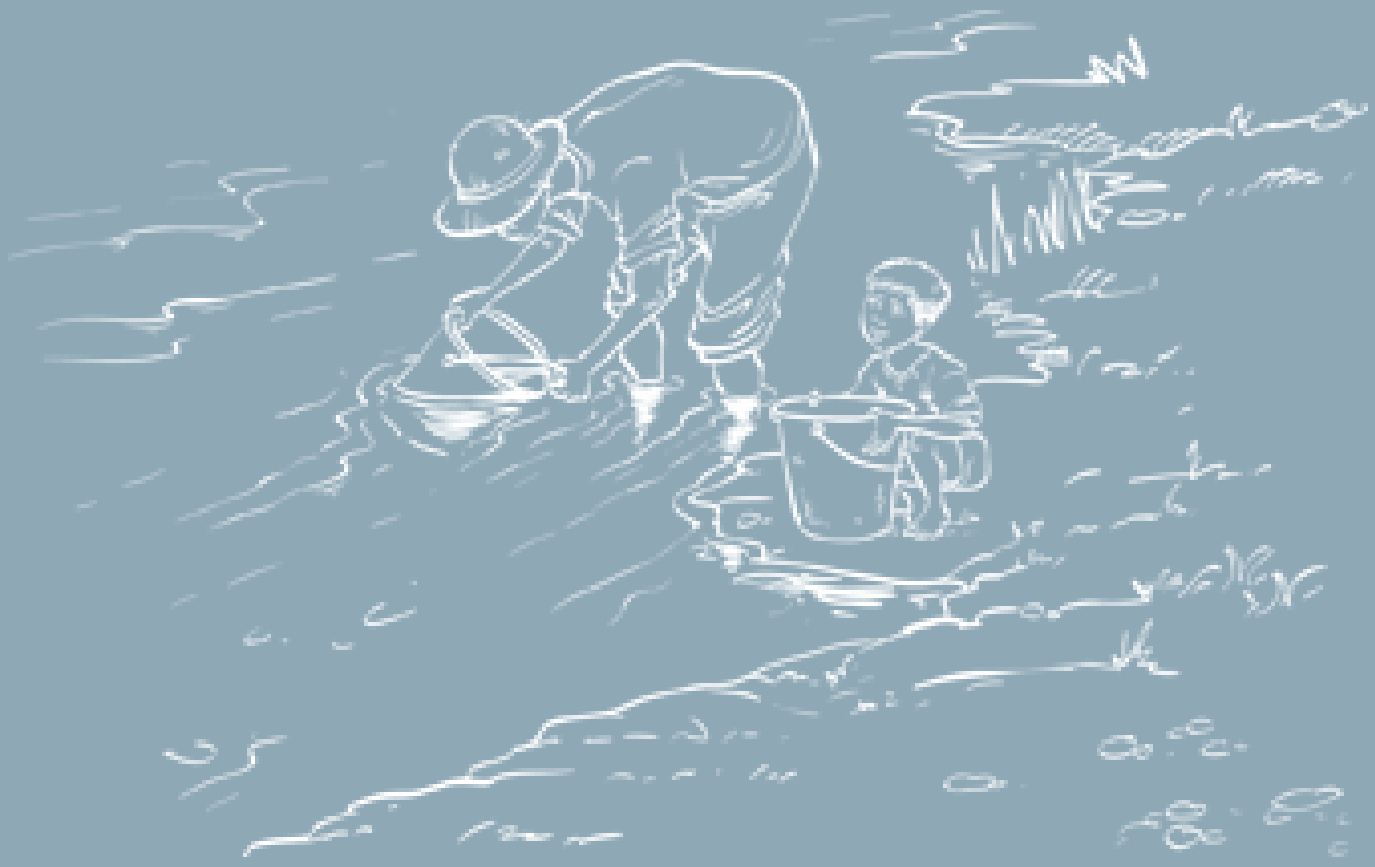


INTRODUCTION

The last decade has seen rapid economic progress in the Kingdom of Cambodia. Per capita income has increased, remaining however low in comparison to that of most of its neighbouring countries. Rural households are still mainly dependent on agriculture and its related subsectors for their livelihoods. In view of the importance of agriculture, the Department of Agricultural Extension (DAE) of the Cambodian Ministry of Agriculture, Forestry and Fisheries (MAFF) has developed a demand-driven, district-implemented, provincially managed, and centrally facilitated agricultural extension system appropriate to the local needs. This National Extension System has been designed around four pillars:

AEA

AGROECOSYSTEMS ANALYSIS

A PARTICIPATORY NEEDS-ASSESSMENT METHODOLOGY, USED BY THE DAE TO IDENTIFY THE MOST IMPORTANT PROBLEMS AND DEVELOPMENT OPPORTUNITIES FOR PEOPLE ENGAGED IN AGRICULTURE AND RELATED ACTIVITIES AT THE COMMUNE LEVEL.

TIPS

TECHNOLOGY IMPLEMENTATION PROCEDURES

IMPROVED AGRICULTURAL TECHNOLOGIES AND SUPPORTING MATERIALS FOR SOLVING THE MAJOR PROBLEMS IDENTIFIED BY COMMUNE AEAS.

CAP

COMMUNE AGRICULTURAL PLAN

AN INTEGRATED PLANNING PROCESS TO FACILITATE THE DELIVERY OF TIPS TO FARMERS THROUGH THE NATIONAL DECENTRALIZATION AND DECONCENTRATION PROGRAM (D&D) PLANNING SYSTEM.

FSMIS

FARMING SYSTEMS MANAGEMENT INFORMATION SYSTEM

A NATIONAL DATABASE FOR THE STORAGE, MANAGEMENT AND DISSEMINATION OF AEA AND TIP DATA TO KEY STAKEHOLDERS IN CAMBODIA.

BACKGROUND TO THE COMMUNE AGROECOSYSTEMS ANALYSIS (CAEA)

The first pillar of the National Extension System, the AEA, has been adapted to form the Commune Agroecosystems Analysis (CAEA). This participatory analytical tool has been used by the DAE since 2001 to identify and prioritize agricultural development needs at the commune level. The use of this methodology was officially adopted as part of the national policy for agricultural development by the Royal Cambodian Government (RCG) in 2004. The CAEA uses multidisciplinary investigation and participatory analysis to understand and describe the major farming systems practiced in each commune, and to identify and prioritize the most important problems that the farmers face. Based on this, further analyses are conducted to plan appropriate agricultural interventions to address the problems and opportunities identified.

CAEA has now been conducted in approximately 500 communes nationwide supported by a variety of funding sources including MAFF, D&D, the Australian Agency for International Development (AusAID), the International Fund for Agricultural Development (IFAD), the Japan International Cooperation Agency (JICA), the Asian Development Bank (ADB), the European Commission (EC) and a number of non-governmental organizations (NGOs). It is usually implemented through contracts with Provincial Departments of Agriculture (PDAs) who are responsible for ensuring timely outputs of the required quality standards. Quality Assurance (QA) is maintained by a team of professionals in the DAE. A manual explaining AEA contract and QA procedures is available, on request, from the DAE in Phnom Penh.

Up to 2008, CAEA focused mainly on agricultural issues, while problems of the fisheries sector closely interlinked to agriculture in Cambodia were not adequately addressed. CAEA users recognized this weakness and were in agreement that the water and fisheries component be strengthened. As a consequence, between 2008 and 2010, fisheries variables were incorporated and strengthened under the Challenge Program on Water and Food (CPWF) Project Number 71 of the Consultative Group on International Agricultural Research (CGIAR). This revised CAEA adopts a more holistic approach through the incorporation of fisheries variables and also looks at land, water, livelihoods and institutional issues that influence commune development planning. This Guidance Manual reflects the revisions made under the CPWF Project.

TECHNOLOGY IMPLEMENTATION PROCEDURES (TIPS)

Technology Implementation Procedures (TIPs), the second pillar of the national Extension System, describe improved agricultural technologies developed to solve those major problems of farmers as identified by the CAEA. TIPs can best be defined as 'the entire package of information, procedures, methods and materials necessary for an extension worker to implement the improved technology'. TIPs are intended for use by extension workers, NGOs and others working in agricultural development at the field level.

The TIP concept was introduced by the DAE to facilitate the replication of improved technologies across communes, districts and provinces throughout Cambodia according to local agroecological and socioeconomic conditions.

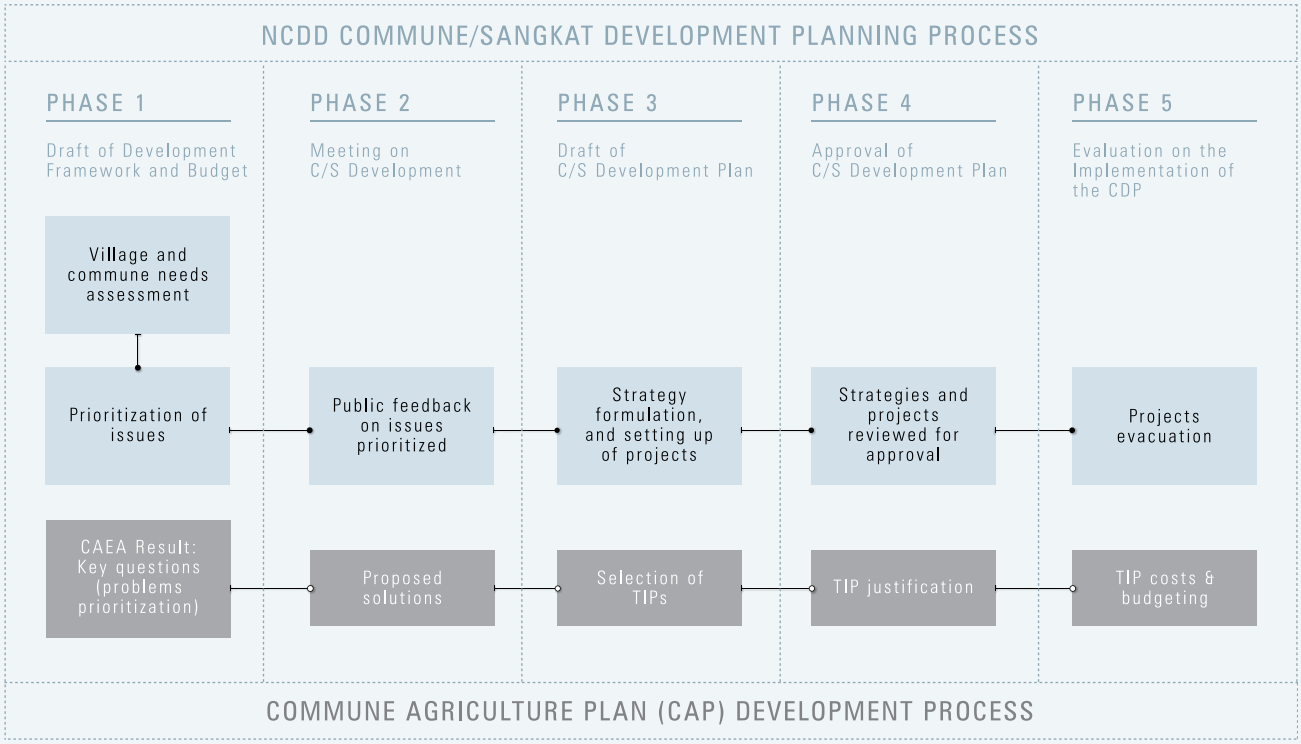
TIPs are commissioned by the DAE, but are prepared by experienced Subject Matter Specialists (SMSs) who are leading experts in their fields in Cambodia. TIPs thus represent the 'current best practice' for each technology. Draft TIPs undergo a peer review before they are endorsed by MAFF and approved for field use. Completed TIPs are held in the Farming Systems [Extension] Management Information System (FSMIS) database where they can be downloaded for use by [Provincial] Offices of Agricultural Extension (OAEs), other provincial offices or NGOs. Around 30 TIPs have now been completed and are available on request from the DAE.

COMMUNE AGRICULTURAL PLAN (CAP)

The third pillar of the National Extension System is the Commune Agricultural Plan (CAP). Under the D&D, Commune Councils first prepare a three-year rolling Commune Development Plan (CDP) which is reviewed each year to produce an annual Commune Investment Plan (CIP), with a work plan and budget. The DAE uses trained commune and district-level stakeholders to prepare a CAP as part of the multi-sectoral CDP. The focus has been on supporting Commune Councilors, D&D district facilitators and district agriculture staff to (i) conduct a CAEA, (ii) use the CAEA results to produce a CAP, and (iii) use the relevant CAEA outputs to support CAP submissions for funding the Provincial Investment Fund (PIF) through the D&D Local Planning Process.

This integration of CAEA, CAP development and the D&D planning process is described in Figure 1.

FIGURE 1: C/S DEVELOPMENT PLANNING PROCESS AND CAP DEVELOPMENT
(Source: Inter-ministerial Working Group: guideline on C/S Development Plan and C/S Investment Program, July 2007)



Note: C/S = commune/sangkat. Sangkat, administratively has the same rank as commune, but it is used when this entity is governed by a city.

Administrative hierarchy of Cambodia:
Country ⟷ Province/City ⟷ District/Khan ⟷ Commune/Sangkat ⟷ Village

FARMING SYSTEMS MANAGEMENT INFORMATION SYSTEM (FSMIS)

The fourth and last pillar of the National Extension System is the Farming Systems Management Information System (FSMIS) held in the National Agricultural Database. As CAEA coverage expanded, a means of storing and managing the growing amount of data generated became necessary. The FSMIS was therefore developed to support the management and sharing of this information among agricultural development stakeholders at the national and provincial levels.

The FSMIS has been installed on OAE computers, and CAEA data are entered by OAE staff. These data are used by each province for management and planning purposes, and are also uploaded into the DAE National FSMIS Database in Phnom Penh.

The FSMIS holds five types of data:

1. **Agricultural and Socioeconomic Conditions:** Data on (i) land types, (ii) topography, (iii) soil types, (iv) current land use, (v) cropping systems, (vi) crops grown, (vii) water resources, and (viii) socioeconomic indicators (family labor, landholding, off-farm work, rice self-sufficiency, number of livestock, and major income sources).

2. **Major Problems of Farmers:** Data on the major farming problems encountered in each commune, along with their priority.

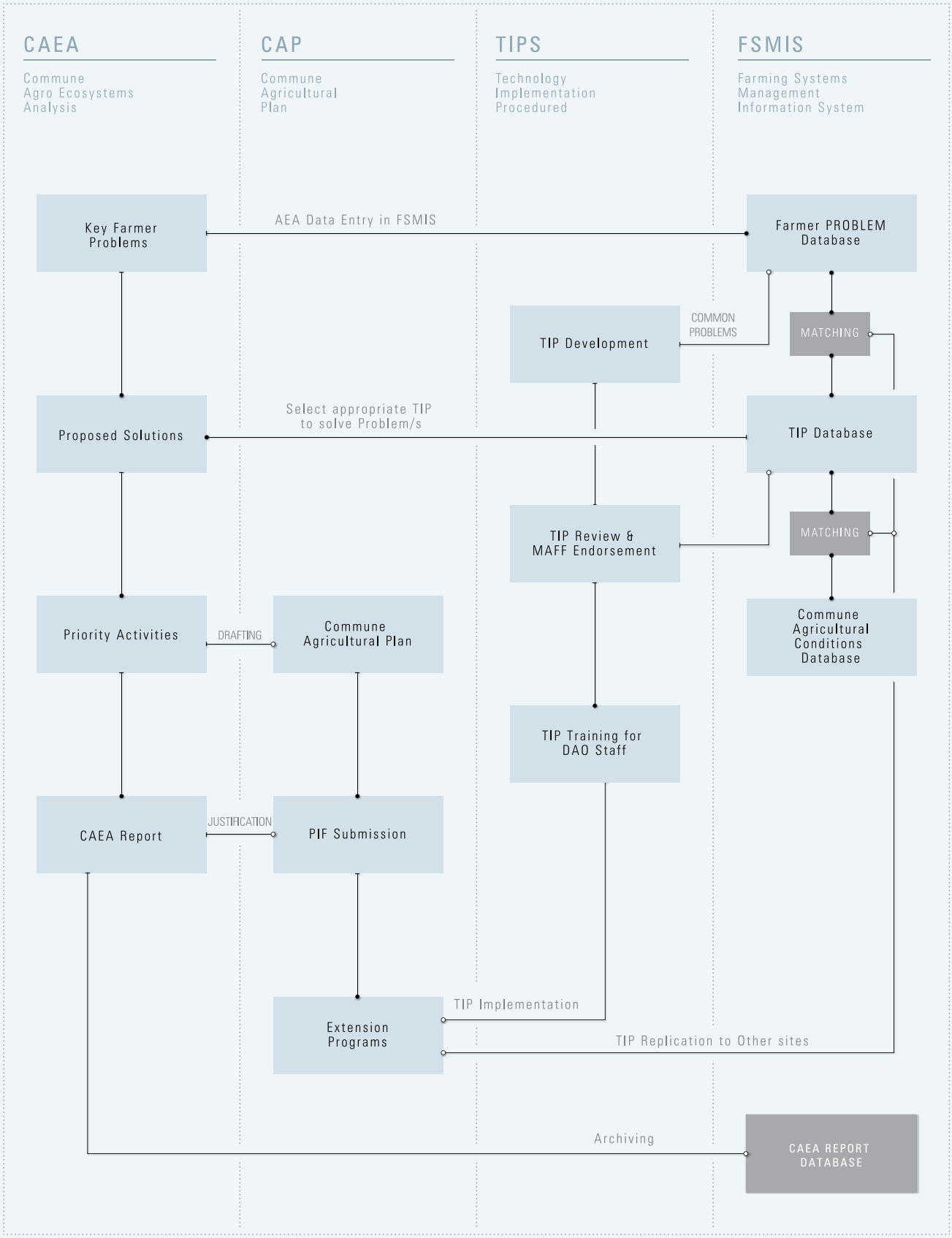
3. **Available TIPs:** Data on improved agricultural technologies available to solve the identified problems.

4. **CAEA Reports:** Archived copies of all CAEA reports produced by the provinces. Users can access the reports and retrieve the information.

5. **Secondary Data:** A range of additional statistical and spatial data sets for use by agricultural extension personnel and researchers.

The FSMIS has been designed to allow a wide range of users, including MAFF departments, research agencies, NGOs, donor or-

FIGURE 2:
FLOW CHART OF THE NATIONAL AGRICULTURAL EXTENSION SYSTEM AND THE RELATIONSHIPS BETWEEN KEY COMPONENTS.
Source: Training Manual for Provincial Investment Fund, CAAEP, Phase 2B, MAFF, 2007



ganizations and the private sector, to perform a number of different functions. It has been developed with dual language capability, and with a range of different output reporting formats based on user needs.

The database has been put to a number of different uses, including:

- Targeting TIPs to common problems and appropriate agroecological and socioeconomic conditions.
- Identifying and ranking the most important problems occurring for farmers in Cambodia.
- Identifying national priorities for agricultural research.
- Locating sites with specific agroecological and socioeconomic conditions, or where particular crops are grown.
- Identifying market potential and private-sector opportunities.
- Identifying potential environmental impacts and important issues related to natural resource management.
- Selecting target sites for donor projects and programs

Although it has been used for many different purposes, the single most important function of the FSMIS is to support the selection and replication of appropriate TIPs to solve the problems identified by CAEA for inclusion in the CAP. The relationships between the main components of the National Agricultural Extension System are summarized in Figure 2.

AGROECOSYSTEMS ANALYSIS

Agroecosystems Analysis (AEA) is a methodology for the analysis of agricultural livelihood systems and for planning and prioritizing research and development activities. It was developed at Chiang Mai University in the late 1970s and has since been used for research and extension planning in many different situations throughout the world.

It was first used in Cambodia in 1997 at the provincial level and then in 1999 for district planning. CAEA was introduced in 2001, and is currently used by the Cambodian DAE to develop CAPs, and forms the primary needs-assessment and planning tool for the agriculture sector of Cambodia's National Rural Development Program and D&D.

KEY CONCEPTS

SYSTEMS

A system is defined as a set of elements (or components) and relationships within a boundary. The elements of one set have strong functional relationships with one another but limited, weak or non-existent relationships with elements in other sets. The central concept of AEA is that it is a "system" and so embodies the system concepts of hierarchies, properties and agroecosystems.

The combined outcome of the strong functional relationships within a system is to produce a distinct behavior of the system in that it responds to stimuli as a whole, even if the stimulus is applied to only one part of it.

SYSTEM HIERARCHIES

The natural world is a nested hierarchy of systems from the ecosystem down to the gene. The processes of agricultural development modify these systems in order to produce food or fiber, thus creating hybrid agroecosystems, which in turn can be arranged in a hierarchic scheme.

Ecology links the hierarchy of natural systems with all the various disciplines of agriculture, while human ecology provides the bridge between both these hierarchies and the hierarchy of social systems - family, kin, minority group, etc. An important feature of agroecosystem analysis is that each level in the hierarchy has to be analyzed in its own right.

AGROECOSYSTEMS

The basic unit used in this Guidance Manual is that of an agroecosystem and may be defined as a spatially and functionally coherent unit of agricultural activity which includes the living and non-living components involved in that unit. Very simply, agroecosystems are natural systems which have been modified by man for food and fiber production in order to improve their livelihoods. However, an agroecosystem is not restricted to the immediate site of agricultural activities (e.g. the farm), but rather includes the area where natural conditions, livelihoods, and social and economic aspects are impacted by these activities.

As the name implies, an agroecosystem can be viewed as any area within the subset of a conventional natural ecosystem which has been modified by humans for agriculture to optimize certain productive features thus bringing about changes in species habitats and biophysical conditions. However an agroecosystem is not restricted to the site of agricultural activities but includes the region impacted by these activities. Linkages with other systems are changed. Naturally occurring flora species may be replaced by cultivated species (crops). Inevitably the composition of natural fauna species will change too with some opportunistic species taking advantage of 'new' niches available. At the same time, the system is made more complex by the introduction of purposeful management and human activity. Very simply, agroecosystems are natural systems which have been modified by man for food and fiber production.

SYSTEM PROPERTIES

Four system properties (productivity, stability, sustainability and equitability) are used to describe the behavior of agricultural systems (see Figure 3).

PRODUCTIVITY:
The level of production of the system (yield, profit, etc., per unit of land, labor, capital).

STABILITY:
The degree to which productivity remains constant over space and time (measured as the inverse of the variability in productivity).

SUSTAINABILITY:
The ability of a system to maintain or increase its productivity over longer periods of time when subjected to stresses or large disturbances (trends in productivity).

EQUITABILITY:
A measure of how evenly the productivity or the benefits of the system are distributed among the local population (various measures of distribution).

EVOLUTION OF AGROECOSYSTEMS

The four system properties of productivity, sustainability, stability and equitability can be used to trace the historical evolution of an agroecosystem and to evaluate its productive potential based on the different forms of land use or the introduction of new technologies; both of which may have the immediate effect of increasing productivity, but may also result in decreasing stability, sustainability and equitability. Consequently, agricultural development involves progressive changes in the valuation of the other properties of agroecosystems. For example, shifting cultivation may have low productivity and stability, but high sustainability and equitability, whereas irrigated paddy rice may have high productivity and stability, but lower sustainability and equitability. The positive and

negative aspects of system properties vary from place to place and situation to situation.

AEA ASSUMPTIONS

AEA is based on the following four assumptions:

1. It is not necessary to know everything about the agroecosystem to produce a realistic and useful analysis.
2. Understanding the behavior and important properties of an agroecosystem requires knowledge of only a few key functional relationships.
3. Producing significant improvements in the performance of an agroecosystem requires changes in only a few key management decisions.
4. Only a limited number of appropriate key questions need to be defined and answered.

AEA PURPOSE

AEA OBJECTIVES

1. Identifying, delineating and characterizing different land-use systems (agroecosystems) within a given land area.
2. Obtaining an improved understanding of agricultural systems and current land use in these agroecosystem zones and their key characteristics.
3. Identifying key issues related to the performance of the entire system and its agroecosystem zones.
4. Identifying agricultural research and extension priorities for the systems.
5. Planning programs, projects and development activities for the systems.

EXPECTED OUTPUTS

1. The delineation and the (biophysical and socioeconomic) description of agroecological zones (agroecosystems) in each commune.
2. An improved understanding of the major agricultural livelihood systems in each zone.
3. A prioritized list of important problems and opportunities attributable to each zone (key questions).
4. A Land Management Strategy or 'development vision' for each agroecosystem zone.
5. A prioritized set of research, development and extension activities to solve the problems.

FIGURE 3: SYSTEM PROPERTIES
The system properties are further explained in the illustrations presented in Appendix 1.

COMMUNE AGROEC

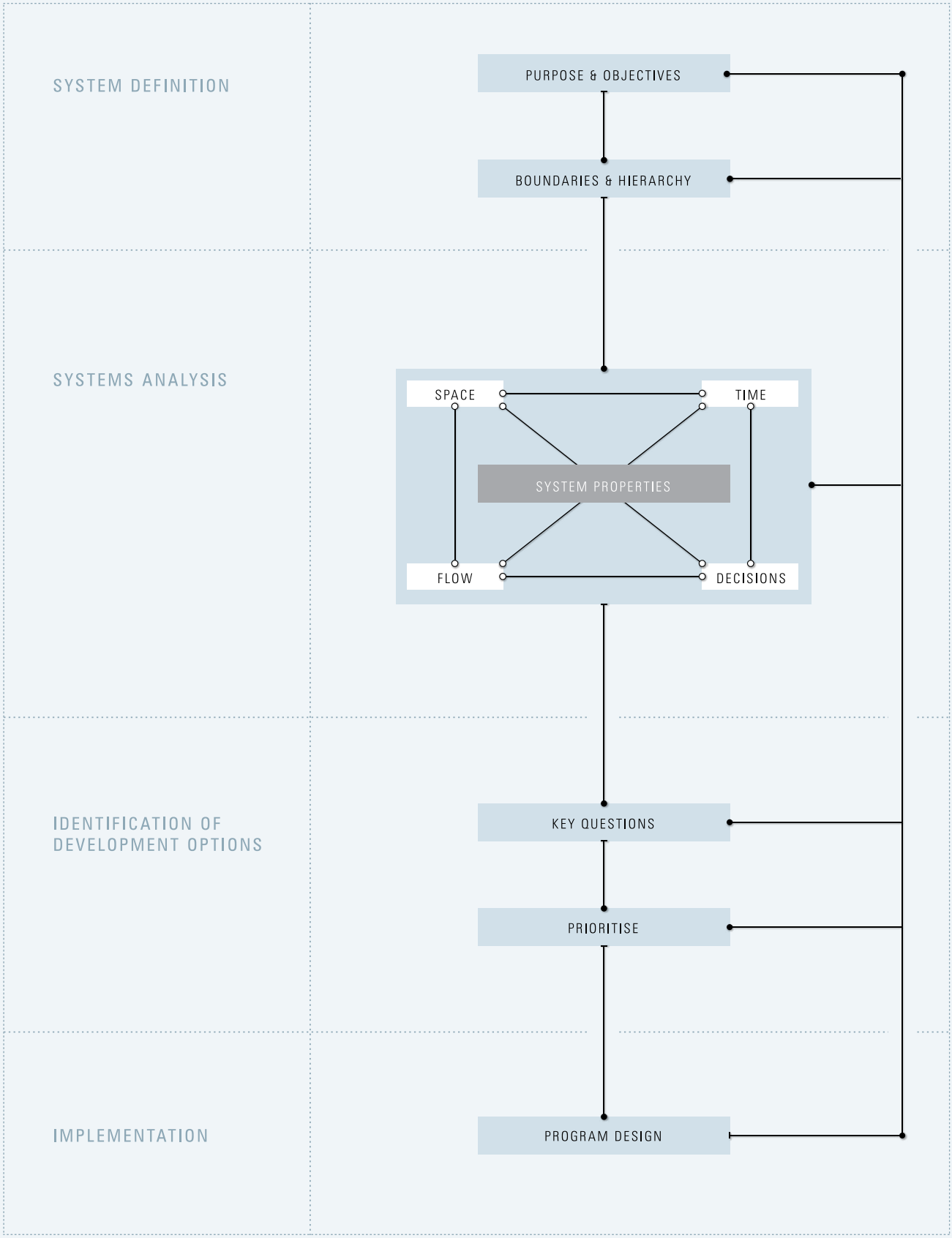
COMMUNE AGROECOSYSTEMS ANALYSIS PROCEDURES

In Cambodia, the CAEA with the endorsement and participation of the Commune Councils (CCs) is performed by district and provincial agriculture staff, initially with training and support from the Department of Agricultural Extension (DAE) Farming Systems Section. It is used to identify the major agroecosystems in the commune and to develop a common understanding of their functioning in order to define the key issues or questions affecting their performance. Key questions are then used to develop appropriate technological interventions for the implementation of extension programs supported by the Provincial Investment Fund (PIF).

It is expected that the CAEA for each commune will be revised from time to time in order to capture a contemporary picture of the commune, its agricultural development status, and any new issues and problems that have arisen. Any recently introduced improved agricultural technologies are also assessed in terms of their relevance for solving any outstanding problems during CAEA revisions.

As shown in Figure 4, CAEA follows step-wise procedures to define the system(s) being studied, set its boundaries, its position in the hierarchy of other systems and its major components and their interactions. As an understanding of these major system properties is developed, a limited number of central issues emerge which are then used to guide participatory follow-up in the field and subsequent analyses. As these issues are clarified and fleshed out, key questions are tabled, elaborated and used to identify priority extension and development activities.

FIGURE 4: AGROECOSYSTEMS ANALYSIS PROCEDURES



PHASES AND STEPS

There are six key stages of CAEA which follow a logical sequence. The first three stages deal mainly with the initial data collection and logistical arrangements. During Stage 4 a Rapid Rural Appraisal is conducted to identify the key issues, while Stage 5 is an analysis of the systems. The final stage is that of report writing and determining the use of the results. These stages are summarized below:

STAGE 1. PLANNING AND PREPARATION

- AEA team formation and organization.
- Brief partners (CC, Planning and Budgeting Committee (PBC), etc.) on AEA objectives, procedures and expected outputs.
- Explain data collection needs to participants and assign responsibilities.
- Arrange logistics for meeting room, materials, supplies, transport, etc.

STAGE 2. SECONDARY DATA COLLATION AND ORGANIZATION

- Assemble, collate and prepare all relevant available data in an appropriate form for use during AEA (see also Function 6 of FSMIS).
- Data required include spatial data (topography, elevation, slope, geology, soils, climate, current land use, watersheds, rivers, administration boundaries, village locations, roads, etc.) and statistical data (demographic, economic, social, agricultural, climatic, hydrological, etc.).

STAGE 3. PRELIMINARY ANALYSIS

- Identify initial boundaries of the agroecosystem zones within the commune.
- Draft initial transects and a description of each zone.
- Identify and fill gaps in information and data.
- Assign responsibilities and prepare for Rapid Rural Appraisal (RRA) and field work.

STAGE 4. RAPID RURAL APPRAISAL

- Select representative participants from all villages in all agroecosystems.
- Tools used: historical profiles, agroecosystem base maps, transects, seasonal calendars, flow diagrams, Venn diagrams, etc.
- Verify and explore key issues with farmers, fishers and other local stakeholders.
- Identify key problems and opportunities with farmers and local stakeholders.

STAGE 5. SYSTEMS ANALYSIS

- Prepare the information on time, flow, space and decision-making.
- Present and analyze the information in plenary sessions.
- Analyze system properties using force-field analysis techniques.
- Prepare a cause-effect diagram for each problem identified.
- Use pair-wise ranking to rank problems identified.
- Formulate key questions and proposed solutions.
- Use the innovation assessment table to rank proposed solutions.

STAGE 6. REPORT WRITING AND USE OF CAEA OUTPUTS

- Draft report and present to the CC, PBC members and villagers.
- Incorporate into the report feedback obtained during the presentation into the report.
- Presentation of identified priorities to district and provincial agriculture staff for consideration in the annual PIF allocation.
- Use in the District Integration Workshop (DIW) at the time of developing temporary contracts (refer to other guidelines for CAEA aggregation to higher management levels).
- Archiving the CAEA report in the FSMIS for use by others at the national level.

The CAEA is normally conducted under a contract with Provincial Departments of Agriculture and costs around US$2,000, depending on the team composition. It requires a total of 11 days of fieldwork followed by write-up, presentation and feedback. The various stages of CAEA are usually interspersed with breaks of a few days; thus, the time to complete an AEA may be up to four weeks or more. The venue and the approximate time each phase takes is shown in Table 1.

TEAM COMPOSITION

The CAEA is conducted by a multidisciplinary team whose joint experience and technical knowledge cover all disciplines relevant to agricultural planning in the commune. A typical CAEA team would normally include the members shown in Table 2.

PRELIMINARY STAGES 1 - 3

STAGE 1. PLANNING AND PRELIMINARY ANALYSIS

This first stage of the AEA involves data collection and analysis, and an initial survey of the commune. This stage is usually completed within a week.

- Conduct a survey of the commune and complete an initial transect by motorcycle.
- Conduct geo-referenced soils identification using the Manual of the Cambodian Agricultural Research Institute (CARDI) and soil maps. If this is not possible, describe each soil type, and assess its fertility.
- Collate, present and analyze survey findings from all of the above.

TABLE 1. THE VENUE AND THE TIME FOR EACH PHASE OF THE CAEA

STAGE OF CAEA	LOCATION	NO. OF DAYS
1. Planning and preparation stage	District Agriculture Office	2
2. Secondary data-collection and preparation	Commune Council Office	3
3. Preliminary analysis	Commune Council Office or DAO	1
4. Rapid rural appraisal	Commune Council Office or selected villages	2
5. Systems analysis	Commune Council Office or DAO	3
6. Report writing and use of CAEA outputs	Provincial Agricultural Extension Office	16+2*

* Total person-days involving the OAE Chief and staff, the DAO Chief, and Fisheries and Environment staff.

TABLE 2. TYPICAL CAEA TEAM MEMBERSHIP

DEPARTMENT	SECTION/EXPERTISE	NO. OF PERSONS
Provincial Office of Agricultural Extension	Chief and two members of staff from the Farming Systems Section	3
Provincial Fisheries Office	Senior Fishery Subject Matter Specialist	1
Provincial Department of Water Resources	Farmer Water User Group Support Section	1
Provincial Department of Environment	Senior National Resource Management Specialist	1
Provincial Department of Land Management	Land Management Specialist	1
District Agriculture Office	Agronomy, Livestock, Fisheries	2
D&D District Facilitator	Commune Development Planning Specialist	1
Commune Council and Planning and Budgeting Committee	Local knowledge and CDP/CIP	3
Villager representatives (during RRA phase)	Local knowledge/community needs	30

- Identify and map draft commune agroecosystem zone boundaries.
- Finalize selection criteria for key informants participating in the RRA (Stage 4) based on the findings of the preliminary survey; select sites and times for RRAs and select and notify key informants.

KEY INFORMANT SELECTION

The selection of the appropriate key informants for the RRA phase of CAEA is crucial to the successful use of the tools. As far as possible, key informants should be representative of the commune population as a whole, and should include representatives from those groups described in Table 3. In addition to farmers, ensure that fishermen using different fishing grounds (paddy fields, flooded forests, lakes, rivers, etc.) are included as participants in this exercise. In addition, ensure both males and females participate.

Allocation of individual key informants to groups using the different CAEA tools is also important as the representation of certain types of people may be critical, as explained in the following examples:

- In wealth ranking, people from each of the different wealth classes must be involved.
- For the historical profile, it is necessary to include elderly participants who can give a long-term perspective of changes in prevailing conditions and livelihood patterns.
- In gender analysis there should be equal representation of males and females.
- In problem tree and pair-wise ranking exercises a range of key respondents are needed to capture the different perspectives of those engaged in different livelihood activities, as well as those from different wealth categories, gender groups and different age classes.

In addition, a number of other more general characteristics of key informants are also important. First, key informants should ideally be knowledgeable about the commune as a whole and in particular about the agroecosystem zone where they live; they should be articulate and able to talk in front of large groups; and finally they should be well-liked and able to get on with others.

STAGE 2. SECONDARY DATA COLLATION AND ANALYSIS

The CAEA relies heavily on secondary data which need to be sourced, collected and organized at the preliminary analysis stage of AEA. The main types of data include:

1. **Spatial data or maps** showing topography, elevation, slope, geology, soils, climate, land use, water-bodies, rivers, administration boundaries, village locations, roads, etc. Overlaying the various maps acquired helps identify and delineate the agroecological zones communes.

2. **Commune statistical data** on demographic, economic, social, agricultural and climatic conditions. Wherever possible, these data should be disaggregated by village so that once agroecological zones have been defined, villages can

TABLE 3. COMMUNE REPRESENTATION AND SELECTION GUIDELINES.

REPRESENTATION	SELECTION GUIDELINES
Geographic	Ensure key informants are selected from each agroecosystem zone in approximately equal proportions.
Gender	Aim for an equal number of men and women
Ethnic	Ensure that all ethnic minorities found in the commune are represented and that numbers are in proportion to the total population of each ethnic group
Age	Ensure that all age groups are represented in the approximate ratio of 1:3:2 corresponding to young, middle-aged and elderly persons, respectively.
Resident period	Ensure that the informant has lived in the commune for a few years – the longer the better
Wealth	Select key informants from better-off, medium, poor and very poor families in approximately equal proportions, but with a slight emphasis on poor representation.
Occupation	Ensure that key informants include farmers, fishers, NTFP collectors and others engaged in locally important occupations.
Social standing	Ensure that there is at least some representation from official leaders (village headmen, etc.), traditional leaders (elders) and lay persons (regular farmers and fishers, etc.).

be allocated to their respective zones, and the data can be reassembled for the zone as a whole, allowing the zone's demographic, socioeconomic and agricultural characteristics to be described.

3. **Commune profile.** The commune profile is a valuable source of maps and information that can help characterize the commune as a whole and its agroecological zones.

4. **Commune Development Plan (CDP) and Commune Investment Plan (CIP).** The CDP and CIP should be obtained and their key chapters (economic, natural resources and gender) should be summarized. The summaries should be reviewed during the preliminary analysis phase of the CAEA and used to guide later analysis (analyses) to ensure that the CAP generated by the CAEA is compatible with, and supports, the overall CDP.

Although not always readily available, information on external factors in the wider rural economy, and the policy and institutional environment that may influence household livelihood and resource allocation decisions should be compiled and used. Where available, statistics on unemployment, participation in the labor market and off-farm labor should be obtained and discussed. This can be used to prompt an assessment of the state of the labor market, and in turn lead to discussions on market development for agriculture and fishery-related inputs and outputs, and the general economic and livelihood opportunities in the area.

STAGE 3. PRELIMINARY ANALYSIS - SYSTEM DEFINITION AND BOUNDARIES

The commune system boundary is mapped, usually on a 1:50,000 topographic map. Following the field survey and initial transect, draft agroecosystem boundaries are added along with any other features identified during the initial survey. Commune land-use maps of the Ministry of Land Management, Urban Planning and Construction, Cambodia (MLMUPC) are an important input to agroecosystem zoning and should be obtained in advance for system definition.

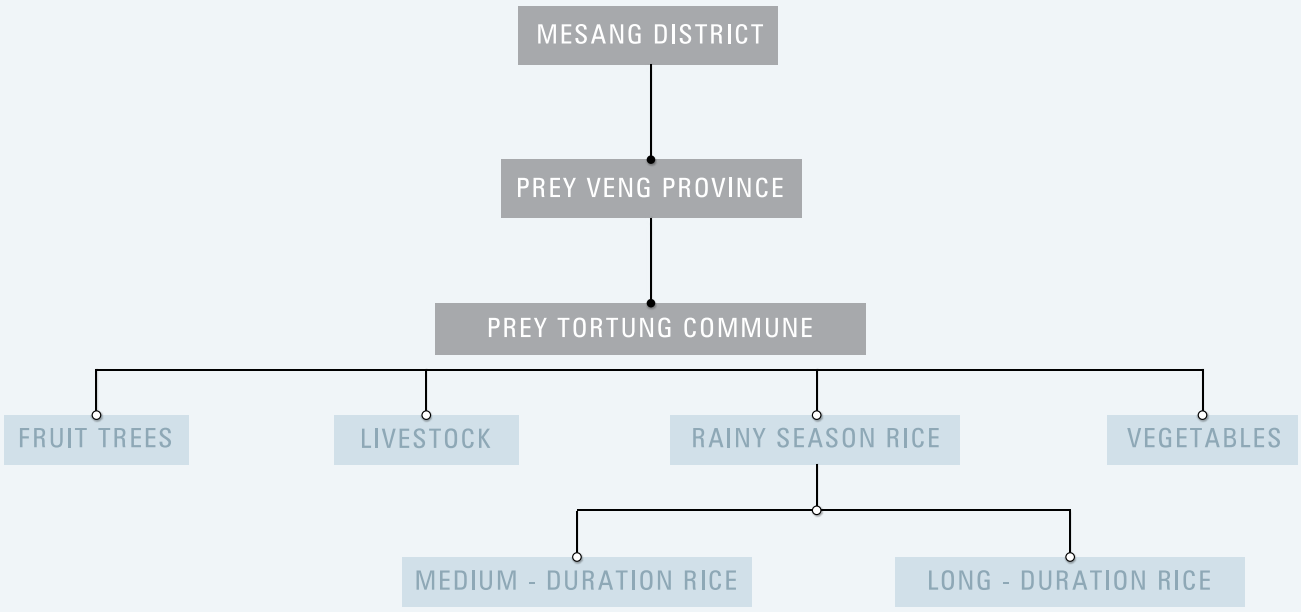
COMMUNE ZONING AND SUBSYSTEMS

A number of subsystems or agroecosystem zones can be identified in all communes. These zones are essentially areas of similar land use and agriculture, and the farming systems in each zone have similar problems and agricultural development potential. These zones are usually characterized by different soils, topography, hydrology and resource endowments. In most cases, three to six distinct zones can be identified in a commune.

SYSTEM HIERARCHY

The system hierarchy comprises the systems above and below the commune which have strong interactions with it. An example from the Svay Rieng province is shown in figure 5.

FIGURE 5. EXAMPLE OF A HIERARCHY FROM PREY TORTUNG COMMUNE, PREY VENG PROVINCE.



RAPID RURAL APPRAISAL

Stage 4 of the CAEA is that of the Rapid Rural Appraisal (RRA) involving participatory discussions with representative male and female participants from all villages in the commune. RRA teams obtain additional information and explore the key issues identified in the preliminary analysis in greater depth. Farming systems, fisheries and livelihood typologies are developed for each agroecosystem, and problems and opportunities are explored in a participatory manner with key informants (usually three to four from each village, and perhaps seven to eight from each zone depending on the number of zones and the population in each zone).

The following sections of this Manual describe the range of participatory tools used during the RRA. To ensure the quality and reliability of the information obtained, and that it reflects an accurate picture of the commune situation, it is important to be aware of and work within the limitations of each of the RRA tools. Where there are obvious difficulties in getting responses to the questions posed, it is better to leave some questions unanswered rather than forcing the issue and obtaining inaccurate information.

SPATIAL ANALYSIS TOOLS

SPATIAL ANALYSIS TOOLS

MAPS & OVERLAYS

True-to-scale map layers should be produced for a number of different parameters, including administrative boundaries, village location, services and communications, land use, soil types and water resources. All maps should be to the same scale and ideally produced on transparency sheets so that they can be overlaid and displayed on an overhead projector to analyze spatial relationships and to help identify the agroecosystem zones in the commune.

GIS facilities to aid map production are available through the DAE in Phnom Penh and in some provincial districts. The FSMIS contains base data sets relevant to CAEA. The central FSMIS database is held at the DAE in Phnom Penh, and FSMIS software has been installed on the OAE computers in 13 provinces. Relevant digital data sets and on-line mapping facilities are also available from the Atlas of Cambodia at http://www.cambodiaatlas.com/. Alternatively, the Atlas of Cambodia produced by Save Cambodia's Wildlife in 2006 and available as a stand-alone CDROM in major bookshops for US$10 allows the production of custom maps of target provinces or communes (1:80,000 terrain, roads and administrative boundaries, soil types, 2002 land use, rice ecosystems, etc).

Where computer facilities are not available, hard copy maps can be produced using transparencies or tracings over hard copy topographic maps or aerial photographs. If no suitable base maps are available, sketch maps can be drawn by hand. These should be as close to scale as possible, but should concentrate more on identifying the main features in the commune than on absolute spatial accuracy.

Mapping should begin during the preliminary survey stage and maps should be continually added to, and revised throughout, the CAEA process. Initial draft maps should be used with villagers during the RRA to ground-truth and revise all spatial information associated with the commune.

CHECKLIST

Commune maps should be produced for the following:

Administrative boundaries.	√
Village locations, roads and government services.	√
Rivers, streams, *boeungs* and other important water resources.	√
Irrigation systems (functioning systems and those in disrepair).	√
Hydrology and flood regimes.	√
Soil types and geology.	√
Land use and natural resources.	√
Any other relevant factors.	√

A selection of example maps and the agroecosystem zones from the map overlay analysis are presented on the right in Figure 6.

KEY STEPS

1 Obtain copies of all available maps from D&D, provincial offices of MLMUPC, CCs, relevant government agencies and NGOs during the secondary data collection and preliminary survey phase of the CAEA.

2 Overlay each map on all the others and begin to draft what appear to be distinct zones.

3 Continually refine the maps and the draft agroecosystem zones as new information is obtained throughout the CAEA process.

4 Use the draft maps with villagers during the RRA to ground-truth their accuracy and to capture additional spatial information for the commune.

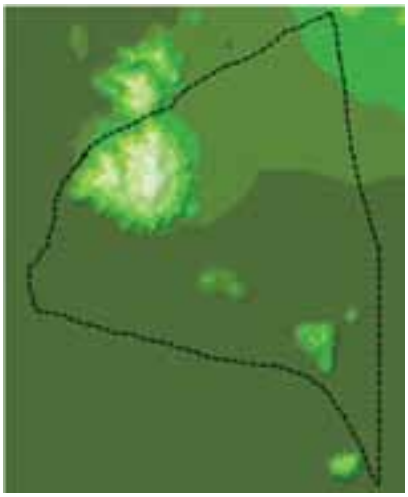
5 Cross-check with the water sources listed in the Water Resource Use Matrix Tool (see Table 5) to ensure that they are recorded on the map and in the Water-Body Attribute Analysis Matrix (see Table 4).

6 During the Systems Analysis (Stage 5) all the map layers are overlaid with one another in order to identify important spatial interactions among natural resources, er bodies, soil types, land use, irrigation, agriculture, fisheries, etc.

FIGURE 6: GENERIC EXAMPLES OF MAPS USED FOR SPATIAL ANALYSIS (TRANGEI COMMUNE, KAMPONG CHHNANG)
(Source: http://www.cambodiaatlas.com/map)

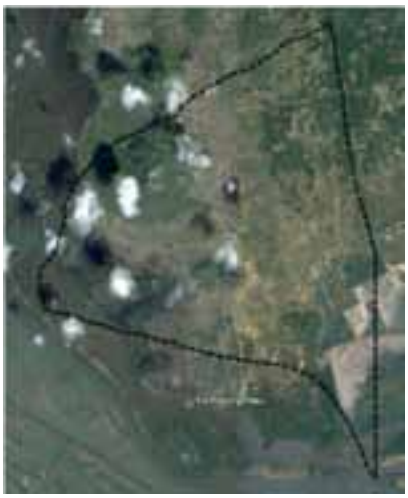
A. ROADS AND WATER BODIES

B. ELEVATION



C. FOREST COVER (2006)

D. SATELLITE IMAGE (Source: Google Earth)



THE WATER-BODY ATTRIBUTE ANALYSIS

The Water-Body Attribute Analysis Matrix is used to improve understanding of the different water resources in the commune and to capture and analyze information on how they are used and on the aquatic resources they contain. An example of tool outputs is provided in Table 4.

CHECKLIST

Water body types to be analyzed by this tool should include:

Rivers, perennial streams, seasonal creeks, reservoirs, lakes, aquaculture ponds, trap ponds, swamps, canals, rice paddies, etc.	√

Attributes of water bodies should include the following:

Agroecosystem zones where the water body occurs.	√
Seasonality (seasonal or permanent).	√
Connectivity (with other water bodies).	√
Key water use conflicts and short description.	√
Water use regulations.	√
Fishing gear used.	√
Key fish species.	√
Key environmental concerns/risks.	√
Breeding/feeding/refuge site?	√
Use of water body by women.	√
Use of water body by men.	√

An example of the tool outputs is provided in Table 4.

KEY STEPS

1 Participant characteristics – in addition to farmers, ensure that fishermen using different fishing grounds (e.g., paddy fields, flooded forests, lakes, rivers etc.) in the AE zone are included as participants for this tool. In addition, ensure both males and females participate.

2 During the RRA, use the water resource map layer to identify all important water sources in the commune and list these in the first row across the top of the matrix.

3 Use the matrix with key respondents to record all the key characteristics of each water source.

4 After the analysis, spend time in summarizing the key findings. In particular, compare productivity levels in different water bodies and identify the reasons for any differences; also assess the extent to which the different water bodies together are able to provide stable, year-round benefits.

5 Summarize the findings from item 3 above for use during the Systems Analysis (Stage 5) of the CAEA.

TABLE 4: EXAMPLE OF WATER-BODY ATTRIBUTE ANALYSIS MATRIX

ATTRIBUTE	WATER BODY: STREAMS (OU)	LAKES (BOEUNG)	CANALS (PRALAI)	DEEP-POOLS (ANG LOONG)	TRAP-PONDS (BIAH)	RICE PADDIES
AGROECOSYSTEM ZONE WHERE WATER BODY OCCURS	Mountain, upland, middle/ lower terrace and floodplain	Floodplain and middle terrace zones	Upland, middle terrace, and lower terrace zones	Mountain zone	Floodplain	Middle and lower terraces zones
SEASONALITY (SEASONAL OR PERMANENT)	Mountain zone all-year-round. Other zones seasonal	Floodplain: all-year-round Middle terrace water in dry season	Wet-season water only	All-year-round water	All-year-round	Wet season only
CONNECTIVITY (WITH OTHER WATER BODIES)	Connected to deep pools, Tonle Sap, canals and rice raddies in the wet season	Flood plain boeungs connected to Tonle Sap. Middle terrace boeungs connected to streams & rice paddies during peak rainfall	Connected to streams, Tonle Sap and paddy fields during the wet season	Connected to streams, canals, rice paddies and the Tonle Sap in the wet season	Connected to Tonle Sap via 'Prek'	Connected to streams, and canals during the wet season
KEY WATER USE CONFLICT AND SHORT DESCRIPTION	Water use for agriculture upstream reduces downstream water availability	Retting (soaking) palm lea-ves for roof thatch conflicts with fishing activities	Upstream use of canal water for agriculture reduces downstream water availability	None	None	
WATER USE REGULATIONS	No rules for irrigation water use. Have rules on fishing but not always followed	No rules for irrigation water use. Have rules on fishing but not always followed	No regulations for use of water for agriculture or fisheries	None	None	None (privately owned land)
FISHING GEAR USED	Traps, push-nets, hooks, basket traps, electricity	Hand-baskets, gill-nets, electricity (illegal)	Long lines of hooks, gill nets, throw-nets,	Hand fishing (tickling), electricity (illegal)	Pull long nets across trap ponds	
KEY FISH SPECIES	Snakehead, walking snakehead, catfish, peacock eel, climbing perch	Snakehead, catfish, climbing perch, peacock eel, common eel, bronze featherback	Mainly juveniles of climbing perch, peacock eel, catfish, crabs, shrimps and frogs	Snakehead, walking snakehead, catfish, peacock eel, climbing perch	Snakehead, walking snakehead, catfish, peacock eel, climbing perch	
ENVIRONMENTAL CONCERNS AND RISKS	Use of natural poisons for fishing. Use of electricity for fishing	Retting (soaking) palm leav-es for roof thatch deoxygenates water Illegal fishing impacts on fish populations	Infiltration of chemical fertilizers Pollution by laundry detergents. Electrical fishing is reducing fish stocks	Use of natural poison (from tree bark) and electricity for fishing are reducing fish population sustainability	No negative impacts	
BREEDING/FEEDING/ REFUGE SITE?	Feeding and refuge site	Feeding and refuge site	Feeding site only	Feeding, breeding and refuge site	Feeding, breeding and refuge site	Feeding site only
USE OF WATER BODY BY WOMEN	Home garden irrigation, cooking water, drinking.	Fishing, retting (soaking) palm leaves for roof thatch.	Fishing, drinking, washing clothes, bathing, cooking	Fishing, drinking, clothes-washing, bathing, cooking	Fishing (30% women)	
USE OF WATER BODY BY MEN	Fishing, irrigation (wet season), cattle-raising	Fishing, cattle-tending, washing (when away at night).	Fishing.	None	Fishing (70% men)	

WATER RESOURCE USE ANALYSIS

Water is used by people for many different, often conflicting purposes. In the analysis of water resources, the CAEA takes into account all the various water uses i.e. use for irrigation, fishing, cattle, conservation, recreation, transport, drinking and domestic use. A Water Resource Use Matrix is used to assess this wide range of water uses and to help identify key water resource development needs. The Water Resource Use Matrix tool is used to improve understanding the use of the different water sources in the commune at different times of the year and to capture and analyze information on their key characteristics. Examples of outputs from this tool are presented in Table 5.

CHECKLIST

Water resources that should be covered in the analysis include:

All surface water bodies (as detailed in Table 5)	√
Groundwater resources (wells, pumps, bores)	√
Rainwater tanks or reservoirs	√
Other water sources used for domestic supply (such as piped water, tanks, bottled water).	√

KEY STEPS

1 Participant characteristics – in addition to farmers ensure that fishermen who use different fishing grounds (e.g., paddy fields, flooded forests, lakes, rivers) in the agroecosystem zone are included as participants in this exercise. In addition, ensure both males and females participate.

2 During the RRA, identify all important water sources in the commune and list these in the first row across the top of the matrix.

3 With the key informants, use the matrix to record the various uses of each water source in both the dry and the wet seasons.

4 Cross-check with the water resource map to ensure that all important water sources have been assessed by the Water Resource Use Matrix (see Table 5).

5 At the end of the analysis, spend a few minutes with participants in summarizing the most important findings from the tool. In particular, assess how the different water sources are used in the different seasons and identify any constraints on water availability that may occur during certain periods.

6 Summarize the findings from item 5 above for later use during the Systems Analysis (Stage 5) of the CAEA.

TABLE 5: WATER RESOURCE USE MATRIX FOR WET AND DRY SEASONS

WET SEASON (JUNE–DECEMBER)

	WATER SOURCE					
	STREAMS	RESERVOIRS	PONDS	RIVERS	LAKES	OTHER[a]
WATER USE						
Cooking/drinking	√	√		√√		√
Washing/bathing	√	√	√√			√
Irrigation	√√	√				√√
Watering livestock		√√√		√√	√	
Home gardens	√√		√√√	√		
Fishing		√√				√
Others (specify)		√√		√√√	√	
WATER SOURCE CHARACTERISTICS						
Water quantity	√√√					
Water quality	√√√					
Fish productivity		√√				
Reliability			√√√	√√	√√	√
Equitable access		√		√		√
WATER SOURCE RANK						
Rank						
	STREAMS	RESERVOIRS	PONDS	RIVERS	LAKES	OTHER[a]

Rank water sources from most to least important to livelihoods (1 = most important)[b]

DRY SEASON (DECEMBER-JUNE)

	WATER SOURCE					
	STREAMS	RESERVOIRS	PONDS	RIVERS	LAKES	OTHER[a]
WATER USE						
Cooking/drinking	√	√		√√		√√√
Washing/bathing	√	√	√√		√√√	√
Irrigation	√√	√				
Watering livestock		√√			√	
Home gardens	√√		√			
Fishing		√√				√
Others (specify)		√√				
WATER SOURCE CHARACTERISTICS						
Water quantity	√√√					
Water quality		√√				√√
Fish productivity		√√				√√
Reliability		√√				
Equitable access**	√	√√√	√√	√√	√	√√
WATER SOURCE RANK						
Rank						
	STREAMS	RESERVOIRS	PONDS	RIVERS	LAKES	OTHER[a]

Rank water sources from most to least important to livelihoods (1 = most important)[b]

[a] Please specify any other resource used.
[b] The answer is expected to include the river, which is the most important water resource as it is close to the village but there is a lack of water from March to May.

LEGEND

Water use:	√√√ = Important source	√√ = Significant source	√ = Marginal source	0 = Unused
Characteristics:	√√√ = Very good	√√ = Good	√ = Marginal	0 = Poor

FISH SPECIES ASSESSMENT TABLE

This tool is used to assess the threats facing important fish species and to identify potential impacts from proposed water resource infrastructural development projects on these species. An example of tool outputs is presented in Table 6.

KEY STEPS

1 Participant characteristics – in addition to farmers ensure that fishermen using different fishing grounds (e.g., paddy fields, flooded forests, lakes, rivers) in the agroecosytem zone are included as participants in this exercise. In addition, ensure both males and females participate.

2 List the five most important fish species for each water body identified by the Water-Body Attribute Matrix in the appropriate row in the table.

3 With the key informants, rank the five species in order of their importance to the commune (i.e. 1= most important) and identify why each species is important. For example, a species may be important because of its high value, even if its abundance is low, or conversely low-value fish may be important due to the large volume caught.

4 For each species, ask the key informants to identify the season(s) when it is fished, the main types of gear used and the percentage change in the average catch over the last 10 years. Record the information in the table.

5 For each fish species, have the Fisheries Administration CAEA team member record which category of fish (guild) it belongs to (black, white or grey). See Appendix 2 for Khmer Fish Names and Guilds.

6 At the end of the analysis, spend a few minutes with the key informants in summarizing the key findings from the tool. In particular, compare the productivity of different species (catch x value) and explore the reasons for changes in species populations in the last 10 years.

7 Summarize the findings from 'item 5' above for use during the Systems Analysis phase of CAEA.

TABLE 6: EXAMPLE OF ASSESSMENT OF FISH SPECIES IN TWO WATER BODIES

WATER BODY: RICE FIELD

FISH	FISHING SEASON	GEAR USED	WHY IMPORTANT	% CHANGE IN THE PAST 10 YEARS	FISH CATEGORY (GUILD)	RANK
Trey Ros *(Channa striata)*	Jun-Nov	Cast net, gillnet, trap, pumping, electro-fishing	Sold for a high price, abundant	Declined 60%	Black	2
Trey Kranh *(Climbing Perch Anabas testudineus)*	Jun-Nov		Very abundant	Stable	Black	1
Trey Changva Angkor *(Garra cambodgiensis)*	Jun-Nov		Not so important	?	Black	5
Trey Chlounh *(Macrognathus siamensis)*	Jun-Nov		Sold for a good price	Declined 30%	Black	4
Trey Kanhchos thmor *(Pseudomystus siamensis)*	Jun-Nov		Sold for a high price	Declined 20%	Black	3

WATER BODY: STREAM

FISH	FISHING SEASON	GEAR USED	WHY IMPORTANT	% CHANGE IN THE PAST 10 YEARS	FISH CATEGORY (GUILD)	RANK
Trey Chhpin *(Hypsibarbus malcolmi)*	April-June	Gillnet, cast net, traps	Household consumption	Stable	White	2
Trey Khya *(Hemibagrus wyckioides)*	Jun -Dec		Sold for good price	Declined 10%	Grey	5
Trey Kanhchrouk krohorm *(Botia modesta)*	Nov-March		Very abundant	Declined 50%	White	3
Trey Pra po *(Pangasius larnaudii)*	April-Jun		Sold for a high price	Declined 40%	White	4
Trey riel top *(Henicorhynchus siamensis)*	Nov-March		Very abundant, household consumption	Increased 20%	White	1

FLOW DIAGRAMS

Flow diagrams are used to analyze the flow of inputs, money, information, labor, etc. Flows occur from one agroecosystem zone to another (e.g. migration of grazing cattle from zone to zone in different seasons); and also up and down the hierarchy (e.g. between commune, district and province). As a consequence two flow diagrams (see Figures 7 and 8) are normally drawn in order to improve clarity and reduce complexity. Figure 9 presents an example of the final flow diagram.

CHECKLIST

The following checklist should be used to identify locally important flows that should be analyzed with the villagers during the RRA:

Flows of agricultural inputs (fertilizer, pesticides, feed, fingerlings, medicines, etc.) and agricultural machinery (tractors, combines, implements, fishing gear, etc.).	√
Farm produce (crops, livestock, fish, NTFPs).	√
Agricultural information (techniques, prices, inputs, etc.).	√
Seasonal migration (women and men) and labor flows (on-farm and off-farm).	√
Credit (formal and informal).	√
Livestock movements (grazing, refuge, sales).	√
Fish migration, breeding and refuge.	√
Others (as locally important).	√

KEY STEPS

1 Participant characteristics – in addition to farmers ensure that fishermen using different fishing grounds are included as participants in this exercise.

2 Construct a diagram to display flows among the agroecosystem zones as shown in Template 1 of Figure 7, and another to display flows up and down the system hierarchy as shown in Template 2 of Figure 8.

3 With the key informants, record flows up and down the hierarchy and also from zone to zone, using the checklist to ensure comprehensive coverage.

4 At the end of the analysis, spend a few minutes with the farmers in summarizing key findings from the tool. In particular, identify constraints, problems or missed opportunities related to flows.

5 Summarize the findings from item 3 above for use during the Systems Analysis (Stage 5) of the CAEA.

FIGURE 7: TEMPLATE 1
FLOW DIAGRAM FOR RECORDING
BETWEEN AGROECOSYSTEMS

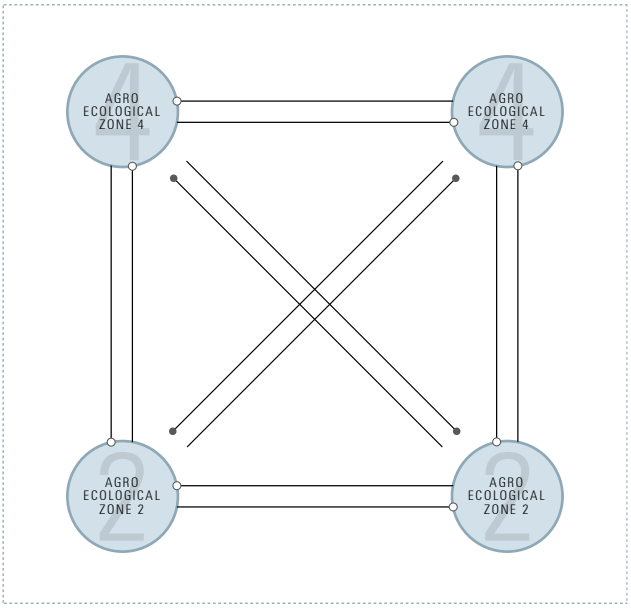


FIGURE 8: TEMPLATE 2
FLOW DIAGRAM FOR RECORDING FLOWS
UP AND DOWN THE HIERARCHY.

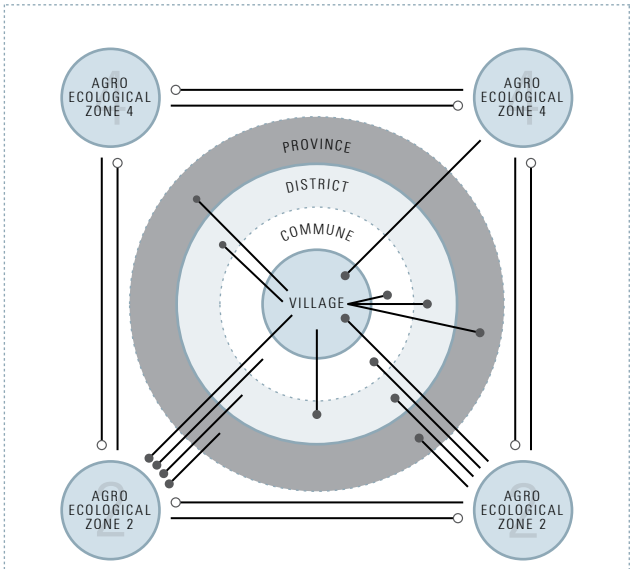
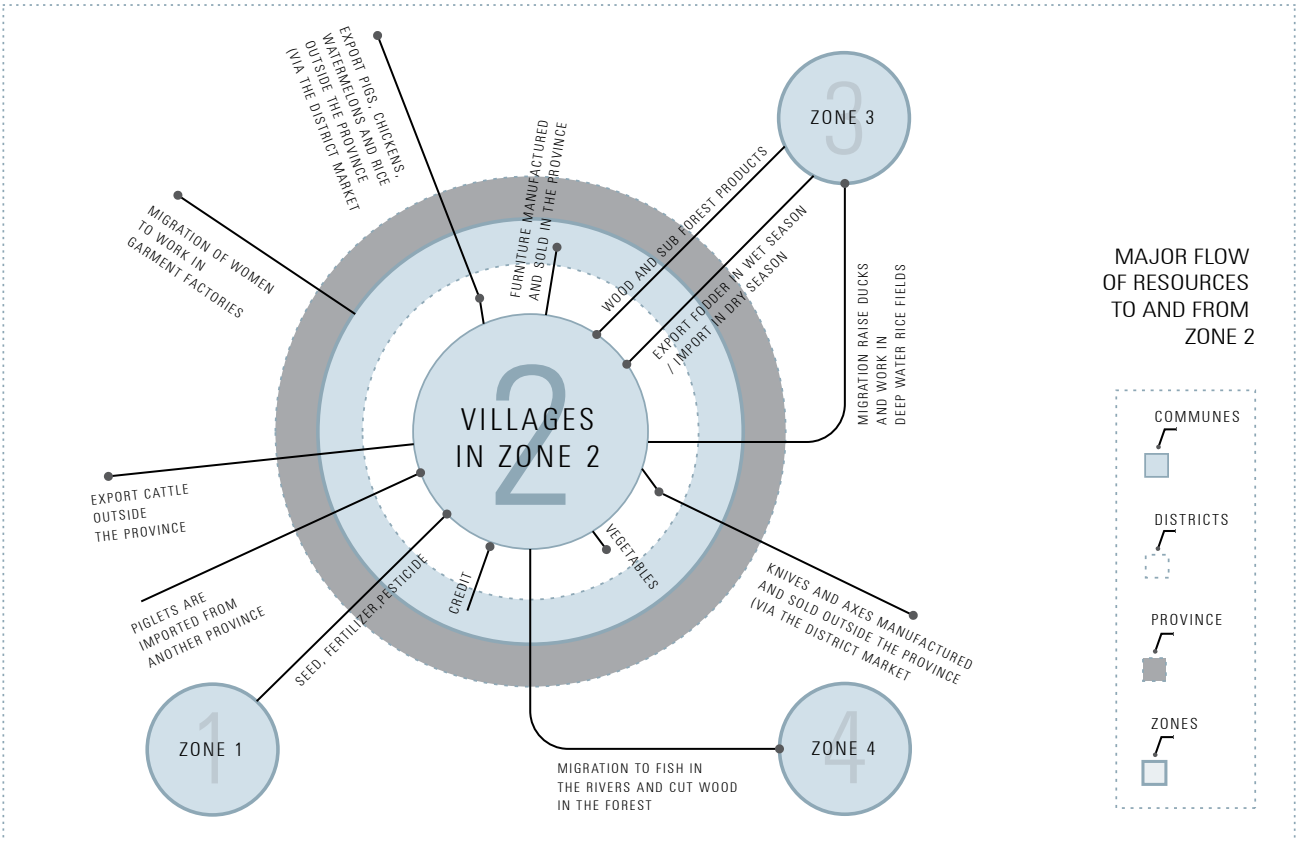


FIGURE 9: EXAMPLE FLOW DIAGRAM,
STUNG CHINIT IRRIGATION SYSTEM, KAMPONG THOM PROVINCE



TRANSECT DIAGRAM

A transect diagram (Figure 10) is used to describe and compare agroecosystem zones according to a standard set of agroecological and socioeconomic parameters.

CHECKLIST

Information on all of the following parameters should be included in the final transect diagram (Figure 11):

Representative photograph and a general description of each agroecosystem zone.	√
Land cover, topography, geology/soils, hydrology, water bodies and irrigation schemes.	√
Natural ecology, wildlife.	√
Wet and dry-season land use including crops, livestock and fisheries.	√
Major income and nutrition sources.	√
Problems, opportunities and key issues.	√
Swamps	√
Canals	√
Rice paddies	√

KEY STEPS

1 With the key informants, develop a transect diagram during the RRA to describe all the parameters included in the template and checklist.

2 Continually expand, revise, and refine the transect diagram during the CAEA process as new information comes to light.

3 During the Systems Analysis (Stage 5) of the CAEA, use the transect diagram to identify important issues and key questions prior to developing appropriate TIPs for their solution.

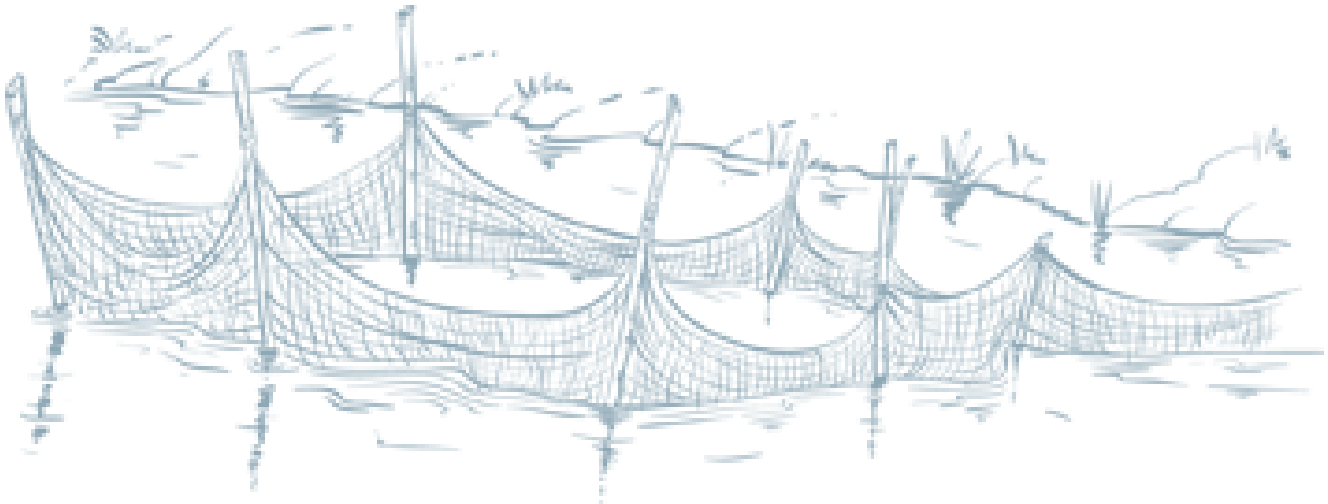
4 At the end of the analysis, spend a few minutes with farmers in summarizing the most important findings from using the tool. In particular, assess how the different water sources are used in the different seasons and identify any water availability constraints that may occur during certain periods.

5 Summarize the findings from item 4 above for later use during Systems Analysis phase of the CAEA.

FIGURE 10: EXAMPLE TRANSECT DIAGRAM

FIGURE 11: FINAL TRANSECT DIAGRAM

	AGROECOSYSTEM ZONE		
			
	LOWLAND WET-SEASON RICE NEAR PERMANENT LAKES AND STREAMS	LOWLAND WET-SEASON RICE AND RESIDENTIAL AREA	SEASONALLY FLOODED OPEN GRASSLANDS WITH NO PADDY BUNDS
Soil Type	Sandy mixed soil Black soil near lakes and streams CARDI Soils Classification Prateah Lang, some Koktrap	Sandy mixed soil CARDI Soils Classification Prateah Lang, some Koktrap	Black soil CARDI Soils Classification Koktrap
Hydrology	Seasonally inundated land.v Inundation period - July to November	Seasonally inundated land. Inundation period - August to November	Seasonally flooded land. Flood period - June to December
Water Sources	Rainfall Some irrigation	Rainfall	River flood Rainfall
Crops	Wet-season rice Some small areas of dry-season rice Grassland.	Wet-season rice Some fruit trees and secondary crops (in and around villages).	Small area of wet season (near edge of the flood zone) Some attempts at dry-season rice. Open grassland (no rice paddy bund)
Livestock	Cow, buffalo, pigs (mainly breeding sows), chicken and duck	Cow, buffalo, fattening pigs, chicken and duck	Cow, buffalo (rangeland)
Land Use	Lowland wet-season rice production Grazing land (cattle/buffalo) Natural fishing Where permanent water is available farmers can irrigate early rice in May and/or grow some dry-season rice from December to March/April	Lowland wet-season rice production Village land, fruit trees and mixed crops.	Open grassland, grazing Buffalo (most) and cattle (a few) Natural fishing
Problems	Illegal fishing in lakes and streams Poisoning of fish and wild birds Lack of water (shallow water in lakes and streams during the dry season)	Natural fertilizer stolen for sale to Vietnam Cattle diseases (FMD) Pigs – diarrhea Chicken and duck – Cholera Insect damage to the traditional rice crop - rice bugs and stem borers Rat damage in the wet-season crop Poor soil fertility	Illegal fishing Acid-sulphate soils Cattle disease – FMD Cholera in chicken and ducks Pigs – internal parasites
Opportunities	Mat weaving Using bamboo for construction, handicraft (baskets) and others Dry-season rice where permanent water is available for irrigation Green manure crops or other legumes prior to, or following, the wet-season rice crop to improve soil fertility and rice yields	Mat weaving when labor is available - after transplanting rice Using bamboo for construction, handicraft (baskets) and others Fish raising in ponds close to houses Green manure crops or other legumes prior to, or following, the wet-season rice crop to improve soil fertility and rice yields	Fishing from lakes or rivers Improved pastures in grassland areas for the development of commercial cattle production



TEMPORAL ANALYSIS TOOLS

HISTORICAL PROFILE [TIMELINE]

A historical profile (Table 7) is used for a timescale analysis over the longer term and to help identify key sustainability issues. Its purpose is twofold. First, is to attempt to identify longer-term trends, for example changes in forest cover, in rice yields, in livelihood systems, etc. Second, it is used to assess the resilience of the agroecosystem to major events, such as floods, droughts, pest outbreaks, market-price fluctuations, etc.

CHECKLIST

The following issues should be explored with villagers' historical profile analysis.

Demographic changes and trends.	√
Political changes.	√
Changes in access, communications and services.	√
Land use changes and trends.	√
Changes and trends in livelihood activities.	√
Changes in NTFP abundance.	√
Changes in land tenure systems and landholding size.	√
Changes in agricultural practices.	√
Trends in rice yields.	√
Trends in soil fertility.	√
Changes in climate (rainfall, drought, flooding, etc.).	√
Changes in hydrology (river, stream, lake and paddy field water-quality and quantity.	√
Changes and trends in fish stocks (production, species mix and local extinctions).	√
Changes in fishing patterns (sites, access, people who fish, gear/techniques, laws and regulations, aquaculture, etc.).	√

KEY STEPS

1 Participant characteristics – at least one elderly person to represent each agroecosystem zone should be included as a participant in this exercise.

2 During the RRA, use the Historical Profile template (see example in Table 7) with key informants to record changes in important parameters over time.

3 Review the time-line to identify any long-term trends, such as changes in demography, rice yields, soil condition, forest cover, land use, fish populations, etc., and with the key informants explore the causes of these changes.

4 Finally, analyze the impacts and responses of the local communities to these trends and record the results in the last two columns.

5 At the end of the analysis, spend a few minutes with farmers in summarizing the most important findings from using the tool. In particular, assess how the different water sources are used in the different seasons and identify any water-availability constraints that may occur during certain periods.

6 Summarize the findings from item 4 above for use during the Systems Analysis phase of CAEA.

TABLE 7: HISTORICAL PROFILE: SNA ANSAR COMMUNE

PERIODS	PRE 1979		1979-1990
POLITICAL	1970-1975	1975-1979	1979-1990
	LON NOL	POL POT	VIETNAM INVASION
ENVIROMENT	NEGLIGIBLE ENVIRONMENTAL IMPACT		
Demographic changes	▪ Fisherfolk richer than farmers ▪ 200 families in floating village		▪ Rapid population increase after 1
Political and administrative changes	▪ Commune office sited in Sna Ansar village ▪ Sna Ansar and Ou Sandan all one commune		▪ Vietnamese occupation ▪ Khmer Rouge insurgency in mou plain zones
Changes in access, communications and government services	▪ All selling and buying in commune market ▪ Fish market opens in the early 1960s ▪ Airfield operating		▪ Commune market closed initially opens
Land use changes	▪ Pristine forest ▪ Land tax $1-1.75/ha.		▪ Paddy rice, deepwater rice and h ▪ Dry-season rice begins
Changes in NTFPs abundance	▪ Wildlife plentiful		▪ Uncontrolled hunting begins
Changes in livelihood activities	▪ Main occupations are wet- season rice and fishing		▪ Shared labor
Changes in land tenure systems and landholding size	▪ Private ownership until Pol Pot regime		▪ Group landholding 3-4 ha for 15 f ▪ Land distributed to families in 19
Changes in agricultural practices	▪ Use compost only. ▪ Good natural fertility ▪ Provincial vet service		▪ No chemical fertilizer use ▪ Good soil fertility
Change in rice yields	▪ Rice yields 2.4-3 T/ha ▪ > 90% of families self- sufficient in rice		▪ Rice yields 2 T/ha
Changes in climate	▪ Rainfall plentiful and regular		
Hydrology: river, lake, stream water quality and quantity	▪ Two dams on creeks ▪ Boeung holds water all year.		▪ Dams on creeks rehabilitated ar
Change in fish stocks (production, species mix, local extinctions)	▪ Catch < 20 kg fish/day. ▪ Many species caught.		▪ Catch < 15 kg fish/day
Fishing changes: sites, access, people, gear, laws, etc.	▪ Fishing in groups (10-15 persons). ▪ Homemade fishing gear. ▪ Gill nets introduced in the late 1960s		▪ Fishing in groups

	1993-1998		1998-2009	
	1990-1993	1993-1998	1998-2003	2003-2009
N	UNTAC		ELECTED GOVERNMENT	
	IMPACTS BEGIN		LARGE IMPACTS	
986	▪ Population growth continues to accelerate		▪ People from floating village begin to migrate to upland zone	
ntain and flood-	▪ UNTAC period ▪ First national elections in 1992 ▪ Political stability after 1997 coup		▪ Commune Councils elected by popular vote. ▪ D&D ▪ Institutionalized in RGC processes	
and then re-	▪ Access/communications improve dramatically		▪ National Road No. 5 upgraded	
ome gardens	▪ Forest encroachment begins ▪ Some dry season rice		▪ 40-50% reduction in flooded forest ▪ Dry season rice area reduced ▪ Land-grabbing in the upland zone	
	▪ Hunting pressure intensifies		▪ Availability of important NTFPs declines significantly	
	▪ Farming by individual families		▪ Rice cultivation, decline in fishing and off-farm work increases.	
families 985	▪ Landholding sizes reduced		▪ Land encroachment in the upland zone	
	▪ Use chemical fertilizer ▪ Soil fertility starts to decline ▪ Livestock nos. increase		▪ Fertilizer use increases year by year. ▪ Pesticide use begins ▪ Even more livestock	
	▪ Rice yields 1.5-2 T/ha		▪ Rice yields < 1 T/ha ▪ Most families are deficient in rice	
nd repaired	▪ Dams still used ▪ Siltation of streams and canal begins		▪ Dry-season rice damaged by floods at harvest time. ▪ Deepwater rice damaged by earlier rapid rise in Tonle Sap water levels	
	▪ Fish catch < 10 kg/day. ▪ Fish extinctions begin ▪ 40% decrease in stocks		▪ More local extinctions of fish species ▪ 70% decrease in stocks	
	▪ Cage culture introduced ▪ Aquaculture begins ▪ Illegal fishing begins		▪ Small-scale fishing declines. ▪ Large-scale fishing starts to dominate ▪ Aquaculture increases	

SEASONAL CALENDAR

Table 8 gives an example of a seasonal calendar showing the analysis of time-related changes for each agroecosystem in a year. Such a calendar is a valuable tool for understanding the issues related to stability of the agroecosystem and should not be too detailed as this will obscure important time-related interactions.

CHECKLIST

The seasonal calendar should cover the following factors:

Climatic (rainfall and temperature).	√
Hydrology (flood period, paddy inundation, risk of drought, groundwater).	√
Rice crops (early, medium, late, upland, deepwater, dry season, recession).	√
Field crops and vegetables (major crops only – maximum of three).	√
Fruit tree crops including sugar palm and coconut (key activities only for major fruit crops – maximum of three).	√
Livestock (disease incidence, feed shortages, etc., of cattle, pigs and chickens – maximum three lines).	√
Fishing patterns (sites, gear used, spawning times, key migration peaks).	√
Off-farm migration and work patterns.	√
Family cash flow showing dominant contributor to income over the year.	√
Annual price movements (rice, major crops, livestock and fish).	√

KEY STEPS

1 Participant characteristics – in addition to those people engaged in agriculture, at least one individual engaged in fishing or a combination of fishing and agriculture should be included in this exercise.

2 During the RRA, construct and complete a seasonal calendar with the villagers following the example in Table 8. The seasonal calendar should not cover more than two flipchart sheets of paper.

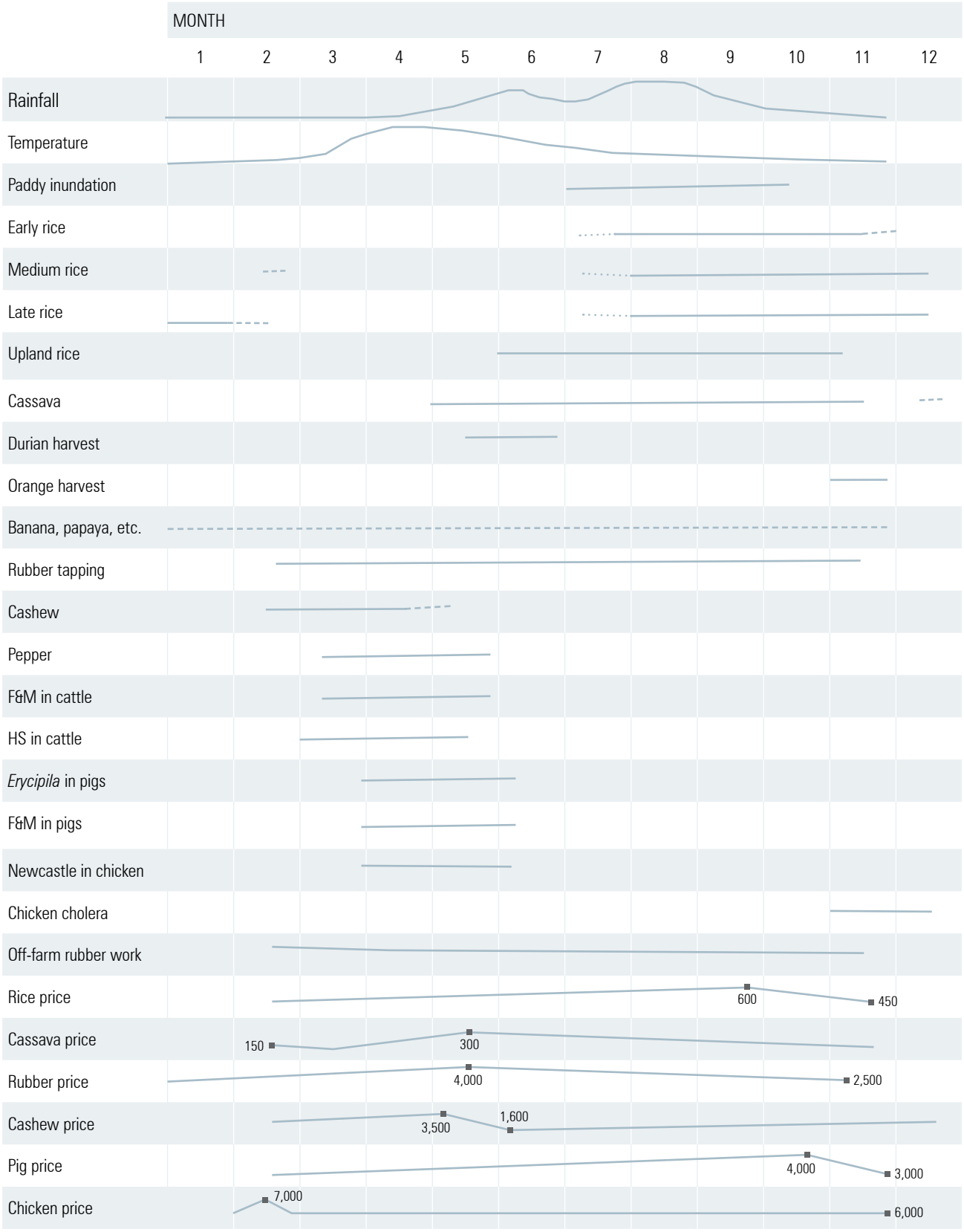
3 Use the seasonal calendar to discuss the temporal relationships within their livelihood systems with the villagers.

4 After completing the analysis, spend a few minutes with the participants in summarizing the most important findings from the tool. In particular, use the seasonal calendar to brainstorm how changes to the timing of livelihood activities or farming practices can be used to increase yields, obtain better prices, improve family cash flow, reduce risk from climatic or economic events, overcome bottlenecks in labor, etc.

5 Summarize the findings from item 4 above for later use during the Systems Analysis (Stage 5) of the CAEA.

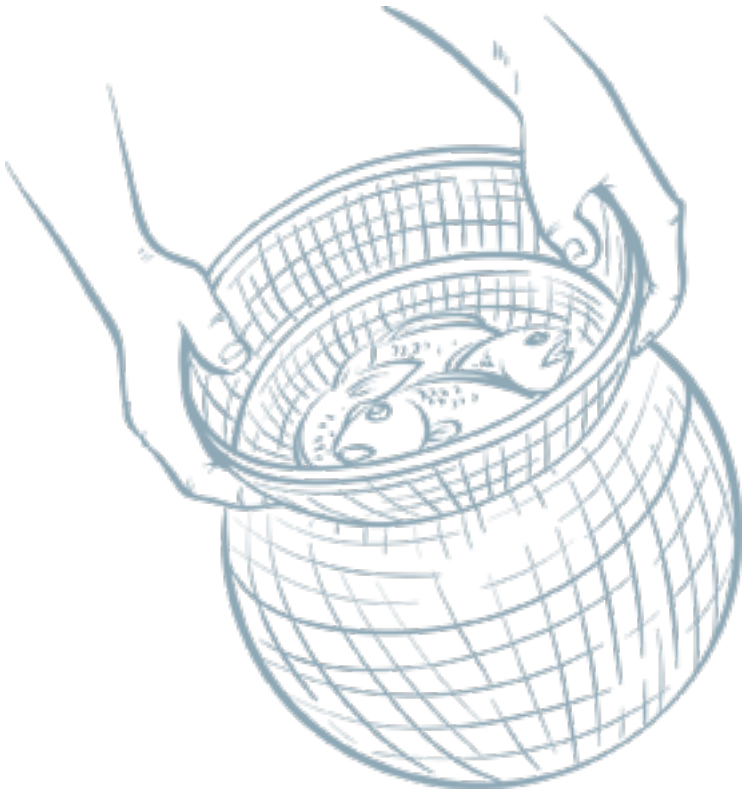
6 During the Systems Analysis (Stage 5) of the CAEA, use the completed seasonal calendar to identify TIPs that can help reduce temporal constraints, bottlenecks or price fluctuations.

TABLE 8: SEASONAL CALENDAR FOR MAJOR FARMING ACTIVITIES, CHOUM KRAVIANG COMMUNE



Note. The following symbols should be used in seasonal calendars:

Crop nursery operations — Crop growth, care and maintenance — Post harvest operations



LIVELIHOOD ANALYSIS TOOLS

WEALTH RANKING ANALYSIS

Wealth ranking (Table 9) helps to illustrate the variations in the poverty levels in a community, to better understand equitability issues and to gain insights into the characteristics, needs and opportunities of each wealth class, particularly the poor. Wealth Ranking Analysis helps to refine key questions to ensure that they target the poorest as a priority.

Wealth Ranking Analysis is conducted during the RRA phase of CAEA, and begins by asking villagers to estimate the proportion of better-off, medium, poor and very poor families in the commune. Further enquiry then identifies the major characteristics of a typical better-off, medium, poor and very poor family. Several different factors are used to characterize each wealth group as shown in the checklist and the examples given in Table 9.

CHECKLIST

Wealth-ranking is conducted in the normal way and should cover the following factors:

Family size and available labor.	√
Landholding: land size, land type(s) and number of parcels.	√
Farm assets (irrigation, wells, fish-ponds, machinery, etc.).	√
Crops grown and relative areas.	√
Crop yields and use of inputs.	√
Livestock numbers and relative mix.	√
Used fishing sites/gear and fish processing activities.	√
Fishing equipment (ownership and usage).	√
Major income sources and relative proportions.	√
Off-farm labor (amount and type).	√
Credit (access, uses and sources).	√

KEY STEPS

1 Participant characteristics – include representatives from different wealth groups in the agroecosystem zones (i.e. the better-off, medium, poor and very poor families); both male and female participants; and both farmers and fishers.

2 During the RRA, ask the key informants to estimate the proportion of 'better-off,' 'medium,' 'poor' and 'very poor' families in the commune.

3 Using these socioeconomic classes, conduct wealth-ranking by following the template presented in Table 9.

4 After completing the analysis, spend a few minutes with key respondents in summarizing the most important findings from the tool. In particular, use the results to analyze the differences among wealth classes, and explore ways in which poorer villagers could move towards the farming system and fishing system typologies which characterize the better off.

5 Summarize the findings from item 4 above for later use during the Systems Analysis phase of CAEA.

6 Wherever possible, represent the findings of wealth analysis pictorially (bar-charts, pie diagrams, etc.) for use during Systems Analysis.

7 During the Systems Analysis (Stage 5) of CAEA, use the results of the wealth-analysis tool to ensure that the interests of all groups, particularly the poor and very poor, are fully considered when identifying appropriate TIPs.

TABLE 9: WEALTH-RANKING TEMPLATE

WEALTH CLASS				
	BETTER-OFF	MEDIUM	POOR	VERY POOR
NEED A TITLE HERE				
Proportion (%)				
Family size				
Available labor				
Total land area (ha)				
No. of parcels				
Fishing				
Others (specify)				
Housing land (ha)				
Paddy land (ha)				
Orchard (ha)				
Other land (ha)				
NEED A TITLE HERE				
NTFPs used				
Fishing sites				
Fishing gear used				
Fish processing				

WEALTH CLASS				
	BETTER-OFF	MEDIUM	POOR	VERY POOR
FARM ASSETS				
Crop 1[a] (ha)				
Crop 2 (ha)				
Crop 3 (ha)				
Aquaculture[b]				
Number of cattle				
Number of pigs				
No. adult chicken				
INCOME				
1st income source				
2nd income source				
3rd income source				
Off-farm labor				
Number of cattle				
Number of pigs				
Use of credit				

[a]Crops for main income (if the crop is less than 20% for the entire commune, it should not be considered in the discussion). Crop types could include recession rice, banana and coconut.

[b]For example, pond size for fish raising must be indicated in square meters or fish cage size must be indicated in cubic meters.

Example results and suggested formats for presenting these attributes are presented in Figures 12-15.

FIGURE 12:
WEALTH CLASS DISTRIBUTION

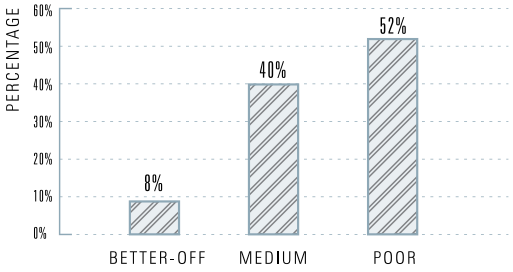


FIGURE 13:
WEALTH CLASS AND LANDHOLDING

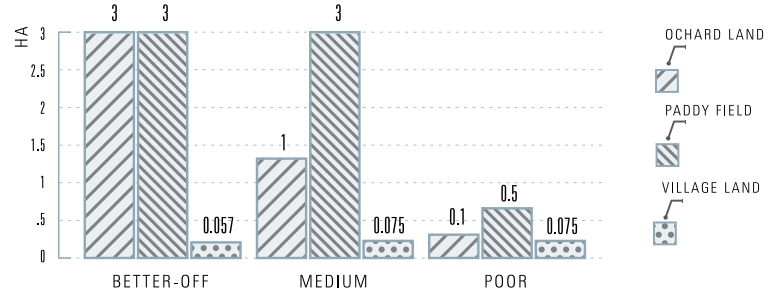
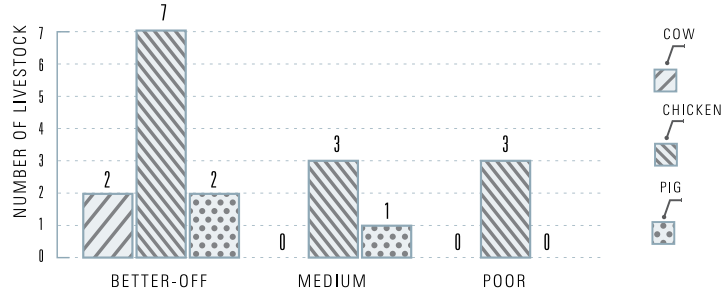


FIGURE 14:
WEALTH CLASS AND LIVESTOCK



LAND TENURE

In many cases, the total landholding varies with wealth class while the type of land held also varies. For historical reasons, it is often the better-off who own the most productive land (better soils, irrigation, good drainage, easy access, etc.). It is important to understand such landholding patterns so that the needs of the poor can be fully addressed in the resulting development plans. A data collection format for this is presented in Table 10.

Presentation of the data for analysis and reporting purposes should be visual wherever possible, and in a format best suited to drawing pertinent and correct conclusions. Figure 15 shows a suggested presentation format.

CHECKLIST

By analyzing land type and tenure issues the CAEA is able to identify agroecosystem zones appropriate for designation as State Private Land for Social Land Concessions (SLC). The characteristics of an agroecosystem zone appropriate for a SLC are:

Low population density.	√
Poor quality or degraded forestland.	√
Low biodiversity values.	√
Adequate agricultural potential.	√
Adequate water resources.	√

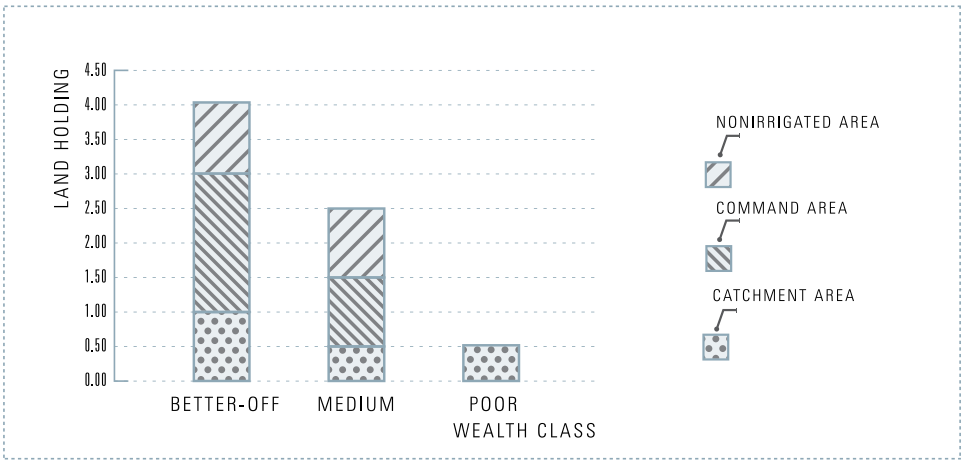
A high incidence of landlessness or particularly small farm sizes in an agroecosystem zone next to a zone with the above characteristics demonstrates an opportunity for an SLC program in the commune. Through these considerations, the CAEA can act as a mechanism for identifying suitable State Private Land for a SLC program for inclusion in the CDP.

TABLE 10:
EXAMPLE OF LAND HOLDING TYPE DATA NEEDED FOR WEALTH RANKING ANALYSIS

LAND HOLDING	CATCHMENT ZONE (HA)	IRRIGATED ZONE (HA)	NONIRRIGATED ZONE (HA)	TOTAL AREA (HA)
Better-off	1	2	1	4
Medium	0.5	1	0.5	2
Poor	0.5	0	0	0.5

Source: Phonley Irrigation Scheme ISAEA, Systems Analysis, July 2006.

FIGURE 15:
EXAMPLE PRESENTATION FORMAT FOR LANDHOLDING TYPE BY WEALTH CLASS



LIVELIHOOD PROFILES

Livelihood profiles are used to integrate an assessment of livelihood assets and other key factors that affect livelihood opportunities into the CAEA process. The tool should be used for each individual agroecosystem zone unless the major livelihood activities are similar across all zones.

Usually, up to three major income sources (i.e. livelihood activities) are identified for each agroecosystem. These will often be noted during the identification of agroecosystem zones in the commune during the Preliminary Analysis (Stage 3) of the CAEA. They may also be identified based on the findings of the transect walk or wealth-ranking.

FURTHER NOTES

A glossary of terms used in the livelihoods analysis above is presented in Appendix 3.

The major income-generating activities within an agroecosystem zone provide the focus for this assessment. Some activities such as fishing may be found in more than one zone and the assessment for that activity need not be repeated for that commune. But fishing in one zone might be very small scale, occurring in rice fields and carried out by poor people while fishing in another zone might be in deeper water requiring boats and different fishing gear. In this case, the livelihood profile should be completed for each of the two different fishing activities.

In the first part of the table identify who is primarily involved in the activity. Is it men or women or both? And which wealth categories are involved? Are there any comments to be recorded about their involvement?

KEY STEPS

1 Participant characteristics– include representatives from different wealth groups in the agroecosystem zones (i.e. better-off, medium, poor and very poor families); both male and female participants; and both farmers and fishers.

2 Use the main livelihood activities (income sources) identified for each agroecosystem as the activities to be analyzed by the Livelihoods Profile tool.

3 If there is a significant overlap of the main livelihood activities in different agroecosystem zones, then it may be sufficient to use these generically across all agroecosystem zones. The zones where the livelihood activity or income source is found can be noted in the first row of the profile.

4 Check if the activities from the above correspond to the most important income sources identified by wealth-ranking. If not, modify the activities to be analyzed by the tool.

5 During the RRA phase of the CAEA use the template shown in Table 11 to compile the livelihood profiles of the livelihood activities for each zone.

6 In completing the rows for livelihood assets, vulnerability factors, organizations and institutions should be prepared to look beyond the borders of the commune to identify important influences. For example, is there a good market for the output in the area and how do prices vary? Or is the labor needed being attracted away from the commune at the critical time?

7 During the Systems Analysis (Stage 5) use the completed livelihoods profiles to identify key problems and solutions to help develop appropriate TIPs. In particular, try to focus on the livelihood activities that are most important for the poor and very poor wealth categories. A TIP that improves knowledge, an organization or market access may be just as valuable as one that improves production.

FURTHER NOTES *cont.*

In the second part of the table consider each of the livelihood assets: human, natural, physical, financial and social capital. Which of these assets needed for this activity are the most important? What may be missing or lacking, either for everyone in the commune or for one or more of the wealth categories?

What are the most important vulnerability factors? These are the factors that can influence the success of an activity and how much income it generates but that are beyond the control of people in the commune. For example, some crops may be more vulnerable to extreme weather or to variation in market prices than others. Some forms of fishing may be more vulnerable to overfishing than others.

What are the key organizations that help an income-generating activity to succeed? It could be a formal organization such as agricultural extension which provides the necessary technical advice, for example, how to control animal diseases. Or it could be an informal village organization which arranges labor-sharing or helps people borrow money to buy inputs.

What laws, rules or customs (institutions) are necessary to make sure the income-generating activity is successful and can continue in the long term? Are there any rules or customs which are having a bad effect because they are stopping the activity from developing in the way that it could?

For each row in the table consider whether the issue is the same for all people or whether there are worse problems for women compared to men, or for poor people compared to wealthy people. Make a note of the problems identified.

TABLE 11: HYPOTHETICAL EXAMPLE OF A LIVELIHOOD PROFILE

AGROECOSYSTEM ZONE:
SEASONALLY FLOODED LOWLAND MIDDLE TERRACE

LIVELIHOOD ACTIVITY: DEEP-WATER RICE

PRIMARY INVOLVEMENT		COMMENTS
Men	√	
Women	√	

WEALTH CATEGORY		COMMENTS
Better-off	√	Lack labor during peak periods
Medium	√	
Poor	√	Lack access to seasonal finance/credit
Very poor		

KEY LIVELIHOOD ASSETS EMPLOYED	DESCRIPTION	DEFICIENCIES/NEEDS:
Human capital - Skills, knowledge, ability, health, etc.	Labor, knowledge of seasonal flooding regime	Shortage of labor at harvest - Poor health during monsoon season
Natural capital - Natural resource base (forest, water bodies, fish, etc.)	Land owned, land rented, Annual flooding of the lake	Seasonal flooding has become increasingly more variable in timing and duration
Physical capital - Basic infrastructure and inputs needed to support livelihoods	Farm tools, rented combine for harvest; roads impassable at harvest	Threshers not available during peak harvest period, particularly for the poor - Reliant on traders to buy crop due to poor roads
Financial capital - Liquid assets, cash and regular cash inflows (pensions, remittances, etc.)	Credit advanced by traders and thresher owners	High effective rates of interest and require immediate repayment at harvest
Social capital - Family, friends, social networks, political affiliations, etc.	Reciprocal labor exchange with neighbors and within kinship networks	Exchange of labor essential to meet peak labor needs
Vulnerability factors - External forces over which people have limited or no control	Inadequate flooding; storm damage to crop; low market prices	Strengthen human capital through improved information provision - Producer groups to share information
Key organizations - Formal and informal	Agricultural Extension Department	Lack relevant recommendations/ technologies
Laws, rules and customs	Restrictions on forest clearance for farmland.	

GENDER TASKS ANALYSIS

The Gender Tasks tool provides disaggregated information on the proportion of men and women engaged in each livelihood sub-task. This provides a better understanding of the different roles played by men and women in the various livelihood activities undertaken in the commune.

This will help ensure that the needs of both men and women can be adequately addressed in the commune during the formulation of key questions and the designing of solutions and innovation assessments. It will also help in better understanding both the positive and negative impacts a potential TIP could have on gender. A suggested data collection format for this is shown in Table 12.

KEY STEPS

1 Participant characteristics – it is important that both men and women take part in this exercise. At least one woman to represent each of the different livelihood activities in the agroecosystem zones, such as farming and fishing should be included.

2 During the RRA, use the Gender Task Analysis Checklist (see Table 11) to identify the most important livelihood activities.

3 List these activities in the left hand column of the Gender Task Analysis Table, as shown in the template in Table 12

4 Discuss with the participants the role of women and men in each livelihood activity and record these on the form on the basis of a percentage effort for each activity.

5 During the Systems Analysis (Stage 5) of CAEA, use the results of the Gender Task Analysis to help assess the gender impacts of proposed TIPs when conducting Innovation Assessment and when preparing gender-impact statements.

CHECKLIST

The following checklist should be used to identify locally important livelihood activities for analysis by the Gender Task Analysis tool (Table 12).

WET-SEASON RICE ACTIVITIES	
Nursery land preparation	
Sowing nursery	
Pulling seedlings	
Transport seedlings	
Land preparation	
Planting/transplanting	
Fertilizing	
Water control	
Weeding	
Harvesting	
Transportation	
Threshing	
Storage	

FISHING ACTIVITIES	
Fishing (income and consumption)	
Marketing	
Processing	
Preparation for home consumption	
Making fishing gear	

OTHER KEY LIVELIHOOD ACTIVITIES	
Home-garden	
Upland cash crops	
Pig raising	
Cattle raising	
Poultry raising	
NTFP collection	
Firewood collection	
Charcoal	
Sericulture	
Water collection	
Maintenance of the irrigation system	

ECONOMIC ACTIVITIES	
Selling agricultural products	
Obtaining/paying back loans	
Trading	
Household expenses	

TABLE 12: TASK ANALYSIS BY GENDER - EXAMPLE DATA COLLECTION FORMAT

	MEN	WOMEN	ADDITIONAL OBSERVATIONS
WET-SEASON RICE ACTIVITIES			
Nursery land preparation	100%		
Sowing nursery	50%	50%	Women soak seeds, men assist in sowing seed
Pulling seedlings		100%	
Transport seedlings	100%		Women sometimes assist if field is near the village
Land preparation	100%		
Planting/transplanting	30%	70%	Amount of transplanted rice will increase after irrigation
Fertilizing	90%	10%	Fertilizer use is likely to increase
Water control	100%		Water control will be easier with irrigation
Weeding		100%	Weed burden is likely to decrease with irrigation
Harvesting	20%	80%	Higher yields with irrigation will increase the workload
Transportation	100%		Higher yields with irrigation will increase the workload
Threshing	90%	10%	Fee for mechanical threshing is 4% of the rice threshed
Storage	20%	80%	
OTHER KEY LIVELIHOOD ACTIVITIES			
Home-garden		100%	Only a few households grow vegetables in home-gardens
Upland cash crops	50%	50%	Mainly the poor and medium wealth classes
Pig raising	10%	90%	If larger scale (>5 pigs) usually managed by men.
Cattle raising	100%		
Poultry raising		100%	
NTFP collection	40%	60%	Some items are gender-specific
Firewood collection	40%	60%	This activity is dramatically decreasing because of availability
Sericulture		100%	There are currently 38 families growing mulberry trees
Charcoal	80%	20%	Seven charcoal production sites around Phonley
FISHING			
Fishing for income	90%	10%	Only in women-headed households are women directly involved in fishing for income, otherwise women are mostly involved in the preparation of fish as food, and in fish processing and sale.
Fish for own consumption	90%	10%	Mostly men do this kind of activity. Fewer women engage in main fishing activities
Fish sales	10%	90%	
Fish processing	10%	90%	Sometimes, men also do fish processing, especially when they have to stay at the fishing sites longer without women accompanying them
Cooking fish		100%	
FISH-RAISING			
Preparing place	90%	10%	In general, men take the lead role. Women just take part in some light work
Find fingerlings	90%	10%	In some cases, (small-scale low input) women could take the lead role. For small- scale high input or SME, mostly men take the lead role
Feeding and caretaking	50%	50%	Not such heavy work
Marketing and selling	10%	90%	This is still considered a "woman's" job
Trading	10%	90%	
Water collection	20%	80%	
Maintenance of the irrigation system	100%		

NON-TIMBER FOREST PRODUCTS

The collection of Non-Timber Forest Products (NTFPs) is often an important livelihood activity, particularly for poor families. It is important to gain an understanding of NTFPs during the CAEA since agricultural and other livelihood development activities may impact on their availability. It is also useful to explore possibilities for sustainable harvesting and domestication. An example template for obtaining NTFP information, with examples, is presented in Table 13.

KEY STEPS

1 Participant characteristics – both men and women engaged in NTFP collection should be included in this exercise.

2 During the RRA, use key informants to identify all the NTFPs important in livelihood activities.

3 List these NTFPs in the left hand column of the template presented in Table 13, and with key informants complete the remainder of the table.

4 After completing the analysis, spend a few minutes with farmers in summarizing the key findings. In particular, identify important NTFPs that are rapidly declining and with farmers explore possible ways to maintain their availability.

5 Summarize the findings from item 4 above for later use during the Systems Analysis phase of CAEA.

6 During the Systems Analysis (Stage 5) of CAEA, use the results of the NTFP Analysis to ensure that important NTFPs are included in the relevant Land and Water Resource Management Strategies.

TABLE 13: NTFP TEMPLATE - EXAMPLE FROM CHOUM KRAVIANG COMMUNE

NTFP	AGRO ECOSYSTEM	USE	FAMILIES	COLLECTION	DECLINE IN THE LAST 10 YEARS (%)	HARVEST PERIOD
Bamboo shoot	All zones	Sale	64	Female	30	July-Oct.
Firewood	All zones	Sale	100	Female	0	All year
Treang palm leaf	Zone III	Sale	4	Male	20	All year
Bamboo	Zone III	Sale	32	Male	30	All year
Canmar leaf	All zones	Family use	-	Both	60	All year
Grass for thatching	All zones	Sale	-	Male	10	All year
Rattan	Zone III	Family use	40	Both	70	All year
Psat leaves (various)	All zones	Family use	-	Female	0	6 months

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ECONOMIC ANALYSIS AND DECISION-MAKING TOOLS

MARKET AND VALUE-CHAIN ANALYSIS

Value-chain mapping allows a better understanding of market-related problems and opportunities for important livelihood products (crops, livestock, fish, NTFPs, etc.). Value-chain maps show the flow of a product through the marketing chain and help identify where and how value is added to the product by the activities of different actors in the chain. Analysis of completed value-chain maps allows price and market constraints to be identified along with opportunities for enhancing value-added by additional or alternative operations by value-chain actors. The outputs of value-chain maps are used to plan market-related interventions (Marketing TIPs).

Value chains are different for different products. For example, the value chain for rice, fish or processed Pra Hok for family consumption is normally short and simple with only one type of actor, namely the farming family. However, the value chain for Tonle Sap high-value fish species that are dried, graded, bulked and exported is typically long and complex, with many different actors (fishermen, processors, middlemen, wholesalers, exporters, etc.).

CHECKLIST

Value-chain maps should contain all of the following:

All actors in the value/market chain.	√
The number of actors at each step in the chain.	√
The value of the product at each step in the chain.	√

KEY STEPS

1 Participant characteristics – in addition to farmers, ensure that fishermen using different fishing grounds (e.g. paddy fields, flooded forests, lakes, rivers) in the agroecosystem zone are included as participants in this exercise.

2 Value-chain mapping should be done for the same important enterprises for which gross margins were done, and should include at least one crop, one livestock type and one fish enterprise. Figure 16 shows a chicken-value chain – lowland lower terrace zone, Snar Ansa Commune, Pursat Province.

3 During the RRA, with key informants, draw flowcharts that trace the movement of the product among the different actors along the marketing chain.

4 Start the value-chain map with the local producers and work backwards along the input supply chain and forwards along the marketing chain.

5 With the informants, obtain an estimate of the number of actors at each stage of the value chain, and obtain estimates of the value of the product at each stage in the chain.

6 After completing the analysis, spend a few minutes with farmers in summarizing the most important findings obtained from the tool. In particular, try to identify the most important constraints, bottlenecks and opportunities for each link in the chain.

7 Summarize the findings from item 6 above for use during Systems Analysis (Stage 5).

8 During the Systems Analysis (Stage 5) of CAEA, use the results of the value-chain analysis to formulate key questions and potential solutions (TIPs) to solve marketing problems for the products covered.

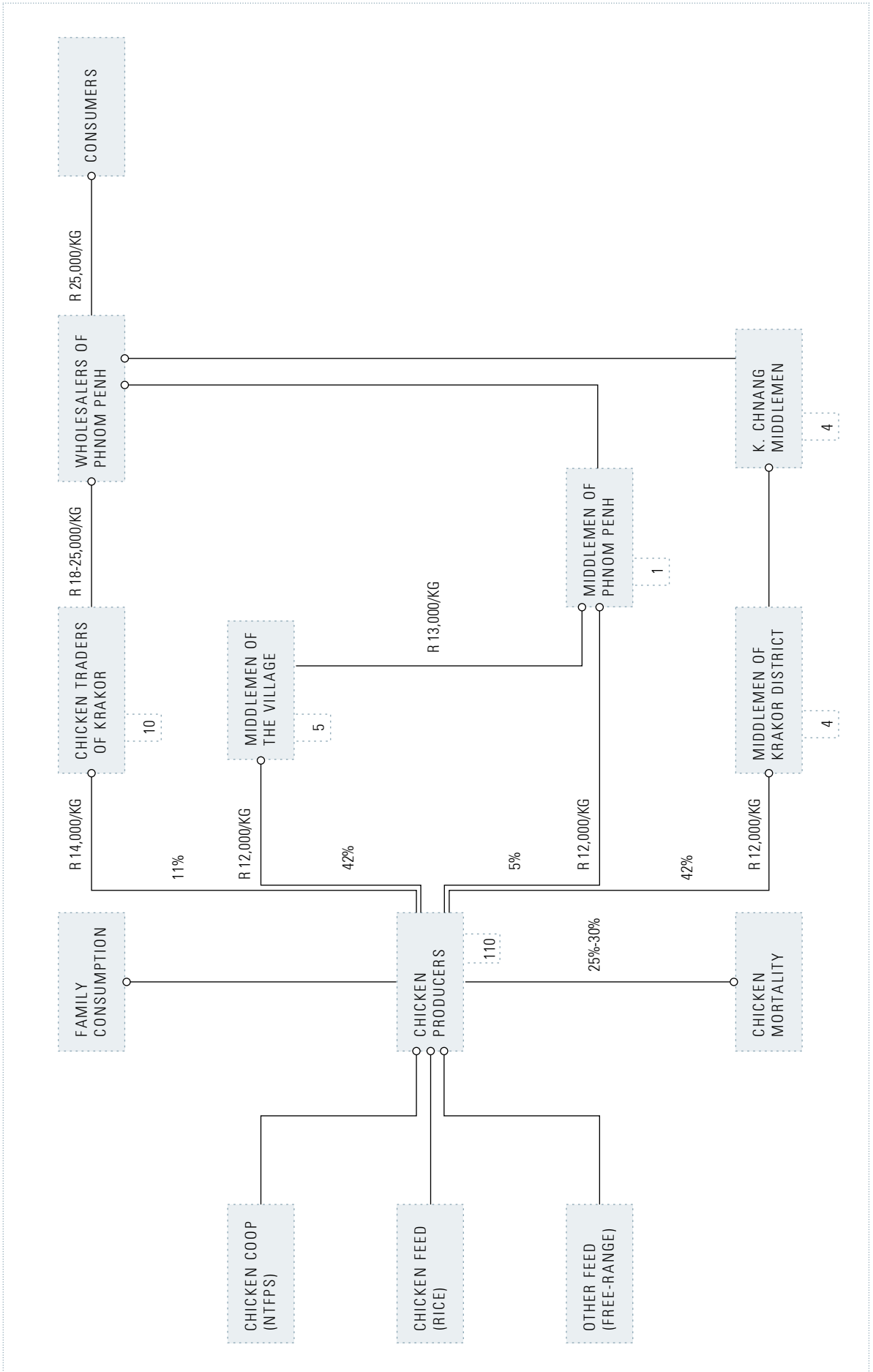


FIGURE 16: CHICKEN-VALUE CHAIN: LOWLAND LOWER TERRACE ZONE, SNAR ANSA COMMUNE, PURSAT PROVINCE.

GROSS-MARGIN ANALYSIS

Gross margins for major enterprises are developed using information derived from the farmers during the RRA, and are used to promote a better understanding of local production systems, and to help identify where improvements can be made. Gross margins for traditional practices can also be compared with those for improved practices to show farmers how they can adjust their farming systems to obtain better returns. An example gross-margin analysis is presented in Table 15.

CHECKLIST

Value-chain maps should contain all of the following:

All actors in the value/market chain.	√
The number of actors at each step in the chain.	√
The value of the product at each step in the chain.	√

KEY STEPS

1 Gross margins should be conducted for the three most important enterprises in respect of income and should include at least one crop, one livestock and one fisheries enterprise (see Table 15).

2 With regard to fish and NTFPs, gross-margin analysis is conducted only for aquaculture or domesticated NTFP enterprises, not for wild capture systems.

3 Gross margins for major enterprises should be developed with farmers using information derived from them during the RRA.

4 After completing the analysis, spend a few minutes with farmers in summarizing the most important findings obtained from the tool. In particular, use the results to identify ways to reduce costs and increase the prices received.

5 Summarize the findings from item 4 above for use during Systems Analysis (Stage 5).

TABLE 14: RAIN-FED, WET-SEASON, TRANSPLANTED-RICE GROSS-MARGIN ANALYSIS, PUNLEY COMMUNE, BANTEAY MEANCHEY PROVINCE

ACTIVITY	QUANTITY (UNITS/HA)	UNIT PRICE (RIEL)	TOTAL PRICE (R/HA)
Seed rice	50 kg	620	31,000
Rice nursery operations			
Land preparation	-	-	15,000
Animal manure	0.25 tons	60,000	15,000
Pull seedlings	10 man-days	6,000	60,000
Paddy rice operations			
Land prep.	1 ha	75,000	75,000
Transplanting	1 ha	75,000	75,000
Animal manure	-	-	-
Basal fertilizer	50 kg	1,070	53,500
Topdressing	-	-	-
Post-harvest operations			
Harvest	1 ha	100,000	100,000
Transport	1 ha	50,000	50,000
Threshing	1 ha	40,500	40,500
		Total expenses	510,300
Yield (kg)	1,710	450	769,500
		Total returns	769,500
		Net returns	256,500

TABLE 15: CHECKLIST: GROSS MARGIN ANALYSIS

COST CALCULATIONS	RETURNS CALCULATIONS
Crops Seed Nursery operations Land preparation Animal manure/fertilizer (basal and topdressing) Harvest Post-harvest (cleaning, threshing, drying, processing) Transport and marketing costs Labor (family and hired) Other downstream costs (specify)	 Yield Post-harvest losses Price received By-products (paddy, fish, crabs, etc.) Other returns (specify)
Livestock Purchase/breeding costs Feed Vaccination/medicines/drenches Labor (family and hired) Transport and marketing costs Labor (family and hired) Other downstream costs (specify)	 Price received By-products (eggs, milk, etc.) Other returns (specify)
Fish Cost of fingerlings Cost of fish feed Labor costs Travel and transport costs Cost of equipment (pumps, cages, etc.) Pumping costs Processing costs Marketing costs Labor (family and hired)	 Yield Post-harvest losses Price received Sale of fish by-products Value of fish consumed Other returns (specify)

PAIR-WISE RANKING TECHNIQUE

Pair-wise ranking (see Table 16) provides a means of objectively ranking issues, problems and solutions. It is used with farmers during the RRA to help them prioritize the problems they face. Objectivity is improved if the ranking is conducted by a group of different types of people (men/women, better-off/poor, young/old, etc.), as then it incorporates a variety of different perspectives and points of view. Consequently, pair-wise ranking should be conducted in a plenary group involving all farmer key informants.

CHECKLIST

Value-chain maps should contain all of the following:

All actors in the value/market chain.	√
The number of actors at each step in the chain.	√
The value of the product at each step in the chain.	√

KEY STEPS

1 List all the problems raised by all groups during the RRA, and by means of a vote, produce a short list of about 10 problems identified as the most important by key respondents.

2 List the priority problems in a matrix as shown in the example in Table 16.

3 Ask the participants to compare each problem with every other problem in turn, and decide which is the most important.

4 Place the number representing the problem voted the most important in each comparison in the appropriate cell in the matrix.

5 When all comparisons have been completed, the scores (response frequency) are totaled as shown in the scoring chart in Table 16, and the problems are listed according to their importance as shown in the final ranking column of the scoring chart (see Table 17).

TABLE 16: PAIR-WISE RANKING MATRIX

KEY QUESTIONS OR PROBLEMS	1. LACK OF WATER IN DRY SEASON	2. POOR ROADS AND DIFFICULT ACCESS	3. LOW MARKET PRICES (DISTRICT MARKET)	4. DECLINING NTFP AVAILABILITY	5. DECLINING SOIL FERTILITY	6. OUTBREAKS OF ANIMAL DISEASES	7. LACK OF ANIMAL MANURE
1. LACK OF WATER IN DRY SEASON							
2. POOR COMMUNICATIONS AND DIFFICULT ACCESS	1						
3. LOW DISTRICT MARKET PRICES	1	2					
4. DECLINING NUMBERS OF NTFPS	1	2	4				
5. DECLINING SOIL FERTILITY	1	2	3	4			
6. ANIMAL DISEASE OUTBREAKS	1	2	6	6	6		
7. LACK OF ANIMAL MANURE	1	2	7	7	7	6	

TABLE 17: PAIR-WISE RANKING SCORING CHART

KEY QUESTION OR PROBLEM	RESPONSE FREQUENCY	RANKING
1. Lack of water in dry season	6	1
2. Poor communications and difficult access	5	2
3. Low district market prices	1	6
4. Declining numbers of NTFPs	2	5
5. Declining soil fertility	0	7
6. Outbreaks of animal diseases	4	3
7. Lack of animal manure	3	4

CAUSE-EFFECT DIAGRAMS

Cause-effect diagrams are used to break down broad problem areas (key issues) into their causal factors which are then used to identify appropriate solutions. Although extremely valuable in helping to better understand problems, the cause-effect tool is rather time-consuming and not easy to use. For this reason, two options are presented. First, if the CAEA team has sufficient confidence and experience, cause-effect diagrams should be produced with farmers during the RRA, but only for the four highest priority problems identified by pair-wise ranking. If skills and experience are limited, pair-wise ranking should be conducted during the Systems Analysis (Stage 5) of CAEA, using CC representatives as key respondents. In this case, the cause-effect tool should be used for the four highest priority TIPs identified by innovation assessment.

Cause-effect diagrams begin with a broad statement of the overall problem which is then broken down into component problems and eventually root causes. The effects of the problem are then investigated to gain a more holistic understanding and to help generate key questions. The steps are illustrated below with an example from Horne. and Stur 2003 – Developing agricultural solutions with smallholder farmers – how to get started with participatory approaches. ACIAR Monograph No. 99. 120 pages. (CIAT, Vientiane, Lao PDR).

KEY STEPS

1 With the key respondents, identify the four most important problems facing the commune as a whole. If appropriate, it may be useful to select one priority from each of the following categories:

- Agricultural problems
- Environmental problems
- Fisheries problems
- Livelihood problems

2 For each priority problem and following the examples presented in the figures, construct diagrams to discuss the following questions:

- What is the main problem? (see Figure 17)
- What are the causes of the problem? (see Figure 18)
- What are the effects of the problem? (see Figure 19)
- How do farmers cope with the problem? (see Figure 20)
- How do we solve the problem? (see Figure 21)

FIGURE 17: CAUSE-EFFECT DIAGRAM 1
WHAT IS THE MAIN PROBLEM?

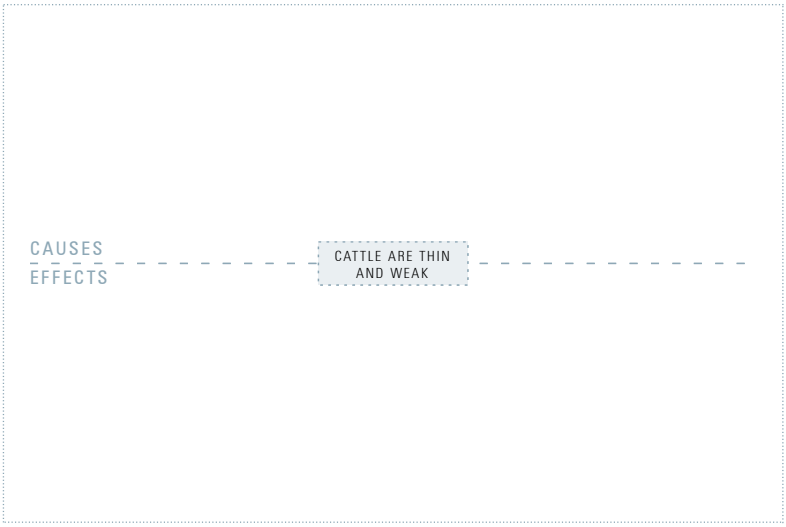


FIGURE 18: CAUSE-EFFECT DIAGRAM 2
WHAT ARE THE CAUSES OF THE PROBLEM?

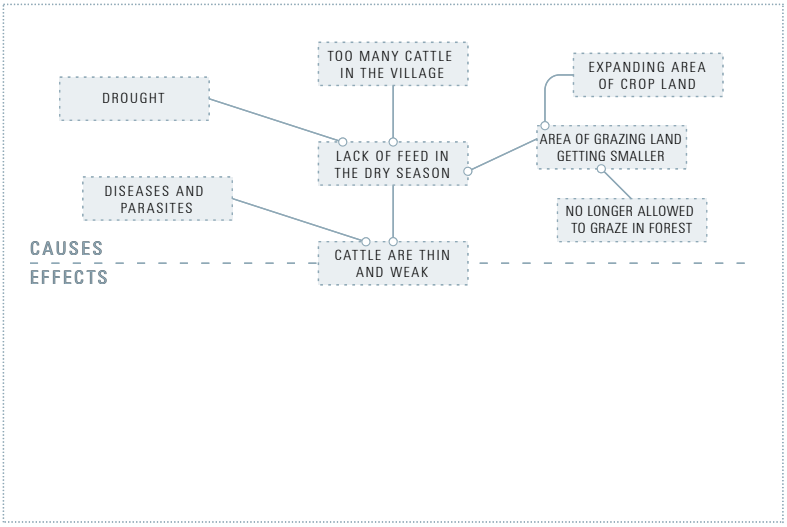


FIGURE 19: CAUSE-EFFECT DIAGRAM 3
WHAT ARE THE EFFECTS OF THE PROBLEM?

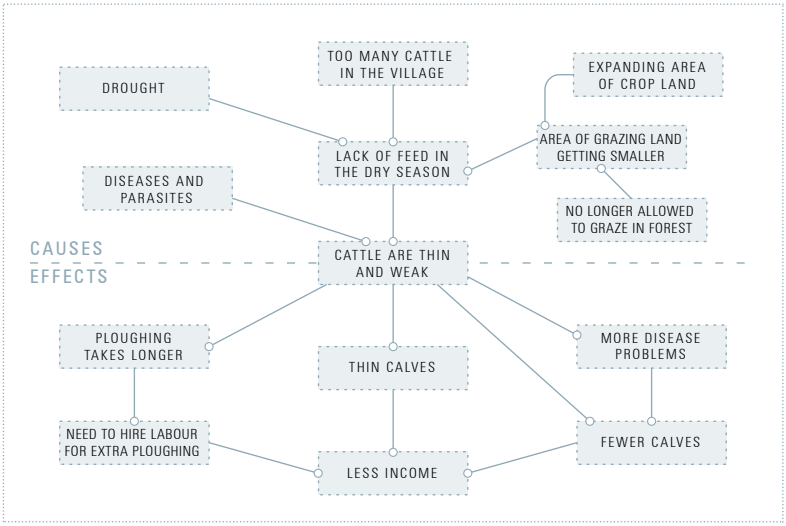


FIGURE 20: CAUSE-EFFECT DIAGRAM 4
HOW DO FARMERS COPE WITH THE PROBLEM?

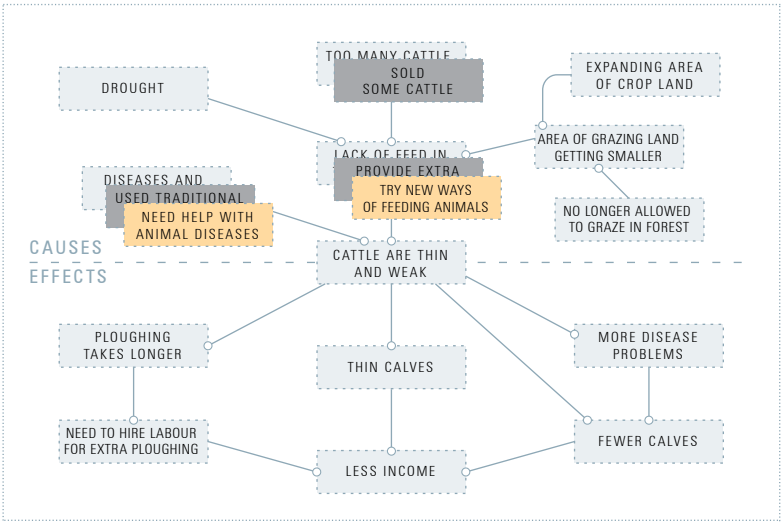
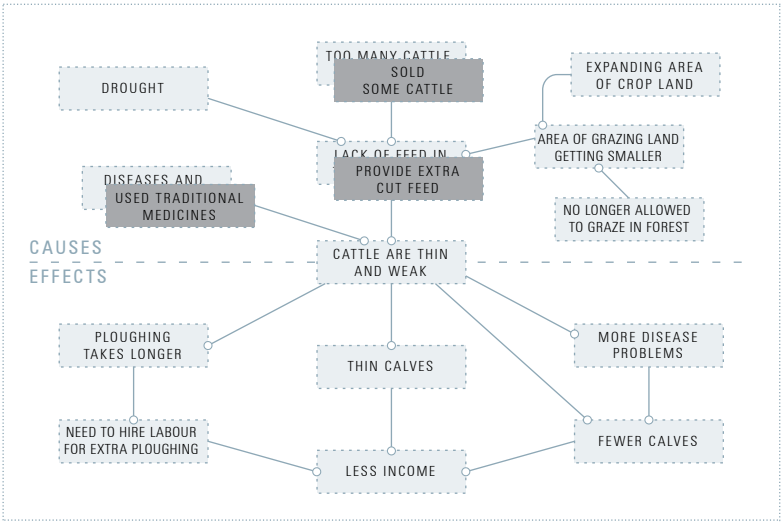


FIGURE 21: CAUSE-EFFECT DIAGRAM 5
HOW DO WE SOLVE THE PROBLEM?



VENN DIAGRAM

A Venn diagram is used to analyze relationships between local communities and those projects and agencies providing them with support. It is useful in identifying potential development partners or detecting where interagency cooperation could be improved. An example Venn Diagram from a CAEA in Kampong Cham is presented in Figure 22.

CHECKLIST

Venn Diagrams should include all projects, programs and activities implemented by:

Government agencies.	√
International donors.	√
NGOs.	√
Nonprofit organizations.	√
SMEs.	√
The private sector	√

KEY STEPS

1 List all projects and programs currently active in the commune, along with a brief description of their major activities.

2 Construct a Venn diagram, noting that overlapping circles represent good cooperation, touching circles represent some cooperation and non-touching circles representing poor or no cooperation.

3 After completing the analysis, spend a few minutes with farmers in summarizing the most important findings. In particular, use the results to identify potential partners for implementing different components of the CAP.

4 Summarize the findings from item 3 above for later use during the Systems Analysis (Stage 5) of CAEA when identifying potential partners for TIP implementation.

FIGURE 22: VENN DIAGRAM FOR CHOUM KRAVIANG COMMUNE, KAMPONG CHAM PROVINCE.

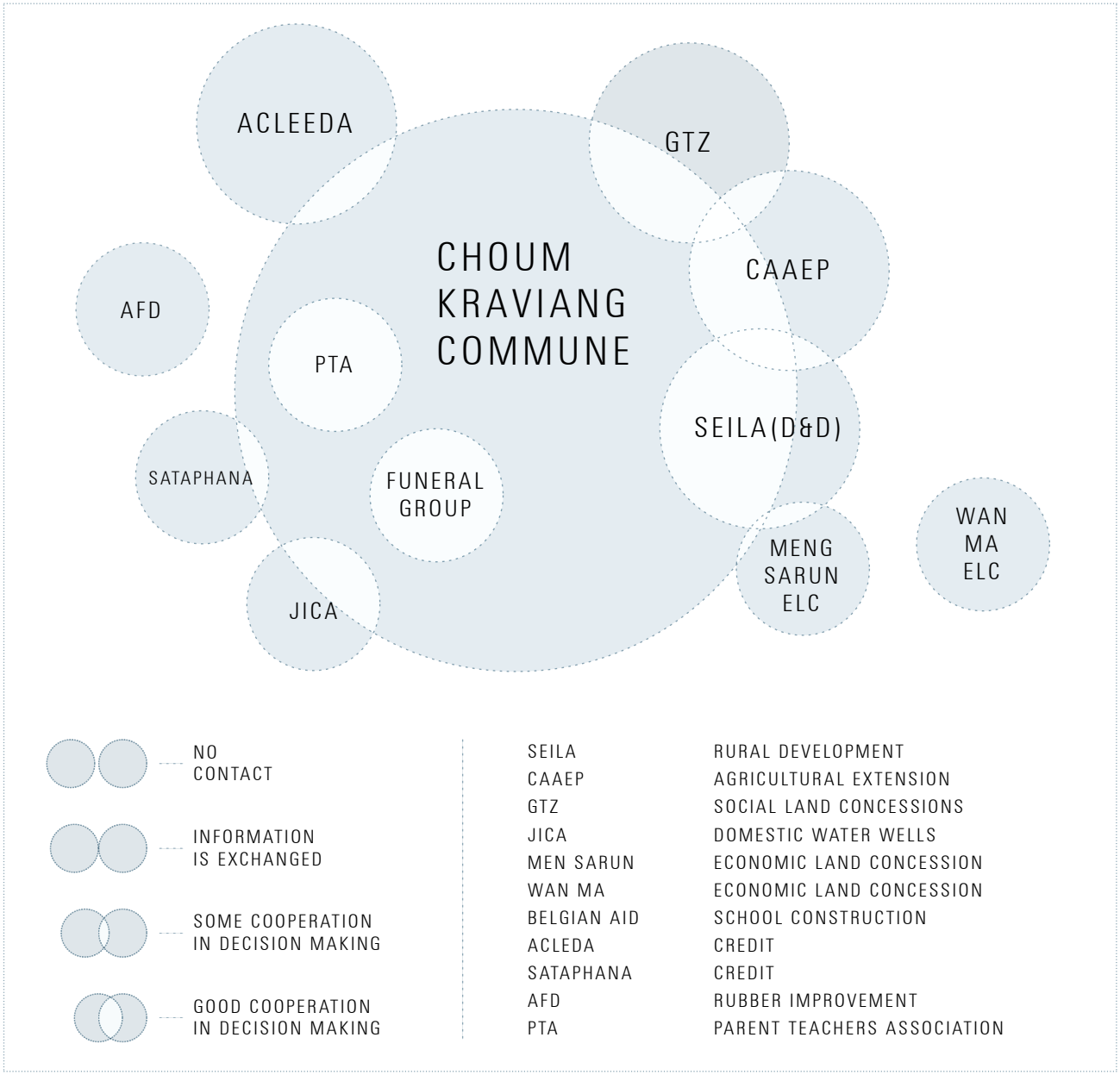


TABLE 18: ANALYSIS OF SYSTEM PROPERTIES USING RRA TOOLS

RRA TOOL	SYSTEM PROPERTY ADDRESSED	FURTHER ANALYSIS RECOMMENDED
Maps	Stability (spatial)	Compare productivity levels in different areas and identify the reasons for these.
Water body analysis	All to some extent	Compare productivity levels in different water bodies and identify the reasons for these; also assess to what extent the different water bodies together are able to provide stable, year-round benefits.
Assessment of fish species	Productivity and sustainability	Compare the productivity of different species (catch x value) and explore the reasons for changes in species populations in the last 10 years.
Flow diagrams	All to some extent	Analyze how each type of flow affects each system property. For example, extractive flows such as nutrient flows or land clearing (sustainability); intermittent flows such as migration (stability); labor flows (productivity), etc.
Transect analysis	All to some extent	Compare the productivity, stability, sustainability and equitability of major enterprises in the different agroecosystems and analyze the reasons for any differences.
Time line	Sustainability	Review the time line to identify any long-term trends and their causes, such as the reasons for decline of rice yield, soil erosion, overgrazing, overfishing, etc. Ask farmers if they can identify any other long-term trends that are occurring. Analyze the cause and the impacts of these long-term trends.
Seasonal calendar	Stability	Look at the timing of key livelihood activities to see if shifts are possible to avoid drought, flooding, disease, etc. or to obtain better quality, prices, etc.
Wealth analysis	Equitability	Analysis will show the key differences among the wealth classes. Analyze the differences and explore ways in which poorer farmers could move towards the farming system typologies which characterizes the better-off.
Livelihood profiles	All to some extent	Productivity, sustainability and equitability can be affected if one or more livelihood assets are deficient or lacking for a wealth group. Stability can be affected if the livelihood activity is vulnerable to an external factor beyond the control of households. Having the right organizations and institutions in place can contribute to all four systems properties.
Analysis of gender task	Equitability	Identify any problems specific to women and explore possible solutions. Assess the gender impacts of proposed interventions (TIPs). Use the results when conducting Innovation Assessment and when preparing gender-impact statements.
NTFP analysis	Sustainability	Identify important NTFPs that are rapidly declining and with farmers explore possible ways to maintain their availability. Explore the potential for the domestication of key NTFPs.
Cause and effect	All to some extent	Analyze how each root cause of the problem affects the various system properties and explore potential solutions with farmers.
Venn diagrams	Decisions	Use the results to guide proposed solutions, e.g., synergies with other projects, possibilities for cooperation with other agencies in implementing the CAP. Explore how other stakeholders might be able to provide assistance to key problems identified in the above analyses.
Gross margins	Productivity (profit)	Compare traditional and improved practices with farmers with respect to gross margins, and identify what changes could be made to increase productivity.
Analysis of market chain	Productivity (profit)	Review the results to identify key bottlenecks in the market chain or points in the value chain where value-added opportunities might exist.

ANALYSIS OF RRA TOOL OUTPUTS

There is sometimes confusion among CAEA practitioners as to the difference between stability and sustainability. In the context of AEA, there are events such as floods or droughts that have a destabilizing effect (short-term), while sustainability relates to stresses and strains (long-term) such as rising soil salinity, soil erosion or climate change.

Although no RRA technique directly addresses a system property, different tools are helpful in identifying and analyzing the various properties (see Table 18). For example, time lines help identify longer-term trends that occur (sustainability); seasonal calendars are used to identify sporadic events within a year (stability); wealth analysis identifies the characteristics of different wealth classes (equitability); and comparative analysis of gross margins for different enterprises promotes an improved understanding of productivity. Table18 provides guidelines for the analysis of the outputs of the main RRA tools, and a few minutes should be allocated after using each tool to conduct these analyses.

SYSTEMS ANALYSIS

Following the RRA, the information gained from the tools is organized and prepared for further analysis. The Systems Analysis phase integrates and analyzes information obtained from the secondary data, the preliminary survey and the RRA in order to identify the most important agricultural problems and opportunities and to develop a future 'vision' for the commune.

To facilitate the process it is useful to maintain and continually update two flip charts throughout this phase. The first, entitled "Key Issues" is used to record important issues as they are identified; these are then used to help define and formulate key questions. The second flip chart, entitled "Future Vision" is used to record the ideas and aspirations of villagers and CC representatives in terms of their vision for the commune in 10-20 years' time; the results are used to develop commune land and water management strategies as the final step in systems analysis.

Systems analysis proceeds, in plenary session, through a number of steps using the following tools:

SWOT ANALYSIS

SWOT analysis identifies and analyzes the **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats facing agriculture, fisheries and livelihoods in the commune. The results of a SWOT analysis for Punley Commune, Banteay Meanchey Province are presented as an example in Table 19.

CHECKLIST

The following technical areas should be covered by the SWOT analysis (Table 19):

Land and water (including climatic events such as floods and droughts).	√
Agriculture and fisheries.	√
Environment and forestry.	√
Livelihoods, poverty and gender.	√
Law and policy.	√

KEY STEPS

1 Use the Commune Profile with key informants and CC representatives to identify other projects and programs being implemented in the commune.

2 If possible, construct a Venn diagram according to each program's level of communication with the Commune Council and its integration with the CDP.

3 Discuss the Commune Profile and the completed Venn diagram with key informants and analyze the strengths, weaknesses and lessons learned from other projects and programs.

4 Use the results of Venn diagram analysis and from discussions during key question formulation to identify potential partners for implementing the TIPs.

TABLE 19: EXAMPLE OF A SWOT ANALYSIS FOR PUNLEY COMMUNE, BANTEAY MEANCHEY PROVINCE

KEY QUESTION OR PROBLEM	RESPONSE FREQUENCY
Strengths	Large land area and size of landholdings
	Variety of land types
	Adequate remaining natural resources
	Good water resources (reservoir, creeks, ponds)
	Good returns from rice, and cattle
	Good employment opportunities in Thailand
Weaknesses	Inappropriate land use in some zones
	Inequitable landownership
	Deforestation and resource degradation
	Waterlogging in chamkar crops
	Inappropriate cultural practices related to rice
	Unsuitability of saline groundwater for agricultural use
	Labor shortages in peak periods
Opportunities	Soil fertility improvement
	Crop diversification
	Improved chamkar production with irrigation
	Recession rice in reservoir drawdown area
	Increased cropping intensity by improved water use efficiency
	Eco-tourism associated with the reservoir
	Growing markets for cash crops
Threats	Soil erosion and reservoir sedimentation
	Further degradation of forests
	Land conflict as a result of irrigation development (land loss, etc.)
	Loss of wildlife habitat
	Increased inappropriate use of agrochemicals
	Livestock diseases
	Burning rice straw after harvest

ANALYSIS OF SYSTEM PROPERTIES

Following the SWOT analysis, the four system properties of productivity, stability, sustainability and equitability are assessed using the SWOT results. The analysis is conducted by constructing a matrix as shown in the example in Table 20, and identifying the system property(ies) impacted positively or negatively by each of the SWOT elements.

It should be emphasized that the purpose of the analysis of system properties is to stimulate discussion and promote understanding of issues related to each of the system properties. The scores generated in the final column are merely for cross-checking the results and should not be recorded in the CAEA report.

KEY STEPS

1 Construct a system properties analysis matrix using the SWOT results.

2 Identify the main system property(ies) impacted positively or negatively by each of the SWOT elements and record the results in the matrix.

3 Add up the total 'hits' for each system property, and if any have particularly low scores relative to the others go back to the SWOT analysis and attempt to identify additional SWOT issues related to that system property.

4 The results in the combined SWOT/System Properties matrix should be reviewed when finalizing key questions to ensure that no important issues have been omitted.

TABLE 20: EXAMPLE OF A SWOT ANALYSIS FOR PUNLEY COMMUNE, BANTEAY MEANCHEY PROVINCE

		PRODUCTIVITY	STABILITY	SUSTAINABILITY	EQUITABILITY
Strengths	Large land area and size of landholdings	√			
	Variety of land types		√		
	Adequate remaining natural resources			√	√
	Good water resources (reservoir, creeks, ponds)	√	√	√	√
	Good returns from rice and cattle	√			
	Good employment opportunities in Thailand		√		√
Weaknesses	Inappropriate land use in some zones	√		√	
	Inequitable land ownership				√
	Deforestation and resource degradation			√	√
	Water-logging in upland crops	√	√		
	Inappropriate cultural practices related to rice	√		√	
	Saline groundwater inappropriate for agricultural use	√		√	
Opportunities	Soil fertility improvement	√		√	
	Crop diversification		√		
	Improved upland crop production with irrigation	√	√		
	Recession rice in reservoir draw-down area	√			√
	Increased cropping intensity by improved water use efficiency	√			
	Eco-tourism associated with the reservoir	√	√		√
Threats	Soil erosion and reservoir sedimentation			√	
	Further forest degradation			√	√
	Land conflict as a result of irrigation development				√
	Loss of wildlife habitat			√	√
	Increased inappropriate use of agro-chemicals	√	√	√	
	Livestock diseases	√	√		
	Burning rice straw after harvest			√	
	Total:	14	9	12	10

FORMULATING KEY QUESTIONS AND DESIGNING SOLUTIONS

Key questions address important issues identified by the CAEA. They emerge throughout the process from preliminary analysis onwards, and it is helpful to keep a list of key issues as they arise and record these on flip charts. Initially, the issues are likely to be rather general and poorly formulated, but as the analysis proceeds they become clearer and more focused. As these issues are clarified and fleshed-out, key questions and hypotheses are tabled, elaborated and used to identify important agricultural development and extension activities.

The use of 'Key Question Attributes' can provide valuable insights into the nature of the issue and help better formulate the question and the steps necessary to address it. The process essentially poses the questions of what? when? who? where? and most importantly, how? and why? and ensures that all aspects of the problem are explored. Table 21 provides guidelines for formulating key questions and identifying TIPs for their solution.

Once key questions have been formulated, guidelines for addressing them are established and plans for implementing extension and development programs made. Key questions are formulated and TIPs designed to address them by identifying a series of elements for each question as shown in the checklist. Examples of completed Key Questions and relevant TIPs are presented in Table 2.

CHECKLIST

The technical components of the proposed program that addresses the key question.	√
The extension methods and delivery mechanisms proposed to transfer the proposed technology to farmers.	√
Technical reports and extension materials that will be useful in developing and disseminating the proposed technology.	√
Potential partners for developing and extending the proposed technology.	√
Target farmer groups and the agroecological zone(s) where the proposed technology will be used.	√

KEY STEPS

1 The technical components of the proposed program that addresses the key question.

2. The extension methods and delivery mechanisms proposed to transfer the proposed technology to farmers.

3 Technical reports and extension materials that will be useful in developing and disseminating the proposed technology.

4 Potential partners for developing and extending the proposed technology.

5 Target farmer groups and the agroecological zone(s) where the proposed technology will be used.

TABLE 21: FORMULATING KEY QUESTION AND DESIGNING SOLUTIONS

KEY QUESTION ATTRIBUTE	IDENTIFYING ATTRIBUTES	FORMULATING PROPOSED DEVELOPMENT ACTIVITIES
Major problem(s) addressed **WHY?**	Use cause-effect diagrams to analyze the problem and identify the root causes. List the root causes in order of importance.	Ensure that the proposed solution targets all root causes and, if necessary, expand it to achieve this.
Discipline(s) involved in providing a solution **WHO?**	List all the disciplines which may be required to assist in solving the problem in order of importance.	Ensure that provision is made for the involvement of all relevant disciplines in the proposed solution.
System property(ies) addressed **HOW?**	List the system properties addressed by the key question in order of importance.	Ensure that the proposed solution optimizes all system properties which may be affected.
Agroecosystem(s) the key question relates to **WHERE?**	List any unique characteristics of the relevant agroecosystem(s) which have an effect on the key question.	Make sure that the proposed solution takes full account of these unique characteristics.
Subsystem or enterprise the key question relates to **WHERE?**	Identify the specific subsystem or farm enterprise the key question relates to.	Make sure that the proposed solution is tailored to focus specifically on the subsystem or enterprise.
Target group(s) that the key question focuses on **WHO?**	Identify those individuals or groups most affected by the problem.	Ensure that the proposed solution specifically targets the intended individuals or group.
Implementation steps and issues **WHEN and HOW?**	List the main steps and the timing that needs to be followed to deliver the proposed solution to the intended recipients.	Review the steps to ensure that the proposed solution is the most effective and efficient way of delivering the technology to intended beneficiaries.

FORMULATING KEY QUESTIONS AND DESIGNING SOLUTIONS

TABLE 22: KEY QUESTIONS AND GUIDELINES FOR IMPLEMENTING PROGRAMS TO ADDRESS THEM

KEY QUESTION	TECHNICAL COMPONENTS
LOW RICE YIELDS	
There is already a general lack of villager understanding of appropriate cultural practices related to rice. Irrigation provision will necessitate even more changes in rice production techniques – how can we introduce cultural behavior changes in rice transplantation and sowing in both irrigated and non-irrigated zones?	Improved varieties Quality seed Land preparation Management of soil fertility. Integrated pest management Weed management Water management Post-harvest
DECLINING RICE YIELDS	
There has been a steady decline in rice yields in the irrigated zone over the last 30 to 35 years – what are the reasons for this decline and how can it be reversed?	Soil identification and mapping Soil analysis Soil-fertility studies Iron chemistry
RECESSION CROPPING	
There is an opportunity for recession cropping in the reservoir drawdown zone – how can we identify and introduce appropriate recession cropping systems to farmers with land in the drawdown zone without causing sedimentation and pollution problems?	Crop selection Water management Appropriate varieties Quality seed Soil-fertility management Integrated pest mgt. Cultural practices
SOIL SALINITY	
There is a soil problem that appears to be related to salinity which occurs particularly in high spots in the field – how can we identify the cause of this problem more clearly and develop appropriate solutions?	Land leveling Water control Soil-fertility management Varietal adaptation Soil identification Soil analysis
CASH CROPS	
There is a high production potential and good market opportunities for upland cash crops on the lighter Prateah Lang soils around Punley village – how can we best achieve this potential?	Provision of irrigation to chamkar area Crop selection Quality seed Upland crop agronomy Marketing

EXTENSION METHODS	USEFUL REFERENCES	PARTNER AGENCIES	TARGET ZONE(S)	PROPOSED INTERVENTION
				LOW RICE YIELDS
Technical training Farmer Field Schools On-farm demos Field days Extension materials	Rice Variety TIP Soils TIP Land leveling TIP AQIP post-harvest TIP CARDI rice agronomy manual	DAO (implement) CARDI (variety) AQIP (seed) PDA (backstop) FWUC (water) DAE (TIPs)	Irrigated zone Non-irrigated zone	Rice yield improvement programme
				DECLINING RICE YIELDS
On farm trials Farmer field schools Plot studies	CARDI soils manual Soils TIP	CARDI (TA) PDA (implement) OAE (assist)	Irrigated zone	Rice yield improvement programme
				RECESSION CROPPING
Awareness raising of potential negative impacts Farmer study tour Farmer Field School On-farm demonstration	CARDI rice agronomy manual Soils TIP Vegetable TIP	DAO (implement) AQIP (seed) PDA (support) PDWRAM (advise) FWUC (water) DAE (TIPs) Ecosorn (veg. TA)	Draw-down zone	Recession cropping development
				SOIL SALINITY
Applied research On farm trials Farmer field school	CARDI soils manual Soils TIP	DAO (implement) PDA (backstop) CARDI (TA)	Irrigated zone Non-irrigated zone Catchment zone	Soil salinity amelioration
				CASH CROPS
Farmer training Farmer Field School for upland crops Upland crop production & marketing group	Vegetable TIP	DAO (implement) PDA (support) DAE (TIP) Kbal Koh (TA)	Non-irrigated zone	Cash crop development

INNOVATION ASSESSMENT

Implementation of the full set of proposed programs or TIPs resulting from the key questions is normally beyond the financial resources available to the CCs. It is therefore necessary to have some means of setting priorities. Innovation assessment (see Table 23) is used to help set priorities in a rational and objective manner by assessing and scoring all proposed TIPs on a number of factors in order to provide a balanced assessment of the benefits that the commune can expect. Example results of innovation assessment are presented in Table 24.

CHECKLIST

The checklist presented in Table 23 should be used to explain the assessment criteria to the CC members and obtain their agreement that these are valid for use in setting priorities.

KEY STEPS

1 Construct a matrix that lists all proposed TIPs in the left-hand column of the Innovation Assessment and the assessment criteria to be used across the top row.

2 Score each TIP (from 1 = lowest to 3 = highest) for each of the assessment criteria and record this in the matrix.

3 Once all of the proposed TIPs have been scored, scores are summed and a ranking is obtained.

4 The rankings obtained from innovation assessment are merely indicative, and decisions on which activities to be implemented should be made in collaboration with a range of commune stakeholders.

TABLE 23: INNOVATION ASSESSMENT

Productivity	The expected impact of the proposed TIP on the productivity of the system
Stability	The expected impact of the proposed TIP on the stability of the system
Sustainability	The expected impact of the proposed TIP on the sustainability of the system
Equitability	The expected impact of the proposed TIP on the equitability of the system
Cost	The cost of the program to implement the proposed TIP
Time	The time taken before the benefits of the proposed TIP are realized
Feasibility[a]	The ease of implementing the proposed TIP
Resilience to climate change	The extent that the proposed TIP will still provide benefits in the face of climate change
Terrestrial environmental impact	The expected positive impact of the proposed TIP on the terrestrial environment
Aquatic environ-mental impact	The expected positive impact of the proposed TIP on the aquatic environment
Gender impact	The expected positive impact of the proposed TIP on women
Poverty impact	The expected positive impact of the proposed TIP on the poor
Compatibility with the CDP	The extent to which the TIP is in line with, supports or adds value to other elements of the CDP
Compatibility with RGC policy[b]	The extent to which the TIP is in line with government policy.

[a]The following factors should be considered when assessing feasibility: (i) technical feasibility, (ii) administrative feasibility, (iii) social acceptability, (iv) availability of service providers, and (v) previous experience and available skills.

[b]b Current government policy priorities that should be considered are: (i) food security, (ii) agricultural productivity, (iii) agricultural diversification, (iv) improved market access, (v) farmer organization development, (vi) irrigation development, (vii) land and water resource management, (viii) community fisheries development, (ix) aquaculture, (x) community forestry development, (xi) biodiversity conservation, and (xii) law enforcement (forestry and fisheries).

TABLE 24: EXAMPLE RESULTS OF INNOVATION ASSESSMENT

KEY QUESTIONS	PRODUCTIVITY	STABILITY	SUSTAINABILITY	EQUITABILITY	COST	TIME	FEASIBILITY	TERRESTRIAL ENVIRONMENT IMPACT	AQUATIC ENVIRONMENT IMPACT	GENDER IMPACT	POVERTY IMPACT	COMPATIBILITY WITH CDP	RGC POLICY COMPATIBILITY	SCORE	RANKING
1. Rice yield improvement program	3	2	2	2	3	3	2	1	2	2	2	3	1	31	3=
2. Recession cropping development	2	3	2	3	3	2	2	1	1	2	2	2	2	28	6=
3. Soil salinity amelioration	2	1	3	2	2	1	1	3	3	2	2	2	1	26	10
4. Upland cash crop development	3	2	2	2	3	2	2	2	2	2	2	2	3	32	2
5. Rat control	2	3	3	2	1	2	2	2	2	2	2	2	2	28	6=
6. Home garden development	2	3	2	3	3	2	2	2	2	3	3	2	2	33	1
7. Sericulture development	2	2	2	2	2	2	2	2	2	3	2	2	2	29	5
8. Improved water control in catchment	2	3	2	3	1	1	1	2	2	2	3	2	2	27	9
9. Improved pig fattening systems	2	2	2	3	2	3	2	2	2	3	2	2	2	31	3=
10. Livestock disease control program	2	3	2	2	2	2	2	2	2	2	1	2	2	28	6=

IMPACT ASSESSMENTS OF POVERTY, GENDER AND ENVIRONMENTAL

Impact assessments are used to assess the impact of proposed TIPs on poverty, gender, and the terrestrial and the aquatic environments. The results are used to modify the TIP so as to reduce negative impacts and increase positive ones. Impact assessment proceeds by completing the appropriate templates. Similar methods are used for all four cross cutting issues (poverty, gender, and the terrestrial and aquatic environment). A terrestrial environmental impact assessment template, an aquatic environmental impact assessment template, a poverty impact assessment template and a gender impact assessment template are given in Tables 25, 26, 27 and 28 respectively.

CHECKLIST

A number of different aquatic indicators should be used to assess the impact of proposed TIPs on the aquatic environment. These include:

Efficiency of water use.	√
Impact on domestic uses and public access to water resources.	√
Impact on livestock, transport and amenity values of water.	√
Impact on water quality.	√
Impact on hydrology and groundwater.	√
Impact on connectivity of water bodies.	√
Impact on wetland habitats and aquatic species (including amphibians, reptiles, waterfowl, etc.)	√

KEY STEPS

1 Discuss the proposed TIP, its objectives and expected outcomes.

2 As a group, identify the interactions the TIP will have on each of the four cross-cutting issues.

3 Identify the likely positive and negative impacts of the TIP on these issues.

4 Use the results of these analyses to modify the proposed interventions to maximize their positive impacts and minimize their negative impacts on all the cross-cutting factors.

TABLE 25: TERRESTRIAL ENVIRONMENTAL IMPACT ASSESSMENT TEMPLATE

Description of proposed TIP	
…….	
Objectives and expected outcomes of the TIP	
…….	
What will be the major interactions of the TIP with the terrestrial environment?	
…….	
What are the potential positive and negative consequences on the environment of the widespread adoption of the proposed TIP, and how can the positive ones be enhanced and the negative ones reduced?	
Positive impacts on the terrestrial environment	How can these be enhanced?
1.	1.
2.	2.
3.	3.
Negative impacts on terrestrial environment	How can these be reduced?
1.	1.
2.	2.
3.	3.
Overall impact on the terrestrial environment will be: very positive (++), positive (+), neutral (0), negative (-), very negative (--)	

TABLE 26: AQUATIC ENVIRONMENTAL IMPACT ASSESSMENT TEMPLATE

Description of proposed TIP	
…….	
Objectives and expected outcomes of the TIP	
…….	
What will be the major interactions of the TIP with the aquatic environment?	
…….	
What are the potential positive and negative consequences on the aquatic environment of the widespread adoption of the proposed TIP, and how can the positive ones be enhanced and the negative ones reduced?	
Positive impacts on the aquatic environment	How can these be enhanced?
1.	1.
2.	2.
3.	3.
Negative impacts on the aquatic environment	How can these be reduced?
1.	1.
2.	2.
3.	3.
Overall impact on the terrestrial environment will be: very positive (++), positive (+), neutral (0), negative (-), very negative (--)	

TABLE 27: POVERTY IMPACT ASSESSMENT TEMPLATE

Description of proposed TIP	
.....	
Objectives and expected outcomes of the TIP	
.....	
What will be the major interactions of the TIP with poverty?	
.....	
What are the potential positive and negative consequences on poverty of the widespread adoption of the proposed TIP, and how can the positive ones be enhanced and the negative ones reduced?	
Positive impacts on poverty	How can these be enhanced?
1.	1.
2.	2.
3.	3.
Negative impacts on poverty	How can these be reduced?
1.	1.
2.	2.
3.	3.
Overall impact on the terrestrial environment will be: very positive (++), positive (+), neutral (0), negative (-), very negative (--)	

TABLE 28: GENDER IMPACT ASSESSMENT TEMPLATE

Description of proposed TIP	
.....	
Objectives and expected outcomes of the TIP	
.....	
What will be the major interactions of the TIP with gender?	
.....	
What are the potential positive and negative consequences on gender of the widespread adoption of the proposed TIP, and how can the positive ones be enhanced and the negative ones reduced?	
Positive impacts on gender	How can these be enhanced?
1.	1.
2.	2.
3.	3.
Negative impacts on gender	How can these be reduced?
1.	1.
2.	2.
3.	3.
Overall impact on the terrestrial environment will be: very positive (++), positive (+), neutral (0), negative (-), very negative (--)	

LAND AND WATER RESOURCE MANAGEMENT STRATEGIES

Based on the combined outputs of the CAEA, land and water resource management strategies are formulated for each agroecosystem zone in the commune. These management strategies describe the 'development vision' for each agroecosystem zone and are used to guide agriculture and infrastructure development over the longer term, and help ensure that commune development plans are socially responsible and environmentally sound.

The land and water resource management strategies are formulated following the example presented in Table 29. The suggested format for the strategy includes a summary of the current land use which can be extracted directly from the relevant parts of the Transect Diagram. This is followed by a description of the vision for both land and water including the technical-support requirements to reach the vision.

Land and water resource management strategies should be revisited each year to assess progress towards the vision and to decide which elements of technical support should be included in the current year's CIP.

CHECKLIST

For each agroecosystem zone in the commune provide the following information:

Current land and water resource use	√
Land resource management strategy	√
Technical support requirements to achieve the strategy	√
Water and fisheries resource management strategy	√
Technical support requirements to achieve the strategy	√

KEY STEPS

1 As a final step in the Systems Analysis phase of the CAEA, and in close collaboration with the CC, review and come to an agreement on the understanding generated, the key issues identified and the development plans prioritized.

2 With CC representatives involved in the CAEA, brainstorm the commune problems and potential in order to develop a future 'vision' for each agroecosystem zone.

3 Compare and contrast the outputs of items 1 and 2 above, and discuss with the CC representatives how to move from the issues and potential to the 'vision' (and identify where the gaps are).

4 Use the results from item 1 to item 3 to produce land and water management strategies for each agroecosystem zone in the commune.

5 Identify and list the technical interventions that will be required to implement the strategies.

6 Enter the findings in a table following the example presented in Table 29 - an example land and water resource management strategy table – adapted from CAEA report of Kor Koh Commune, Kompong Thom Province.

TABLE 29: EXAMPLE LAND AND WATER RESOURCE MANAGEMENT STRATEGY TABLE – ADAPTED FROM CAEA REPORT OF KOR KOH COMMUNE, KOMPONG THOM PROVINCE

AGROECOSYSTEM ZONE	UPLAND MIXED CROP ZONE	LOWLAND WET-SEASON RICE ZONE	FLOATING RICE ZONE	INTEGRATED FARMING AND BIODIVERSITY ZONE	FLOODED FOREST ZONE
Current land and water resource use	Small hills, rolling upland with seasonal creeks. Used for cashew, community forestry upland crops, wet-season grazing, sandstone quarries, tourism and housing area.	Flat transition area with small streams and lakes between upland and floodplain. Used for rain-fed rice, vegetables, water melon, dry season grazing and aquaculture	Flat seasonally flooded fertile area with many small lakes. Used for floating rice, recession rice, cucumber. Dry-season grazing, community fisheries.	Flat seasonally flooded grassland area with many larger lakes and a high water table. Used for floating rice, fishing, grazing, firewood. Important habitat for Bengal Florican and fish breeding.	Very flat seasonally flooded very fertile flooded forest area. Used for floating rice, recession rice, firewood and lotus. Important habitat for waterfowl and fish breeding.
Land resource management strategy	Modern cashew production and processing integrated with mixed cropping and community forestry with market links to sustainable tourism and farm produce sales along National Road 6.	A zone of high and stable rice yields supported by new varieties, sustainable soil fertility management strategies and well-maintained irrigation infrastructure.	Environmentally sound deepwater and recession rice systems, coupled with vegetables, NTFPs and grazing under an equitable and secure land tenure system.	Sustainable livelihoods and natural resource management based on integrated farming, fishing and conservation of the globally threatened Bengal Florican.	Well-protected flooded forest area with sustainable use for NTFPs, firewood and grazing on a well-controlled community-managed basis.
Technical support requirements to achieve the strategy	1. Improved cashew varieties. 2. Cashew processing. 3. Tourism development. 4. Market group support.	1. Improved rice varieties and production technology. 2. Improvement of rice quality and marketing support. 3. Soil fertility management.	1. Improved dry-season and floating rice production technology. 2. Establishment and support for rice production and marketing groups. 3. Land reform and land titling via Social Land Concession scheme.	1. Floating rice improvement. 2. Grassland management for cattle and wildlife. 3. Conservation program for the Bengal Florican. 4. Eco-tourism development.	1. Flooded forest protection. 2. Biodiversity conservation (habitat, waterfowl and reptiles). 3. Sustainable NTFP harvesting.
Water and fish resources management strategy	Watershed conservation through reforestation and soil and water conservation practices.	Limited small-scale diversion irrigation with groundwater development for aquaculture and domestic use	Environmentally sound irrigation systems for intensive dry season rice with adequate fish refuges and dry season habitat.	Well-protected and sustainably managed fish refuges and breeding sites.	Well-protected flooded forest and fish conservation zone sustainably managed by local communities.
Technical support requirements to achieve the strategy	1. Community forestry. 2. Soil conservation and fertility management. 3. Zero-tillage techniques	1. Irrigation rehabilitation. 2. FWUC establishment and strengthening. 3. Groundwater development. 4. Aquaculture support.	1. Irrigation development for floating and recession rice. 2. FWUC establishment and support. 3. Community fisheries program. 4. Reservoir fish conservation program	1. Community fishery program. 2. Conservation of fisheries breeding sites.	1. Protection program for fisheries breeding sites. 2. Form a community fishery association. 3. Reptile conservation program.

REPORT WRITING AND USE OF CAEA OUTPUTS

Following the systems analysis, Stage 6, the final stage, takes place, i.e. the writing up of the results of the CAEA in a report according to a standard format with the Table of Contents as shown below.

A first draft of the CAEA report should be presented to the CC for review, comments and feedback, and any modifications made accordingly. Copies of the final report should be provided to the CC who should also be helped to integrate the CAEA outputs into their CIP for submission for PIF funding through the D&D local planning process. Two copies of the final CAEA report should also be provided to the DAE for Quality Assurance and archiving.

The commune map showing the agroecosystem zones along with the transect diagram describing each zone should be provided to the GIS Unit of the Provincial D&D Office for digitizing as a complementary map layer to the commune land use map.

EXECUTIVE SUMMARY

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SYSTEM DEFINITION

SUMMARY OF COMMUNE INVESTMENT PLAN

SYSTEM BOUNDARY AND CONTEXT

SYSTEM HIERARCHY

RESULTS OF THE RAPID RURAL APPRAISAL

SPATIAL ANALYSIS
Maps and Overlays
Matrix of Water-Body Attribute Analysis
Matrix of Water Resource Use
Flow Diagrams
Transect Diagram

TEMPORAL ANALYSIS
Historical Profile
Seasonal Calendar

LIVELIHOOD ANALYSIS
Wealth Ranking Analysis
Livelihood Profiles
Gender Tasks Analysis
Non-Timber Forest Products (NTFPs)

ECONOMIC ANALYSIS AND DECISION MAKING
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Gross Margin Analysis
Value-Chain Mapping

SYSTEMS ANALYSIS
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System Properties Analysis
Formulating Key Questions
Innovation Assessment
Impact Assessments (Poverty, Gender and Environment)
Land and Water Resource Management Strategies

APPENDICES

COMMUNE INVESTMENT PLAN

SECONDARY DATA SUMMARIES

FARMING SYSTEMS MANAGEMENT INFORMATION SYSTEM (FSMIS)

After finalizing the report, key AEA data for each commune are entered into a provincial database by OAE staff. Provincial data sets are then transferred by CD ROM and uploaded to the national FSMIS database held by the DAE in Phnom Penh.

FSMIS DATABASE STRUCTURE

These provincial and national FSMIS databases (see Figure 23) comprise five major components, each containing different types of information.

1. Agricultural and Socioeconomic Conditions. This database contains commune data on: (i) land types, (ii) topography, (iii) soil types, (iv) current land use, (v) cropping systems, (vi) crops grown, (vii) water resources, and (viii) socioeconomic parameters.
2. Major Farmer Problems. This database contains commune information on the major problems encountered, their priority and the root causes.
3. Available Technology Implementation Procedures (TIPs). This database contains information on the improved agricultural technologies or TIPs available to solve the identified problems.
4. AEA Report Archives. This archive contains copies of all commune AEA reports produced to date. Users can access these reports and retrieve information.
5. Secondary Data. This part of the database contains a range of statistical and spatial information for use as input to the CAEA or for other purposes as required by the PDA or OAE.

The FSMIS also has GIS capability and is able to geographically locate and link the information in all of the above databases.

FSMIS FUNCTIONS

The FSMIS allows a range of users, including RGC departments, research agencies, NGOs, donors and the private sector to perform a number of different functions. It has dual language capability to allow its use by both English and Khmer speakers. Various reporting formats have also been developed that allow users to query the database and generate a variety of output reports according to their specific needs.

1. Matching TIPs with priority problems identified by CAEA for specific agroecosystem zones

This is the primary function of the FSMIS, and is intended to provide the DAO and OAE with information on available technologies for addressing the priority problems identified by the CAEA and which are appropriate for use under the prevailing agroecological and socioeconomic conditions. By comparing local problems (key questions) and agroecological conditions with technologies in the TIP database, the FSMIS can identify relevant technical interventions suitable for use under local conditions.

When appropriate technologies have been identified, the entire package of technical information, procedures, methods and materials necessary to implement an extension program for that technology is assembled from the appropriate archive and made available to the relevant OAE/DAO.

2. Identifying research priorities and targeting new research technologies.

The FSMIS contains information on farmer-prioritized problems occurring across Cambodia. These can be grouped and ranked to provide a national picture of farmer needs, thereby providing valuable information on research priorities. Some comparisons of priority problems with available technologies fail to produce adequate matches. By 'flagging' these failed matches, the FSMIS can identify commonly occurring problems for which no suitable technologies are yet available, and thus help determine areas where further basic or applied research is required.

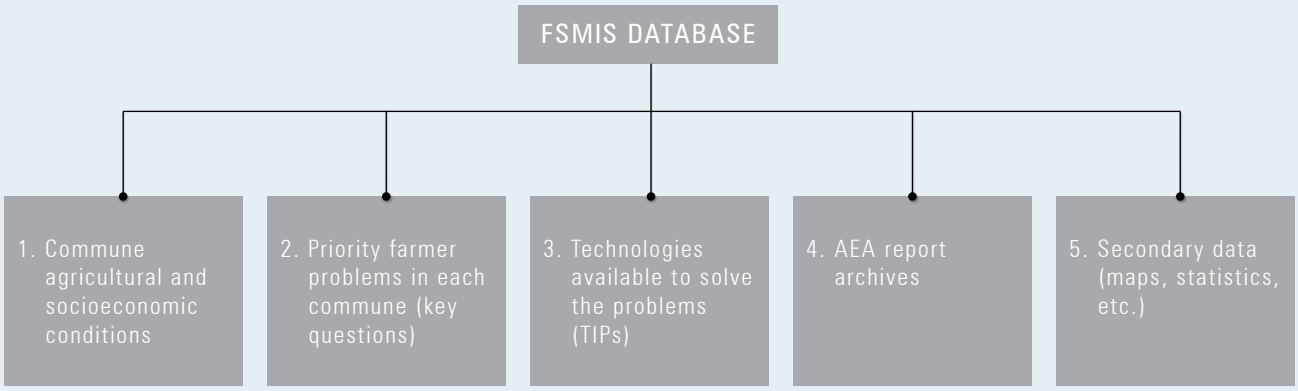


FIGURE 23: THE FSMIS DATABASES

Similarly, matching technologies in the TIP database with problems and agroecological conditions identified by the CAEA can help identify technologies for solving farmer problems across Cambodia.

3. Locating specific agroecological and socioeconomic conditions
Searches of the agroecosystems database for a specific set of agroecological and socioeconomic conditions can be run by the FSMIS to identify locations where these conditions exist. This assists the DAE in following government policy initiatives such as targeting programs in poverty areas or focusing activities on environmentally fragile agroecosystems. The FSMIS can also be used in this way to assist other agencies to better target their development activities and to assist research institutions in locating appropriate sites for research, such as multi-line advanced yield trials (AYT) or on-farm adaptive trials (OFAT), etc., in areas with the desired conditions.

Similar searches can be run for the private sector to locate areas with the required conditions for a wide range of agribusiness ventures. In this way, the system can help producers of agricultural inputs locate appropriate markets, direct merchants to the required crop-production areas, and help entrepreneurs locate a variety of agribusiness opportunities in the most suitable areas of the country.

4. Identifying and locating common problems occurring across the country
By comparing, classifying and grouping key questions identified by CAEAs, the FSMIS is able to assist in setting provincial and national-level priorities. It is also capable of identifying areas with common problems, and locating the incidence of any specific problem(s), thereby helping to target extension and development activities to sites where the need is greatest. By this means, the FSMIS does not only help the DAE to target programs but can also assist NGOs and other agencies working in a specific field to target their activities to areas of the greatest need.

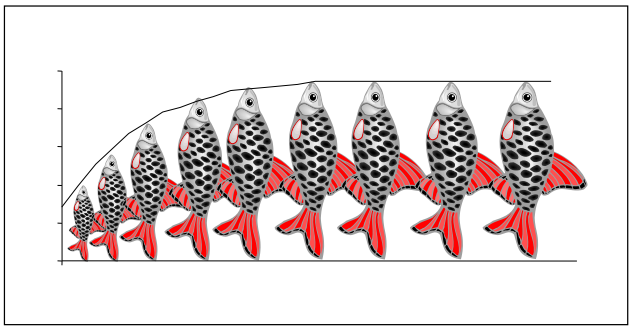
5. Monitoring and directing the implementation of AEA
Records of CAEAs provide the DAE and PDAs with a powerful management tool for tracking and directing CAEA implementation.

6. Producing Commune Information Packages as Inputs for AEA
In addition to AEA output information, the FSMIS contains a wide range of spatial and attribute data, such as maps of administrative boundaries, topography, land cover and land use, and Seila data, World Food Program statistics, etc. The OAEs are be able to use the FSMIS to retrieve and assemble this information into specially tailored 'information packages' to be used as inputs to commune AEAs. This reduces the time and effort required by the OAE and DAO in preparing for CAEAs, and helps ensure that the complete package of secondary data is available at the start of each CAEA.

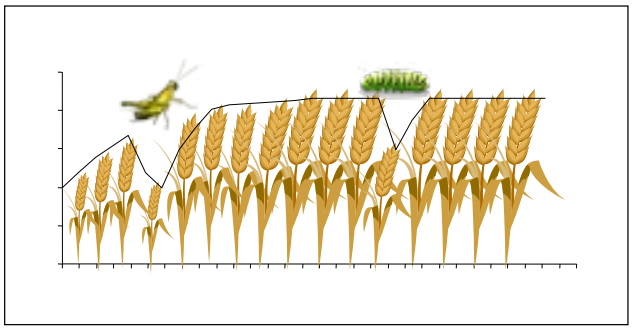
APPENDIX 1
AGRICULTURAL SYSTEM PROPERTIES

The four properties used to describe the behavior of agricultural systems as defined on page 7 are further illustrated below:

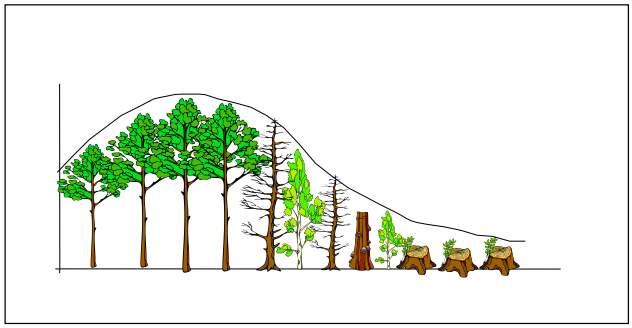
PRODUCTIVITY:



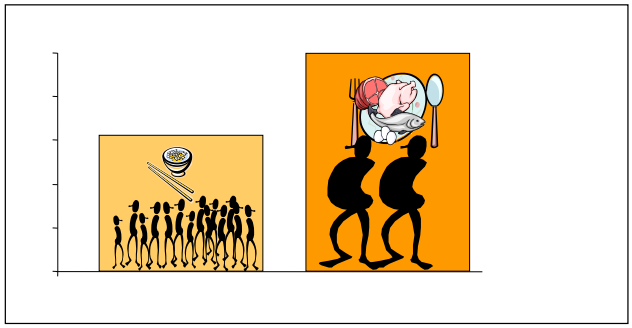
STABILITY:



SUSTAINABILITY:



EQUITABILITY:



Our thanks go to Eric Baran who prepared these slides for the CPWF PN71 project.

APPENDIX 2
KHMER FISH NAMES AND GUILDS

KHMER NAME IN ROMAN	KHMER NAME IN KHMER	FAMILY	LATIN NAME	GUILD
Trey Ampil tum	ត្រីអំពិលមុំ	Cyprinidae	Puntius orphoides	Grey
Trey Andaeng ngang	ត្រីអណ្តែងងាំង	Clariidae	Clarias nieuhofii	Black
Trey Andaeng reung	ត្រីអណ្តែងរឹង	Clariidae	Clarias batrachus	Black
Trey Andaeng toun	ត្រីអណ្តែងទន់	Clariidae	Clarias meladerma	Black
Trey Andarthpi	ត្រីអណ្តាតពី	Cyprinidae	Barbichthys nitidus	White
Trey Andat chhkae	ត្រីអណ្តាតឆ្កែ	Cynoglossidae	Cynoglossus microlepis	White
Trey Andat chhkae	ត្រីអណ្តាតឆ្កែ	Cynoglossidae	Cynoglossus feldmanni	White
Trey Andat chhkae	ត្រីអណ្តាតឆ្កែ	Soleidae	Brachirus orientalis	White
Trey Andat chhkae	ត្រីអណ្តាតឆ្កែ	Soleidae	Brachirus harmandi	White
Trey Andat chhkae	ត្រីអណ្តាតឆ្កែ	Soleidae	Achiroides melanorhynchus	White
Trey Andat chhkae	ត្រីអណ្តាតឆ្កែ	Soleidae	Achiroides leucorhynchos	White
Trey Andat chhkae veng	ត្រីអណ្តាតឆ្កែវែង	Soleidae	Brachirus panoides	White
Trey Andat pee	ត្រីអណ្តាតពីរ	Cyprinidae	Epalzeorhynchos munense	White
Trey Angkot prak	ត្រីសង្កត់ប្រាក់	Cyprinidae	Puntius brevis	Grey
Trey Angkot prak	ត្រីសង្កត់ប្រាក់	Cyprinidae	Puntius aurotaeniatus	Grey
Trey Antong	ត្រីអន្ទង់	Synbranchidae	Monopterus albus	Black
Trey Antong	អន្ទង់	Anguillidae	Anguilla marmorata	White
Trey Antong sor	អន្ទង់ ស	Ophichthidae	Opsarius koratensis	White
Trey Antong srae	អន្ទង់ ស្រែ	Ophichthidae	Pisodonophis boro	White
Trey Arch kok	ត្រីអាចម៍កុក	Cyprinidae	Labiobarbus siamensis	White
Trey Bandol ampeuo	ត្រីបណ្ឌូលអំពៅ	Clupeidae	Corica laciniata	Black
Trey Bandol ampeuo	ត្រីបណ្ឌូលអំពៅ	Clupeidae	Clupeoides borneensis	Black
Trey Bandol ampeuo	ត្រីបណ្ឌូលអំពៅ	Clupeidae	Clupeichthys goniognathus	White
Trey Bandol ampeuo	ត្រីបណ្ឌូលអំពៅ	Clupeidae	Clupeichthys aesarnensis	Black
Trey Bandol sok or Snok	ត្រីបណ្ឌូលសុក រឺ ស្នុក	Gyrinocheilidae	Gyrinocheilus aymonieri	White
Trey Bangkouy/Dorng Darv	ត្រីបង្គួយ រឺ ដងដារ	Cyprinidae	Luciosoma bleekeri	White
Trey Bei kam nat or Khla	ត្រីបីកំណាត់ រឺ ត្រីខ្លា	Cyprinidae	Puntius partipentazona	Grey
Trey Bong Lao	ត្រីបុងឡាវ	Pangasiidae	Pangasius krempfi	White
Trey Changva	ត្រីចង្វា	Cyprinidae	Rasbota pauciperforata	Black
Trey Changva	ត្រីចង្វាឆ្នូត	Cyprinidae	Rasbora paucisqualis	Black
Trey Changva	ត្រីចង្វា	Cyprinidae	Rasbora myersi	Black

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Trey Changva	ត្រីចង្វា	Cyprinidae	Rasbora hobelmani	Grey
Trey Changva kros	ត្រីចង្វាក្រុស	Cyprinidae	Crossocheilus atrilimes	Grey
Trey Changva angkor	ត្រីចង្វាអង្គរ	Cyprinidae	Garra cambodgiensis	Black
Trey Changva chnot	ត្រីចង្វាឆ្នូត	Cyprinidae	Trigonostigma espei	Black
Trey Changva chnot	ត្រីចង្វាឆ្នូត	Cyprinidae	Rasbora urophthalmoides	Black
Trey Changva chnot	ត្រីចង្វាឆ្នូត	Cyprinidae	Rasbora paviei	Black
Trey Changva chnot	ត្រីចង្វាឆ្នូត	Cyprinidae	Rasbora daniconius	Black
Trey Changva chunchuk	ត្រីចង្វាជញ្ជក់	Cyprinidae	Crossocheilus reticulatus	White
Trey Changva moul	ត្រីចង្វាមូល	Cyprinidae	Rasbora tornieri	Black
Trey Changva phleang	ត្រីចង្វាភ្លៀង	Cyprinidae	Esomus metallicus	Black
Trey Changva phleang	ត្រីចង្វាភ្លៀង	Cyprinidae	Esomus longimanus	Black
Trey Changva ronoung	ត្រីចង្វារនោង	Cyprinidae	Lobocheilos melanotaenia	Grey
Trey Changva ronoung	ត្រីចង្វារនោង	Cyprinidae	Garra fasciacauda	Black
Trey Changwa Moul	ត្រីចង្វាមូល	Cyprinidae	Rasbora aurotaenia	White
Trey Changwa Sraloung	ត្រីចង្វាស្រល្វង	Cyprinidae	Rasbora rubrodorsalis	Black
Trey Changwa Sraloung	ត្រីចង្វាស្រល្វង	Cyprinidae	Rasbora borapetensis	Black
Trey Changwas pot	ត្រីចង្វាពោត	Cyprinidae	Rasbota spilocerca	Black
Trey Changwas pot	ត្រីចង្វាពោត	Cyprinidae	Rasbora caudimaculata	Black
Trey Cheik tum	ត្រីចេកមុំ	Bagridae	Bagrichthys obscurus	Black
Trey Cheik tum	ត្រីចេកមុំ	Bagridae	Bagrichthys macropterus	Black
Trey Cheik tum	ត្រីចេកមុំ	Bagridae	Bagrichthys macracanthus	Black
Trey Chhdau	ត្រីឆ្ពៅ	Channidae	Channa micropeltes	Black
Trey Chhkaok	ត្រីឆ្កោក	Cyprinidae	Cyclocheilichthys enoplos	White
Trey Chhkaok phloeung	ត្រីឆ្កោកភ្លើង	Cyprinidae	Cyclocheilichthys furcatus	White
Trey Chhkaok pukmotbai	ត្រីឆ្កោកពុកមាត់បី	Cyprinidae	Cyclocheilichthys heteronema	White
Trey Chhkaok tytuy	ត្រីឆ្កោកទីទុយ	Cyprinidae	Albulichthys albuloides	White
Trey Chhkok Kda / Kampoul Bai	ត្រី ឆ្កោក ឫត្រីកំពូលចាយ	Cyprinidae	Cosmochilus harmandi	White
Trey Chhlang	ត្រីឆ្លាំង	Bagridae	Hemibagrus spilopterus	Grey
Trey Chhlang	ត្រីឆ្លាំង	Bagridae	Hemibagrus nemurus	Grey
Trey Chhlang khmao	ត្រីឆ្លាំងខ្មៅ	Bagridae	Hemibagrus wyckii	Grey
Trey Chhlarm	ត្រីឆ្លាម	Carcharhinidae	Rhizoprionodon acutus	White
Trey Chhma	ត្រីឆ្មា	Engraulidae	Setipinna melanochir	White
Trey Chhmar krapeu	ត្រីឆ្មាក្រពើ	Engraulidae	Lycothrissa crocodilus	White
Trey Chhpin	ត្រីឆ្ពិន	Cyprinidae	Hypsibarbus pierrei	White
Trey Chhpin	ត្រីឆ្ពិន	Cyprinidae	Hypsibarbus malcolmi	White
Trey Chhpin	ត្រីឆ្ពិន	Cyprinidae	Hypsibarbus lagleri	White
Trey Chhpin krohorm	ឆ្ពិនក្រហម	Cyprinidae	Hypsibarbus wetmorei	Grey
Trey Chhpin prak	ត្រីឆ្ពិនប្រាក់	Cyprinidae	Barbonymus gonionotus	Grey
Trey Chlounh	ត្រីឆ្លួញ	Mastacembelidae	Macrognathus siamensis	Black

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Trey Chongwa	ត្រីចង្វា	Cyprinidae	Opsarius pulchellus	Grey
Trey Chra keng	ត្រីច្រកែង	Cyprinidae	Puntioplites wanderssi	White
Trey Chra keng	ត្រីច្រកែង	Cyprinidae	Puntioplites proctozystron	White
Trey Chra keng	ត្រីច្រកែង	Cyprinidae	Puntioplites falcifer	White
Trey Chunlungh moan	ត្រីជន្លួញមាន់	Engraulidae	Coilia macrognathos	Grey
Trey Chunlungh moan	ត្រីជន្លួញមាន់	Engraulidae	Coilia lindmani	Grey
Trey Chunteas phluk	ត្រីជន្ទាសភ្លុក	Cyprinidae	Parachela williamminae	Grey
Trey Chunteas phluk	ត្រីជន្ទាសភ្លុក	Cyprinidae	Parachela siamensis	Grey
Trey Chunteas phluk	ត្រីជន្ទាសភ្លុក	Cyprinidae	Parachela oxygastroides	Grey
Trey Chunteas phluk	ត្រីជន្ទាសភ្លុក	Cyprinidae	Parachela maculicauda	Grey
Trey Domrei	ត្រីដំរី	Eleotridae	Oxyeleotris marmorata	Black
Trey Dong khteng	ត្រីដងខ្ទែង	Cyprinidae	Macrochirichthys macrochirus	Grey
Trey Ka-ao	ត្រីការអោរ	Cyprinidae	Tor tambroides	White
Trey Ka-ao	ត្រីការអោរ	Cyprinidae	Tor sinensis	White
Trey Kabo or Chai kropeu	ត្រីកាប៊ូ រឺ ចៃក្រពើ	Syngnathidae	Doryichthys boaja	White
Trey Ka-ek	ត្រីក្អែក	Cyprinidae	Labeo chrysophekadion	White
Trey Ka-ey	ត្រី ក្អី	Notopteridae	Chitala blanci	Grey
Trey Kahe krohorm	ត្រីកាហែក្រហម	Cyprinidae	Barbonymus altus	White
Trey Kahe lueung	ត្រីកាហែលឿង	Cyprinidae	Barbonymus schwanenfeldii	Grey
Trey Kam pream loeung	ត្រីកំព្រាម លឿង	Polynemidae	Polynemus borneensis	White
Trey Kam pream sor	ត្រីកំព្រាម ស	Polynemidae	Polynemus dubius	White
Trey Kambot chramos	ត្រីកំបុតច្រមុះ	Cyprinidae	Amblyrhynchichthys truncatus	White
Trey Kamphleanh phluk	ត្រីកំភ្លាញភ្លុក	Osphronemidae	Trichogaster microlepis	Black
Trey Kamphleanh srae	ត្រីកំភ្លាញស្រែ	Osphronemidae	Trichogaster trichopterus	Black
Trey Kamphleav	ត្រីកំភ្លៀវ	Siluridae	Kryptopterus schilbeides	Grey
Trey Kamphleav	ត្រីកំភ្លៀវ	Siluridae	Kryptopterus hexapterus	Grey
Trey Kamphleav khlanh	ត្រីកំភ្លៀវខ្លាញ់	Siluridae	Kryptopterus cryptopterus	Grey
Trey Kamphleav stung	ត្រីកំភ្លៀវស្ទឹង	Siluridae	Kryptopterus cheveyi	Grey
Trey Kampot	ត្រីកំពត	Tetraodontidae	Tetraodon leiurus	Grey
Trey Kampot	ត្រីកំពត	Tetraodontidae	Tetraodon cochinchinensis	Grey
Trey Kampot	ត្រីកំពត	Tetraodontidae	Tetraodon biocellatus	Grey
Trey Kampot	ត្រីកំពត	Tetraodontidae	Carinotetraodon lorteti	Grey
Trey Kampot	ត្រីកំពត	Tetraodontidae	Auriglobus nefastus	Grey
Trey Kanhchak slar	ត្រីកញ្ឆាក់ស្លា	Toxotidae	Toxotes microlepis	White
Trey Kanhchak slar	ត្រីកញ្ឆាក់ស្លា	Toxotidae	Toxotes chatareus	White
Trey Kanhchanhchras thom	ត្រីកញ្ឆាញ់ច្រាស់ធំ	Ambassidae	Parambassis apogonoides	Grey
Trey Kanhchanhchras torch	ត្រីកញ្ឆាញ់ច្រាស់តូច	Ambassidae	Parambassis siamensis	Grey
Trey Kanhchos	ត្រីកញ្ឆុះ	Bagridae	Mystus micracanthus	Grey
Trey Kanhchos bai	ត្រីកញ្ឆុះចាយ	Bagridae	Mystus albolineatus	Grey

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Trey Kanhchos chnot	ត្រីកណ្ដុះឆ្នូត	Bagridae	Mystus mysticetus	Grey
Trey Kanhchos chnot	ត្រីកណ្ដុះឆ្នូត	Bagridae	Mystus multiradiatus	Grey
Trey Kanhchos Kdoang	ត្រីកណ្ដុះក្តោង	Bagridae	Mystus bocourti	Grey
Trey Kanhchos thmor	ត្រីកណ្ដុះ ធ្ម	Bagridae	Pseudomystus siamensis	Black
Trey Kanhchoun chey	ត្រីកញ្ឆនជ័យ	Channidae	Channa lucius	Black
Trey Kanhchrouk	ត្រីកញ្ជ្រុក	Cobitidae	Botia morleti	White
Trey Kanhchrouk	ត្រីកញ្ជ្រុក	Cobitidae	Botia beauforti	White
Trey Kanhchrouk chnot	ត្រីកញ្ជ្រុកឆ្នូត	Cobitidae	Botia helodes	White
Trey Kanhchrouk krohorm	ត្រីកញ្ជ្រុកក្រហម	Cobitidae	Botia modesta	White
Trey Kanhchrouk leung	ត្រីកញ្ជ្រុកលឿង	Cobitidae	Botia lecontei	White
Trey Kantho	ត្រីកន្ធរ	Osphronemidae	Trichogaster pectoralis	Black
Trey Kantrob	ត្រីកន្ត្រៀប	Nandidae	Pristolepis fasciata	Black
Trey Kantrorng preng	ត្រីកន្ត្រងប្រេង	Ambassidae	Parambassis wolffii	Grey
Trey Kantuy krohorm	ត្រីកន្ទុយក្រហម	Cyprinidae	Discherodontus schroederi	White
Trey Ka-ork	ត្រីក្អុក	Ariidae	Netuma thalassinus	Grey
Trey Ka-ork	ត្រីក្អុក	Ariidae	Cryptarius truncatus	Grey
Trey Ka-ork	ត្រីក្អុក	Ariidae	Cephalocassis borneensis	Grey
Trey Ka-ork	ត្រីក្អុក	Ariidae	Arius stormii	Grey
Trey Ka-ork	ត្រីក្អុក	Ariidae	Arius sona	Grey
Trey Ka-ork	ត្រីក្អុក	Ariidae	Arius maculatus	Grey
Trey Ka-ork	ត្រីក្អុក	Ariidae	Arius intermedius	Grey
Trey Kasan	ត្រីក្សាន	Channidae	Channa gachua	White
Trey Kbork	ត្រីក្បក	Clupeidae	Tenualosa thibaudeaui	White
Trey Keat srang	ត្រីគៀតស្រង	Cyprinidae	Balantiocheilos melanopterus	White
Trey Kes	ត្រីកែស	Siluridae	Micronema bleekeri	White
Trey Kes Chumrov	ត្រីកែសជំរៅ	Siluridae	Kryptopterus apogon	White
Trey Kes prak	ត្រីកេសប្រាក់	Siluridae	Kryptopterus bicirrhis	Grey
Trey Kes thom	ត្រីកែស្តធំ	Siluridae	Micronema micronema	Grey
Trey Khchoeung	ត្រីខ្ជឹង	Mastacembelidae	Mastacembelus favus	Black
Trey Khchoeung	ត្រីខ្ជឹង	Mastacembelidae	Mastacembelus armatus	Black
Trey Khchoeung	ត្រីខ្ជឹង	Mastacembelidae	Macrognathus taeniagaster	Black
Trey Khchoeung	ត្រីខ្ជឹង	Mastacembelidae	Macrognathus maculatus	Black
Trey Khchoeung pkhar	ត្រីខ្ជឹងផ្កា	Mastacembelidae	Mastacembelus erythrotaenia	Black
Trey Khchoeung pleung	ត្រីខ្ជឹងភ្លើង	Mastacembelidae	Macrognathus circumcinctus	Black
Trey Khla	ត្រីខ្លា	Coiidae	Datnioides polota	White
Trey Khla	ត្រីខ្លា	Datnioididae	Datnioides undecimradiatus	White
Trey Khla	ត្រីខ្លា	Datnioididae	Datnioides pulcher	Black
Trey Khla	ត្រីខ្លា	Datnioididae	Datnioides microlepis	Grey
Trey Khlang hay	ត្រីក្លាំងហាយ	Siluridae	Belodontichthys dinema	Grey
Trey Khman	ត្រីខ្មាន់	Cyprinidae	Hampala macrolepidota	Grey

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Trey Khman	ត្រីខ្មាន់	Cyprinidae	Hampala dispar	Grey
Trey Khnorng veng	ត្រីខ្នងវែង	Cyprinidae	Labiobarbus lineatus	White
Trey Khnorng veng	ត្រីខ្នងវែង	Cyprinidae	Labiobarbus leptocheila	White
Trey Khya	ត្រីខ្យា	Bagridae	Hemibagrus wyckioides	Grey
Trey Kranh	ត្រីក្រាញ់	Anabantidae	Anabas testudineus	Black
Trey Kray	ត្រីក្រាយ	Notopteridae	Chitala ornata	Grey
Trey Kray	ត្រីក្រាយ	Notopteridae	Chitala chitala	Grey
Trey Kray krobei	ត្រីក្រាយក្របី	Notopteridae	Chitala lopis	Grey
Trey Krim kdar	ត្រីក្រឹមក្តារ	Osphronemidae	Trichopsis vittata	Black
Trey Krim peuk	ត្រីក្រឹមភ្ជៀក	Osphronemidae	Betta splendens	Black
Trey Krim tun-sary	ត្រីក្រឹមទន្សាយ	Osphronemidae	Trichopsis schalleri	Black
Trey Krim tun-sary	ត្រីក្រឹមទន្សាយ	Osphronemidae	Trichopsis pumila	Black
Trey Krobei	ត្រីក្របី	Sisoridae	Glyptothorax lampris	White
Trey Krobei	ត្រី ក្របី	Sisoridae	Bagarius yarrelli	White
Trey Krobei	ត្រី ក្របី	Sisoridae	Bagarius suchus	White
Trey Krobei	ត្រី ក្របី	Sisoridae	Bagarius bagarius	White
Trey Kromorm	ត្រីក្រម៉ម	Siluridae	Ompok bimaculatus	Grey
Trey Kromorm	ត្រីក្រម៉ម	Siluridae	Hemisilurus mekongensis	White
Trey Kros	ត្រីក្រុស	Cyprinidae	Osteochilus microcephalus	White
Trey Kros	ត្រីក្រុស	Cyprinidae	Osteochilus lini	Grey
Trey Kros	ត្រីក្រុស	Cyprinidae	Osteochilus hasseltii	Grey
Trey Kros	ត្រីក្រុស	Cyprinidae	Osteochilus waandersi	White
Trey Kros phnom	ត្រីក្រុសភ្នំ	Cyprinidae	Poropuntius malcolmi	Grey
Trey Krum	ត្រីក្រុំ	Cyprinidae	Osteochilus melanopleurus	White
Trey Ksan	ត្រីក្សាន	Gobiidae	Glossogobius aureus	White
Trey Kuch chrea	ត្រីគុចជ្រៀ/កញ្ជ្រៀ	Cyprinidae	Puntioplites bulu	White
Trey Kul chek	ត្រីគល់ចេក	Cyprinidae	Epalzeorhynchos frenatum	Grey
Trey Kulreang	ត្រីគល់រាំង	Cyprinidae	Catlocarpio siamensis	White
Trey Linh	ត្រីលិញ	Cyprinidae	Thynnichthys thynnoides	White
Trey Lolouk sor	ត្រីលលកស	Cyprinidae	Osteochilus schlegelii	White
Trey Paloung	ត្រី ប៉ាលូង	Clupeidae	Tenualosa toli	White
Trey Pase ee	ត្រីប៉ាស៊ីអ៊ី	Cyprinidae	Mekongina erythrospila	White
Trey Pava mouk muoy	តីប៉ាវ៉ាមុខមួយ	Cyprinidae	Labeo erythropterus	White
Trey Pava mouk muoy or Ka-ek pouk	ត្រីប៉ាវ៉ាមុខមួយ រឺ ក្អែកពូក	Cyprinidae	Labeo dyocheilus	White
Trey Phkar char	ត្រីផ្កាចារ	Cyprinidae	Cirrhinus jullieni	White
Trey Phkar ko	ត្រីផ្កាគ	Cyprinidae	Cirrhinus molitorella	White
Trey Phtoung	ត្រីផ្ទោង	Belonidae	Xenentodon cancila	Grey
Trey Phtoung	ត្រីផ្ទោង	Hemiramphidae	Hyporhamphus limbatus	Grey

KHMER NAME IN ROMAN	KHMER NAME IN KHMER	FAMILY	LATIN NAME	GUILD
Trey Phtoung	ត្រីផ្ទោង	Hemiramphidae	Dermogenys siamensis	Grey
Trey Pra chveat	ត្រីឈ្លៀត	Pangasiidae	Pteropangasius pleurotaenia	White
Trey Pra chveat	ត្រីឈ្លៀត	Pangasiidae	Pangasius polyuranodon	White
Trey Pra chveat	ត្រីឈ្លៀត	Pangasiidae	Pangasius macronema	White
Trey Pra kae	ត្រីកែ	Pangasiidae	Pangasius conchophilus	White
Trey Pra kandorl	ត្រីប្រាកណ្តុរ	Pangasiidae	Helicophagus waandersii	White
Trey Pra khchao	ត្រីប្រាខ្ចៅ	Pangasiidae	Pangasius bocourti	White
Trey Pra po	ត្រីពោ	Pangasiidae	Pteropangasius micronemus	White
Trey Pra po	ត្រីពោ	Pangasiidae	Pangasius larnaudii	White
Trey Pra po pruy	ត្រីពោព្រុយ	Pangasiidae	Pangasius sanitwongsei	White
Trey Pra thom	ត្រីប្រាធំ	Pangasiidae	Pangasianodon hypophthalmus	White
Trey Proloung / Chroloeung	ត្រីព្រលួង/ ច្រឡឹង	Cyprinidae	Leptobarbus hoevenii	Grey
Trey Proma	ត្រីប្រម៉ា	Sciaenidae	Boesemania microlepis	White
Trey Pruol / Krolang	ត្រី ព្រួល/ ក្រឡង់	Cyprinidae	Cirrhinus microlepis	White
Trey Reach	ត្រីរាជ	Pangasiidae	Pangasianodon gigas	White
Trey Riel	ត្រីរៀល	Cyprinidae	Cirrhinus caudimaculatus	White
Trey Riel angkam	ត្រីរៀលអង្កាម	Cyprinidae	Henicorhynchus lobatus	White
Trey Riel angkam	ត្រីរៀលអង្កាម	Cyprinidae	Henicorhynchus cryptopogon	White
Trey Riel top	ត្រីរៀលតុប	Cyprinidae	Henicorhynchus siamensis	White
Trey Romeas	ត្រីរមាស	Osphronemidae	Osphronemus exodon	Grey
Trey Ros / Phtuk	ត្រីរស់/ផ្ទក់	Channidae	Channa striata	Black
Trey Ruschek	ត្រីឫសចេក	Cobitidae	Acantopsis dialuzona	Grey
Trey Sanday	ត្រីសណ្តាយ	Siluridae	Wallago attu	Grey
Trey Sawka keo	ត្រីសកាកែវ	Cyprinidae	Raiamas guttatus	White
Trey Slat	ត្រីស្លាត	Notopteridae	Notopterus notopterus	Grey
Trey Sleuk russey	ត្រីស្លឹកឫស្សី	Cyprinidae	Paralaubuca typus	White
Trey Sleuk russey	ត្រីស្លឹកឫស្សី	Cyprinidae	Paralaubuca riveroi	White
Trey Sleuk russey	ត្រីស្លឹកឫស្សី	Cyprinidae	Paralaubuca harmandi	White
Trey Spong	ត្រីស្តង់	Centropomidae	Lates calcarifer	White
Trey Sraka kdam	ត្រីស្រកាក្តាម	Cyprinidae	Cyclocheilichthys repasson	Grey
Trey Sraka kdam	ត្រីស្រកាក្តាម	Cyprinidae	Cyclocheilichthys lagleri	White
Trey Sraka kdam	ត្រីស្រកាក្តាម	Cyprinidae	Cyclocheilichthys armatus	White
Trey Sraka kdam	ត្រីស្រកាក្តាម	Cyprinidae	Cyclocheilichthys apogon	White
Trey Stuok	ត្រីស្នក់	Siluridae	Wallago leerii	White
Trey Ta aon	ត្រីតាអោន	Siluridae	Ompok hypophthalmus	Grey
Trey Tanel	ត្រីតានេល	Bagridae	Hemibagrus filamentus	Grey
Trey Tra sork	ត្រីត្រសក់	Cyprinidae	Probarbus jullieni	White
Trey Tra sork sor	ត្រីត្រសក់ស	Cyprinidae	Probarbus labeamajor	White

APPENDIX 3
GLOSSARY OF TERMS RELATED TO LIVELIHOODS ANALYSIS

HUMAN CAPITAL: People's health and ability to work, and the knowledge and skills they have acquired.

This includes, for example:

- Formal education.
- Skills in handicrafts and construction.
- Local knowledge about farming, fishing and use of other natural resources such as forests.
- Good health and ability to do hard work in the fields.

NATURAL CAPITAL: Assets such as land, water, forests, fish and livestock.

The key issues for natural capital is whether people have secure access to the natural resources needed for the livelihood activity, and whether these natural resources are in danger of being degraded by overexploitation or by some other cause such as pollution.

PHYSICAL CAPITAL: Tools and equipment, and infrastructure such as roads, landing places, market facilities, wells or other water supply facilities, and health facilities.

FINANCIAL CAPITAL: Cash from the sale of production, employment or other income-generating activities; savings and access to credit in the form of loans; and assets that can be easily sold such as gold or other jewellery.

SOCIAL CAPITAL: Connections between people and ways of doing things that help people work together, or help a village or commune work with other organizations including government agencies, including, for example, the following:

- Kinship groups, social groups, village organizations, and clubs or societies.
- Community-based NGOs that help with social organization and contacting government agencies and obtaining government services.
- Ways in which the community may manage natural resources such as forests and fisheries.

VULNERABILITY FACTORS: Things that affect livelihoods in the commune which people in the commune cannot easily influence or control, as for example the following :

- Factors that may cause people to lose tenure or access to natural resources such as land or fishing grounds.
- Bad weather events that affect certain crops, livestock, fishing or other activities.
- Pest and disease threats for crops or livestock.
- Whether human health problems may affect ability to work.
- Variation in market prices for staple commodities or cash crops or production inputs.
- High seasonal demand for labour in other activities.
- Conflict or civil unrest.

INSTITUTIONS: Laws, rules and customs that determine how things are done and who has access to natural resources (natural capital), to infrastructure (physical capital), to savings groups or loans (financial capital), to knowledge or education (human capital), and community initiatives and actions (social capital).