Agroecology and Safe Food System Transitions

Towards an agricultural land use plan to support an agro-ecological transition in the O'Kambor and O'Sakarach watershed areas in Rik Reay commune Rovieng district, Preah Vihear province

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List of abbreviations

AE	Agro-ecology
AFD	Agence Française de Développement - French Development Agency
ASSET	Agro-ecology and Safe food System Transitions project
CBO	Community-based organisation
CDP	Commune Development Plan
CF	Contract Farming
CFo	Community Forestry
CFCC	Contract Farming Coordination Committee
CIP	Commune Investment Plan
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement - French Agricultural Research Centre for International Development
CLUP	Commune Land Use Planning
COAA	Cambodian Organic Agricultural Association
EU	European Union
FA	Forestry Administration
FCM	Fuzzy Cognitive Mapping
FFEM	Fond Français pour l'Environnement Mondial (FFEM) - French Facility for Global Environment
FS	Farming System
FSAC	Farmer Support Agricultural Cooperative
FWUC	Farmer Water User Community
KS	Krom Samaki
LULC	Land Use/Land Cover
LULCC	Land Use/Land Cover Change
MAFF	Ministry of Agriculture, Forestry and Fisheries
MoWRaM	Ministry of Water Resources and Meteorology
NGO	Non-Governmental Organization
OWO	One Window Office
PDAFF	Provincial Department of Agriculture, Forestry and Fisheries
PDoE	Provincial Department of Environment
PDoWRaM	Provincial Department of Water Resources and Meteorology
PMUAC	Preah Vihear Mean Chey Union of Agricultural Cooperatives
RECOFTC	Regional Community Forestry Training Center for Asia and the Pacific
TA	Technical Assistance
WAT4CAM	Water Resources Management and Agro-ecological Transition for Cambodia project
WSAC	Women's Support Agricultural Cooperative

1 Context: an agrarian system upside-down

The pace and scale of agrarian changes that have taken place in Preah Vihear in the last two decades are unprecedented. The province has exhibited transformations that are characteristic of dynamics observed widely across Cambodia.

Central to these transformations is a process of agrarian expansion driven by boom crop export markets (soybean, cassava, cashew, etc.) and fuelled by local smallholder farmers and migrants from lowland provinces attracted by the promise of better income and livelihoods. Large-scale agricultural concessions granted to agri-business companies, mainly for rubber and sugar cane production (Ingalls et al., 2018), have also profoundly transformed the agrarian systems of the province (Figure 1).

Even if farmers have enjoyed high short-term returns, this trajectory of evolution raises some key questions about the sustainability of current practices and the viability of smallholder farming. First, it has put considerable pressure on forest resources (Figure 1) and has incentivized a classical green revolution (chemical fertilizers and pesticides). An analogy with other provinces where similar processes are studied suggests that this development will likely lead to the rapid degradation of soils and water resources (Kong et al., 2019; Nut et al., 2021). Second, it has resulted in widespread commoditization of land resources and higher exposure to risk for smallholders due to the volatility of agricultural commodity markets (Kong et al., 2021; Mahanty & Milne, 2016).

Forest conservation efforts have helped to tackle these adverse consequences through enhanced protected areas (Figure 1) and Community Forestry management. The latter has maintained some forms of collective tenure of natural resources (Rock, 2019), while the associated socio-economic risks and market volatility are partly managed and buffered by contract farming schemes for higher-value organic produce and environmentally-friendly production with rice millers (e.g., IBIS Rice Conservation Co. Ltd, AMRU Rice Cambodia Co. Ltd). But given the magnitude of the agricultural commercialization at work here, natural resources and livelihoods remain under threat.

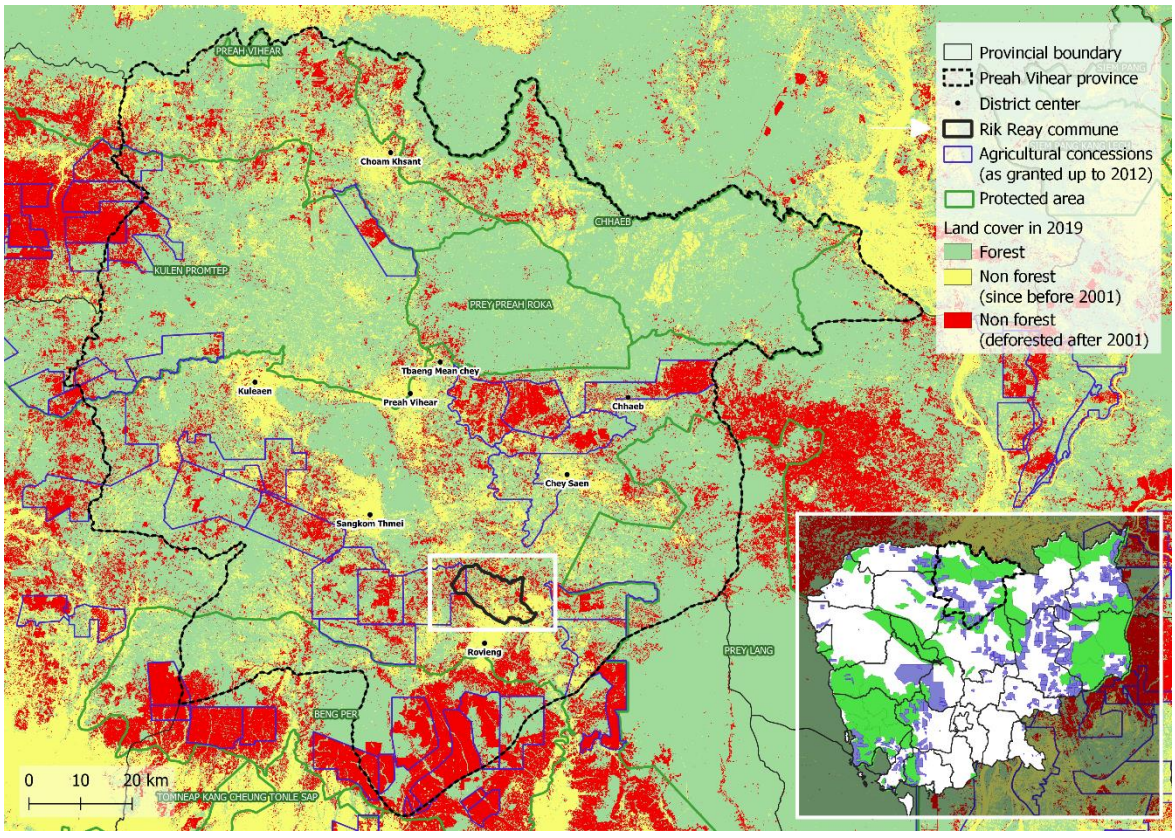


Figure 1. Land cover and land cover change in Preah Vihear province (2001-2019)

2 Study background and objectives

The Agro-ecology and Safe food System Transitions (ASSET) project[1] selected Preah Vihear province as a flagship site in Cambodia through national and regional consultation workshops and committee meetings. In Cambodia, the selection has been based on the scoping study of four provinces (Lienhard et al., 2021).

The ASSET project aims to harness the potential of agro-ecology to support a transition towards more sustainable food and agricultural systems. In this context, the flagship site is where the project concentrates efforts and resources to support and document agro-ecological and safe food system transitions. The approach followed by the ASSET project consists of supporting and scaling-up ongoing and local initiatives that are well aligned with the project ambition. The scoping study conducted in Preah Vihear province identified the Water Resources Management and Agro-ecological Transition for Cambodia project (WAT4CAM) as a promising initiative. The WAT4CAM project intervenes in the Rik Reay commune (Rovieng district). It aims to rehabilitate and expand existing irrigation infrastructure, improve irrigation management and support innovative practices and the organic rice value chain in the lowland areas of the O'Kambor and Sakarach river catchments. On that basis, ASSET endeavours to provide additional support for ongoing initiatives and to look more broadly at the agro-ecological transition of the Rik Reay communal territory.

In this context, this study aims to lay a foundation for the upcoming interventions in the Cambodian flagship area of the ASSET project. It takes Rik Reay commune as a core study area to identify suitable mechanisms for increased lowland-upland integration and support for agro-ecology and safe food system transitions in the commune, and, in particular, in both catchment areas. Based on a multi-stakeholder consultation, the study aims to:

- ⇒ assess the current trend of agricultural development and land tenure management in the upland and lowland areas of the commune, including the management of the community forest and the two small watersheds of the O'Kambor and O'Sakarach reservoirs
- ⇒ assess the impacts associated with those trends on the organic value chain for rice and other potential crops both downstream and upstream
- ⇒ develop a community-based and agro-ecology enhancing agricultural land use plan (with a particular focus on the sub-catchment areas of the two reservoirs in particular), and
- ⇒ explore how this agricultural land use plan can be integrated into development and investment planning at the provincial, district, and/or commune level.

The report is structured to address these different objectives. We first explain the methods and the approach we developed for the assessment. We then examine land use and agrarian dynamics in the Rik Reay commune. The third section offers a mapping of actors and institutions mobilized in land management, agricultural development, and planning in the Rik Reay commune. The fourth describes the planning process we conducted with multiple stakeholders in Rik Reay commune including consultation, modelling, and surveys. In the fifth and last section of the report, we articulate the strategic elements of the agricultural land use plan and discuss ways forward to institutionalize it in local and sub-national planning processes.

1 ASSET is a five-year regional project funded by the Agence Française de Développement (AFD), the European Union (EU), and the Fond Français pour l'Environnement Mondial (FFEM). The project intervenes in four countries (Cambodia, Laos, Myanmar, and Vietnam) and is structured around six main components.

3 Methodology

The core of the study consists of a participatory planning process conducted in Rik Reay commune with multiple stakeholder groups, including the public sector, projects-NGOs, and community-based organizations (CBOs). We informed this process with a review of land use and agrarian dynamics in the commune. We also analysed key policies, institutions, and projects that may contribute to and influence the realization of the agricultural land-use plan. This served as a basis to draft the plan. Figure 2 summarizes the study workflow. The fieldwork was conducted over 12 days in December, and 66 people were consulted (see details in the Annex 10.1).

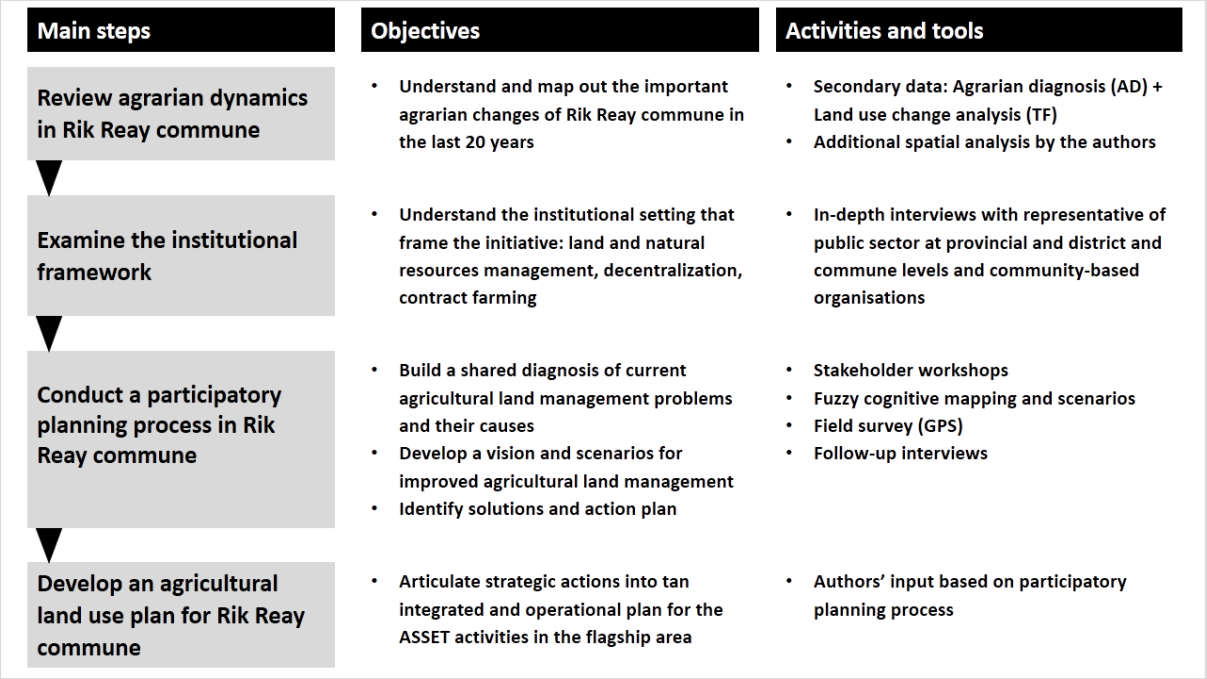


Figure 2. Workflow of the study

3.1 Review of agrarian dynamics

To inform this planning process, we took stock of the existing knowledge about land use and agrarian dynamics in the area. Two agrarian diagnoses conducted by two EU researchers in 2020 (Filloux, 2020) and 2021 (Dayet, 2021) along with the support from the Department of Agricultural Land Resources Management (DALRM, GDA), R4D WAT4CAM and Rada KONG. These studies constitute a solid knowledge base about agrarian dynamics in the area. These studies were complemented by a land-use situation and change analysis, using 30m resolution Landsat imageries (Filloux, 2021). Unfortunately, the raster layers resulting from the supervised classification made by the authors were not available when we started the study (Filloux, personal communication). Further to these research documents, we consulted expert reports of the TA Agri (Sek, 2021) and TA Infra (Schiele, 2021) components of the WAT4CAM program.

To measure the extent and dynamics of forest cover and forest loss data, we consulted the data of the University of Maryland (Hansen et al., 2013), but these turned out to be inaccurate for the study area (under-representation of deforestation over the period 2001-2019). This is probably due to the problem of resolution (30 meters) as noted by Filloux and the difficulty in differentiating between shrub degraded forest (canopy cover of less than 10 percent) and forest (Canopy cover > 10 percent) in a very heterogeneous and rapidly changing forest-crop mosaic.

Instead, we used the ESRI 10 class global land use/land cover (LULC) map for the year 2020 derived from ESA Sentinel-2 imagery at 10m resolution[2]. The 2020 land cover map is accurate according to our fieldwork ground truthing and check and is consistent with the analysis by Filloux (2021). To have a sense of land-use change, we generalized the 2000 land use/land cover classification produced by the Japan International Cooperation Agency (JICA) to be consistent with the 10 classes of the 2020 ESRI land cover map. We believe it provides the most accurate and updated land use [change] classification for the study area. We also benefited from the detailed land use classification of both the O'Kambor and O'Sakarach catchments realized by A. Herledan (of the Egis Group) in the context of the WAT4CAM program.

3.2 Examination of the institutional framework

To understand the institutions mobilized in framing the agricultural land use plan in Rik Reay commune and how the stakeholders position themselves vis-à-vis the initiative, we conducted several interviews with stakeholders from the public sector at provincial (n=11 people consulted), district (n=5), and commune (n=7) levels. We also interviewed NGO and project staff members (n=2) as well as representatives from community-based organizations (n=3) and farmers (n=2). The list is in the Annex 10.1.

3.3 Participatory planning in Rik Reay

We facilitated the planning through a participatory process that enabled the stakeholders to collectively: i) build a diagnosis of key issues affecting agricultural development and natural resources management in the commune; ii) identify and rank key problems; and iii) identify and prioritize potential solutions that were further developed into a specific action plan. We organized two workshops involving a total of 36 people. The entire process is summarized below:

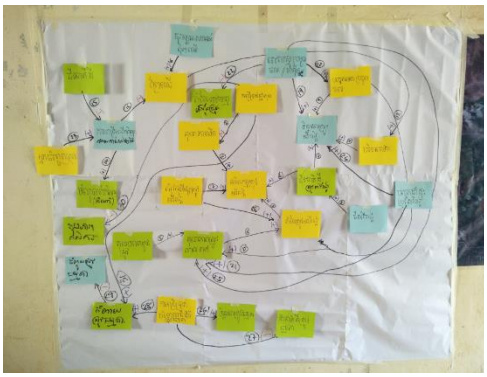
1. Problems – mapping the causes

We asked the participant to identify what they considered to be the key components of the agricultural systems in the Rik Reay commune and the ***elements*** that influence them.

We further asked them to identify ***relationships*** between these elements, i.e., linear relation (A influences B) or interactive relation (A and B influence each other).

We asked them to determine a ***qualitative measure*** of the relationship that ranged from -1 to +1 to assess the intensity of that relationship (e.g., '-1' means that A strongly and negatively influences component B, '+1' is the reverse).

This so-called Fuzzy Cognitive Mapping (FCM) exercise resulted in a graphical representation of the agricultural system that visually illustrates the systemic relationships between key components of the system (Gray et al., 2015). By addressing cross-sector and upland-lowland relationships between elements, the approach broadened the participation of the stakeholders.



[2] https://www.arcgis.com/home/item.html?id=d6642f8a4f6d4685a24ae2dc0c73d4ac

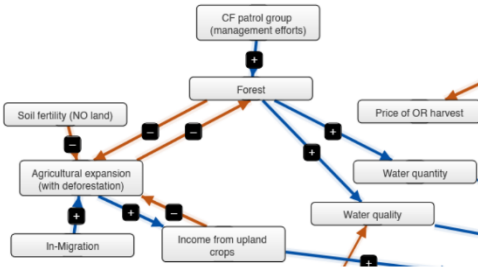
2. Problem ranking and identification of solutions

We recorded all problems identified during a lively discussion that unfolded the production of FCM. We asked participants to validate the list of problems and to select (individually) the most important ones. By simple aggregation of votes, we obtained a ranking. For each of the five most important problems, participants brainstormed the possible solutions to address them.

	Voting
Decrease of forest cover	10
Decline of soil fertility	9
Lack of water	9
Lack of farming techniques (cultivation)	7
Price of organic rice is low	7
Decline in demand for organic rice	6
Patrol of Community forestry is limited	4
Use of chemical pesticides increases	3
Low income from crops	1
Decline in the production of organic rice	1
Lack of [appropriate] technics for rice harvest	1
Lack of rice harvesters	1
Low quality of organic rice seeds	0
Agricultural cooperative lacks running capital	0
Expenses for conventional rice production are high	0

3. Computer modelling

Further, we mapped out the system (elements, relationships, and measures) in an open-source software application (Mental Modeller, http://www.mentalmodeler.org). The computerization of the model proved useful in presenting the model to participants and in adjusting it with them.

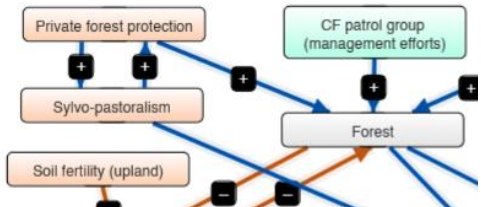


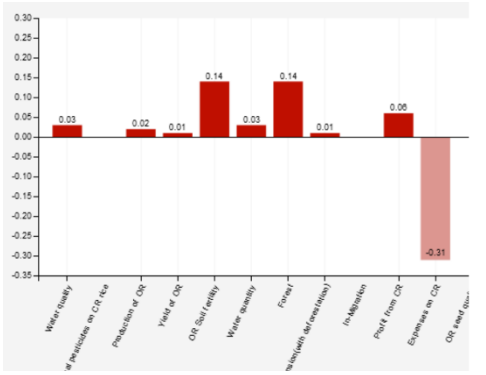
4. Developing and running scenarios

The advantage of computer modelling is that once the model is established, one can easily tailor it by adding or suppressing new elements, or by modulating the intensity of the relationship between others. The model then measures the effects these changes may have on the system as a whole.

Using the logic of '*what would happen if …*', we ran several scenarios based on the solutions identified earlier by the participants (improved land-use practices, innovations, or regulations) and discussed their likely outcomes with them.

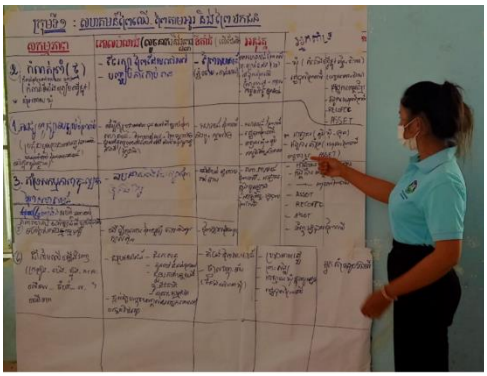
The software produced graphics that helped to visualize the outcomes of each scenario, i.e., the elements of the system that would increase/decrease. In our case, the process was instrumental in building a collective understanding of the issues and in enabling the stakeholders to identify ways to address them.





5. Turning solutions into concrete activities

Based on the modelling and scenarios, the participants identified four main areas of work that were required to tackle the problems in a systemic manner. For each of these 'areas of work', participants formulated an overall objective and identified activities to reach it, including specific and measurable targets. They also proposed an alliance of stakeholders who share strategic interests in carrying out the activity.



4 Agrarian dynamics in Rik Reay Commune

4.1 Rik Reay commune: administration and demographics in a nutshell

Rik Reay commune consists of three villages (Pal Hal, Boh, and Doung). It has a surface area of 9,570 ha and, in 2019, it comprised a total population of 2,546 people (560 families), including 596 people in Pahl Hal (130 families), 821 people (192 families) in Boh, and 1,129 people in Doung (238 families) (NCDD, n.d.). At the commune level, the [natural logarithmic] demographic growth rate between 2008 and 2019 was 2.17 percent per year^{-1}. This is more than the national average for the period (1.3 percent per year^{-1})[3] but less than the average for Preah Vihear province (3.62 percent per year^{-1}) and slightly less than Rovieng district (2.45 percent per year^{-1}). Rik Reay commune is located in a region of intensive in-migration (Diepart & Ngin, 2020).

The commune database allows for the differentiation between the active population (aged from 18 to 60 years) and the non-active population ([0-17] and >60 years old). The active population increases more rapidly than the non-active one (3.41 percent per year^{-1} against 0.84 percent per year^{-1}) (NIS, 2009, 2020). As a result, the dependency ratio (ratio between inactive and active people) dropped from 1.07 to 0.81 between 2008 and 2019 (Figure 3). This means that the share of the working-age population in the total population has increased considerably compared with that of the non-working age. This shift in the age structure represents the so-called 'demographic dividend', a key asset and potential for the economic growth of the province. It also highlights a key challenge for the commune in the years to come: the creation of remunerative jobs.

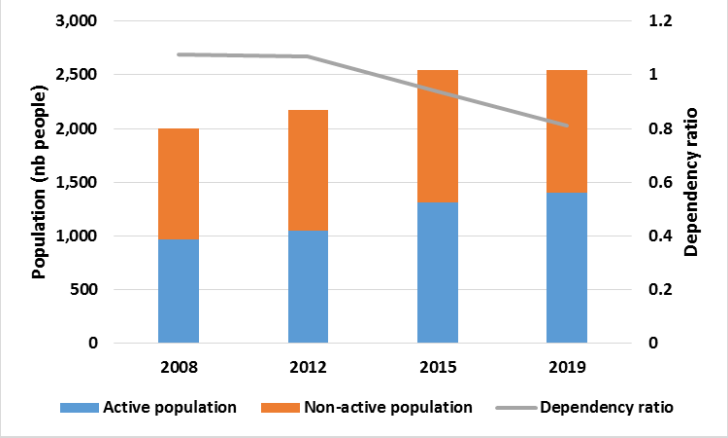


Figure 3. Evolution of the active and non-active population in Rik Reay commune (2008-2019)
Data source: NCDD

4.2 Land cover and land tenure dynamics

In this section we examine the interplay between land acquisition processes and land cover/use change (namely deforestation) in the commune.

4.2.1 Land acquisition and deforestation

Before 1975 (the start of the Khmer Rouge regime), three main agricultural activities structured the life of the Rik Reay commune. Farmers cultivated rice in the lowland paddies located in the southern part of the commune, practised shifting cultivation in the upland, and raised cattle and buffaloes to be draught animals. Dayet (2021) notes that differences in the sizes of landholdings and livestock were already marked as early as 1970.

[3] Census data gives slightly higher population figures for the commune total (2,825 people) but the growth rate 2008-2019 is similar


O'Sakarach reservoir and old water gate

During the Khmer Rouge (KR) regime, access to the forest was forbidden and the population was forced down to the lowland area to contribute to the efforts of agricultural modernization and the development of irrigation infrastructure. The O'Kambor and O'Sakarach reservoirs were excavated during this period but irrigation schemes were never really operational (Dayet, 2021).

The system of Krom Samaki (KS)[4] that was introduced after the fall of the Khmer Rouge was short-lived. As early as 1982, agricultural land was redistributed to individual families. However, unlike the process in the central plain of the country, the redistribution of land and animals was based mainly on the pre-KR distribution of these assets. In addition, during the short KS period, families were allowed to clear upland forest to extend their paddies if they had the labour and the authorization of village authorities to do so. Altogether, this explains why, in the early eighties, differences between farmers in terms of landholding and livestock size were already well marked. For most of the eighties and nineties, the activities were based mainly on lowland rice, with some upland paddies, shifting cultivation in the upland, and livestock-raising for draught animals.

Early 2000 marked the beginning of major transformations, when a gradual process of in-migration, which intensified until 2010, drove the clearance forest in the north-western part of the commune (Figure 4). Coming from Kampong Cham and Kampong Thom provinces, migrants spearheaded forest clearance for tycoons but also progressively established their own *chamcar* and new settlement areas. After purchasing forested land from local farmers (at a cost of around USD300/ha), they introduced soybean, cassava, and cashew in the area and are considered to be the pioneers of boom crops. In 2011, a rubber concession that cropped in the north-western part of the commune (Figure 4) was granted to a Cambodian agro-business person for rubber production. As the land granted was already occupied, conflicts occurred but the company withdrew and the land remains under the management of these new migrants who have not been very successful in integrating into the life of the three villages of the commune.


Large and fenced cashew plantation of migrant, Northwest of Rik Reay

After 2010, migrants from Kampong Cham and Kampong Thom provinces continued to arrive, including people from Kampot and Battambang. But their enthusiasm for boom crops (cassava and cashew) embraced the local population as well. The prospects of high incomes incentivized farmers living in lowland areas to expand their landholding into the uplands. The process has recently intensified (2016-2019) to include migration movements from the neighbouring Rumdaoh and Reaksa communes in the north-east (Figure 4). Farmers claimed access to forestland not only based on their clearance activities in the early '80s, but also through opportunistic clearance. The land market is now active in the commune. The value of land has risen and plots have been increasingly transferred through monetary transactions.

[4] Groups consisting of 10-15 families who were organized collectively by the State to share land, animals, and other means of production

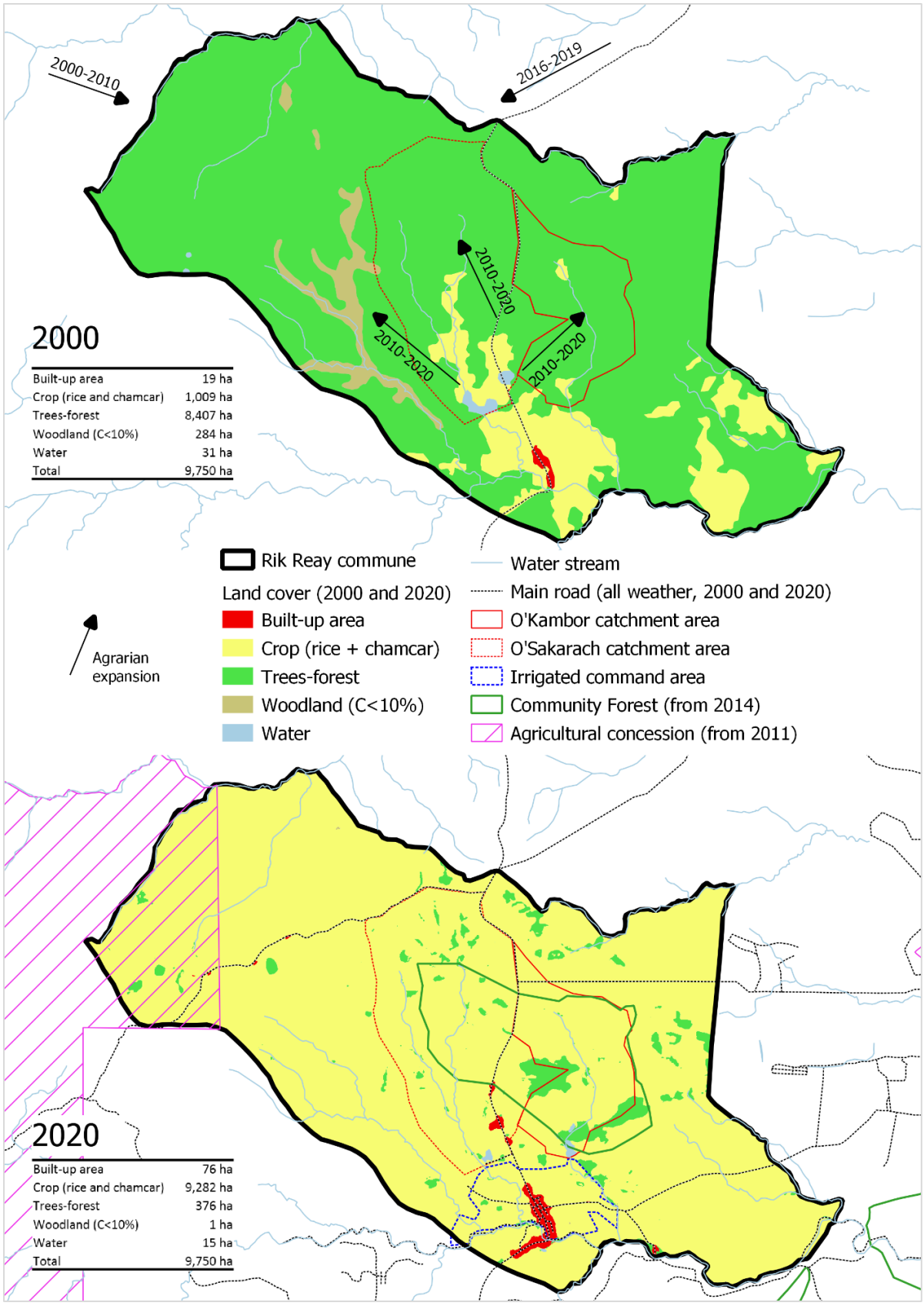


Figure 4. Land cover change in Rik Reay commune (2000-2020)

By 2020, 95 percent of the forest cover in 2000 had been reduced to approximately 376 ha, equivalent to 4 percent of the commune area.

As shown in Figure 4 (map at the bottom) some small patches of forest persist, here and there, across the commune. Locals refer to these forests as '*prey kbal srae'*. They are essentially forest areas acquired by families (so they are privatized) but not yet cleared. They are located at the edge of land cultivated by a family but are available for clearance should the family who own them wish to extend their agricultural landholding. *Prey Kbal Srae* plays another important role as grazing land for cattle and buffaloes.

Prey kbal srae forest (upland forest at the edge of cultivated land)

4.2.2 A detailed overview of land use in the O'Kambor and O'Sakarach catchments

Based on the more detailed and updated land use classification of 2021, Figure 5 shows the mosaicking of forest, and annual and perennial crop patches inside the O'Kambor and O'Sakarach catchments. Figure 6 presents the topography and land use sequence along a transect line that crosses the catchment from north to south.

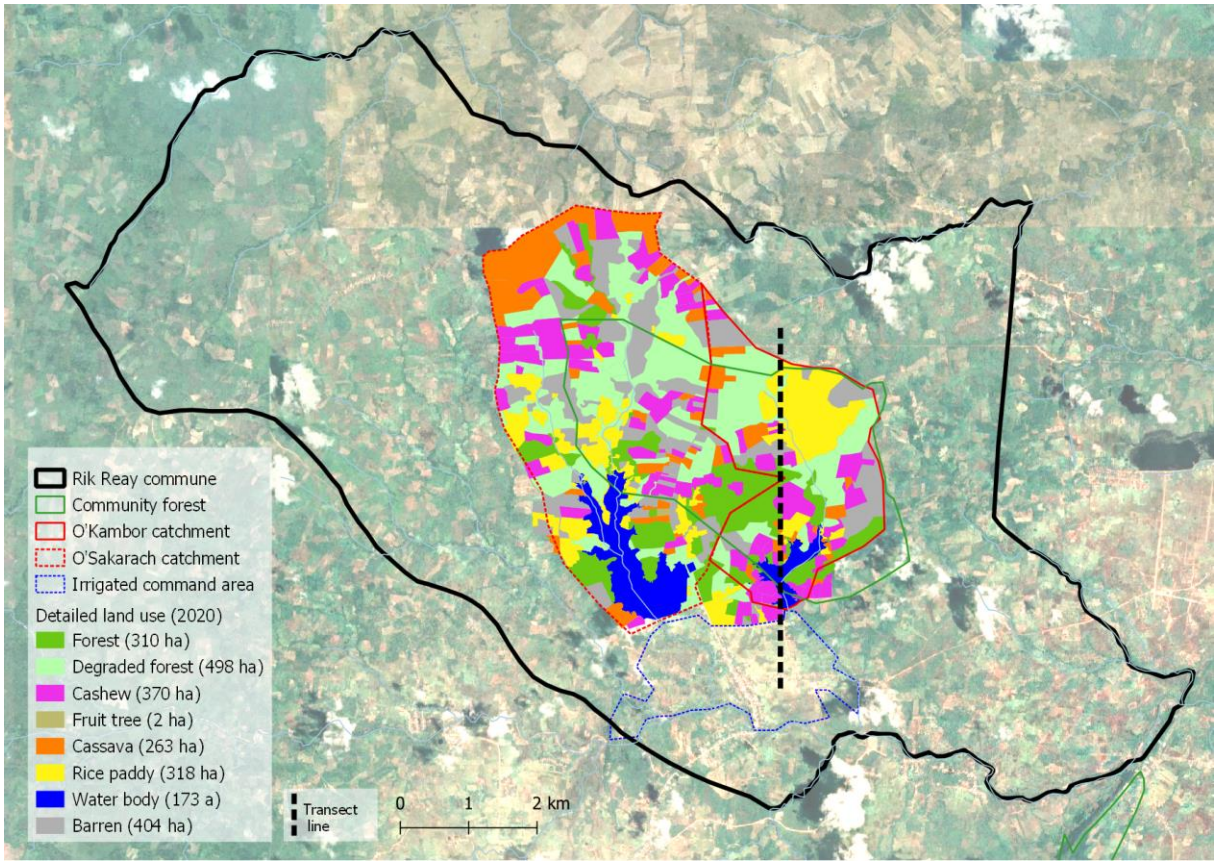


Figure 5. 2021 Detailed land use in the O'Kambor and O'Sakarach catchment areas + transect line
Data source: 2020 land Use by A. Herledan (Egis Group)

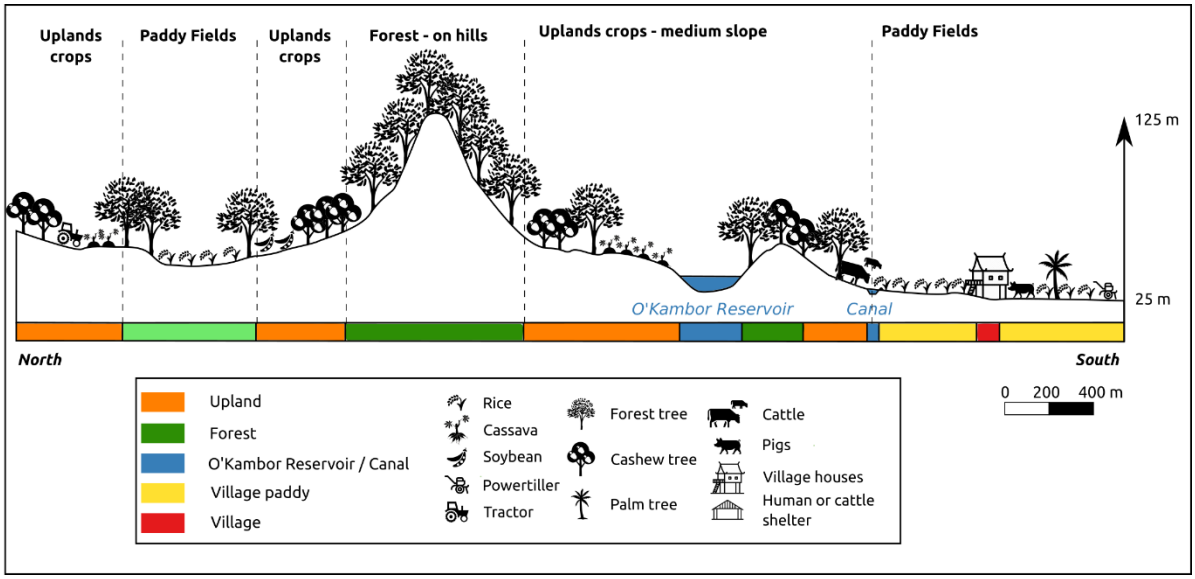


Figure 6. Topography and land use along the transect line (indicated on Figure 5)
Source: Dayet, 2021

4.3 Farming systems

This section reviews the economic aspects of cropping and livestock systems. An analysis in terms of agrarian differentiation helps to clarify the trajectories of families and presents a typology of farming systems. We then discuss the constraints of different types of farming systems to engage in an agro-ecological transition.

4.3.1 Economic results of main cropping and livestock systems

As far as the economic results are concerned, there are large differences between cropping and livestock systems. All results are presented here as labour productivity (gross value-added (GVA)[5] per man/day) to allow for a comparison between cropping and livestock activities (Figure 7). All data and results are taken from Dayet (2021). Annex 10.2 presents more details of the calculations.

First, we note significant differences in rice-based systems between organic and conventional rice. The contrasts in land productivity are particularly sharp (USD141/ha for conventional rice against USD700/ha for organic rice, ratio = 1/5) while labour productivity of conventional rice is just about half that of organic rice. This is because organic rice requires more work - such as transplanting - more regular care, and so on. Consequently, provided that a high price can be maintained and additional labour can be allocated to it - or reduced with new practices and appropriate machinery - organic rice production makes economic sense for farmers.

[5] The GVA equals the value of the gross product (production self-consumed, sold, given or lost in post-harvest activity) minus the value of all Intermediate Inputs (IIs) used during the production cycle. It measures the wealth created during the production process. For this reason, the wages paid to external workers, the land rent if a farmer leases it, the taxes paid to the State and the interest rate paid to credit institutions are not counted as Intermediate Inputs because they determine how the wealth is distributed, rather than created.

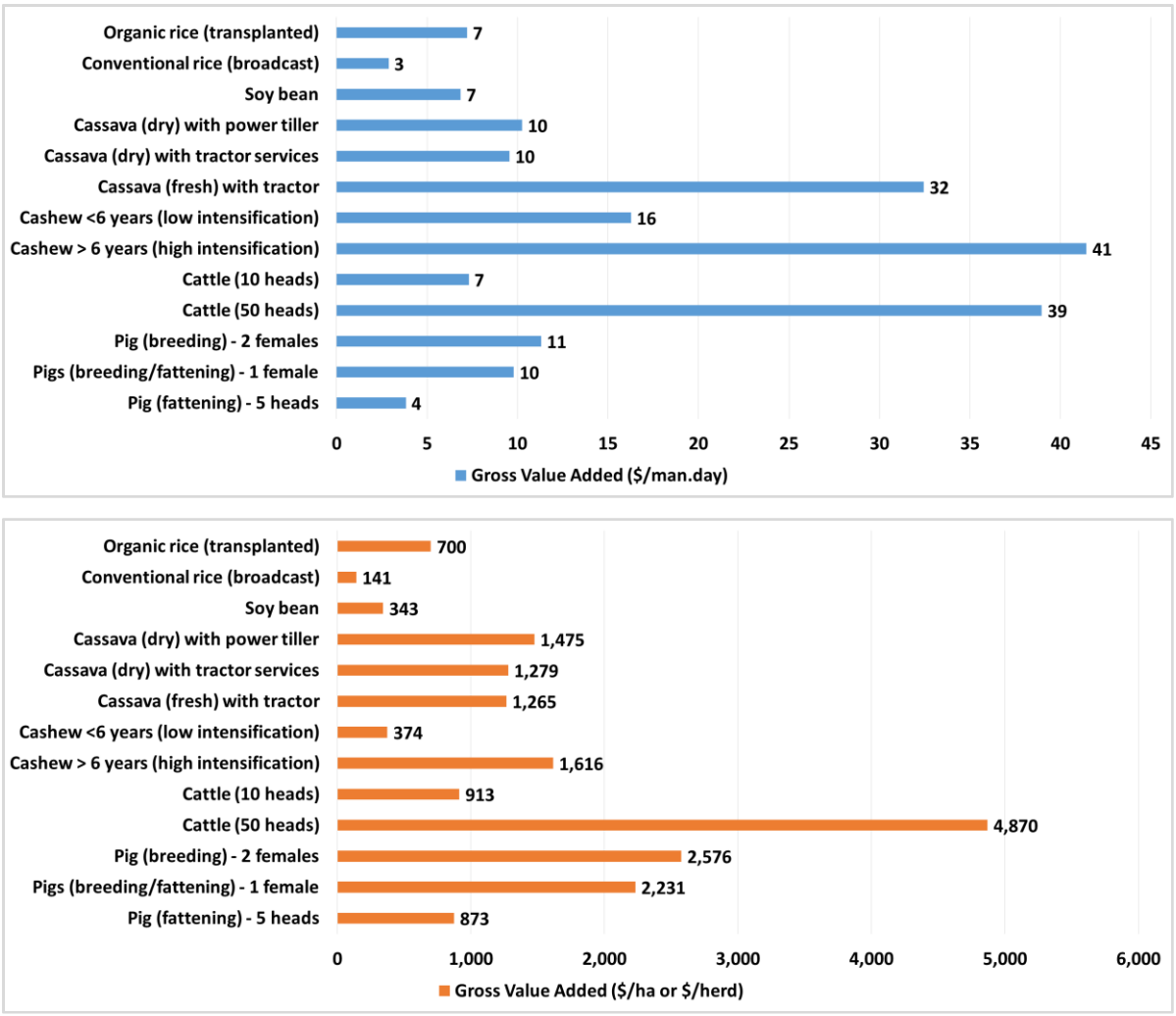


Figure 7. Labour productivity (above) and land/herd productivity (below) of main cropping and livestock systems in Rik Reay commune (gross value-added per man/day)
Data Source: Dayet, 2021

Second, the interest in upland crops is driven by the promise of higher economic returns. The value-added created in rice-based systems does not compete with that of cassava-based systems, where labour and land productivity vary from USD10 to USD33/man/day and from USD1,250 to USD1,450/ha, respectively. The differences are more pronounced when cashew production is considered but the latter requires higher upfront investment and other resources to buffer the three years before the first harvest and associated income. However, the intensification of upland crops with chemicals represents a threat to the lowland organic rice certification.

Interestingly, livestock systems offer good results in terms of labour productivity, particularly for large cattle herds and pig production in breeding mode. The conditions needed to develop these systems are capital-intensive (pens, grazing, and fodder), but livestock is a credible complementary (or alternative) activity, particularly with upland crops. A well-integrated animal-crop system could also offer a strong economic incentive to limit the use of chemicals in upland crops systems.

4.3.2 Household trajectories and typology of farming systems

In her fine-grained agrarian diagnostic, Dayet (2021) analysed the trajectories of Rik Reay families along the time line we briefly sketched in the land cover change section above (Figure 8). She made clear that important differences in landholding and herd sizes existed even before the Khmer Rouge came to power. She further argued that these differences quickly re-emerged after the Krom Samaki, as the redistribution of land and animals that took place in 1982 was based mainly on people's asset

possession before 1975. Another differentiating factor in land access relates to the capacity of farmers (labour and social connection) to acquire and clear forestland during the short Krom Samaki period. History matters! So when land markets were recognized as the key institutions in facilitating access to land resources, migrants came in with a strong appetite for boom crops. The households of Rik Reay were not on an equal footing in finding a place in these new agrarian landscapes. +

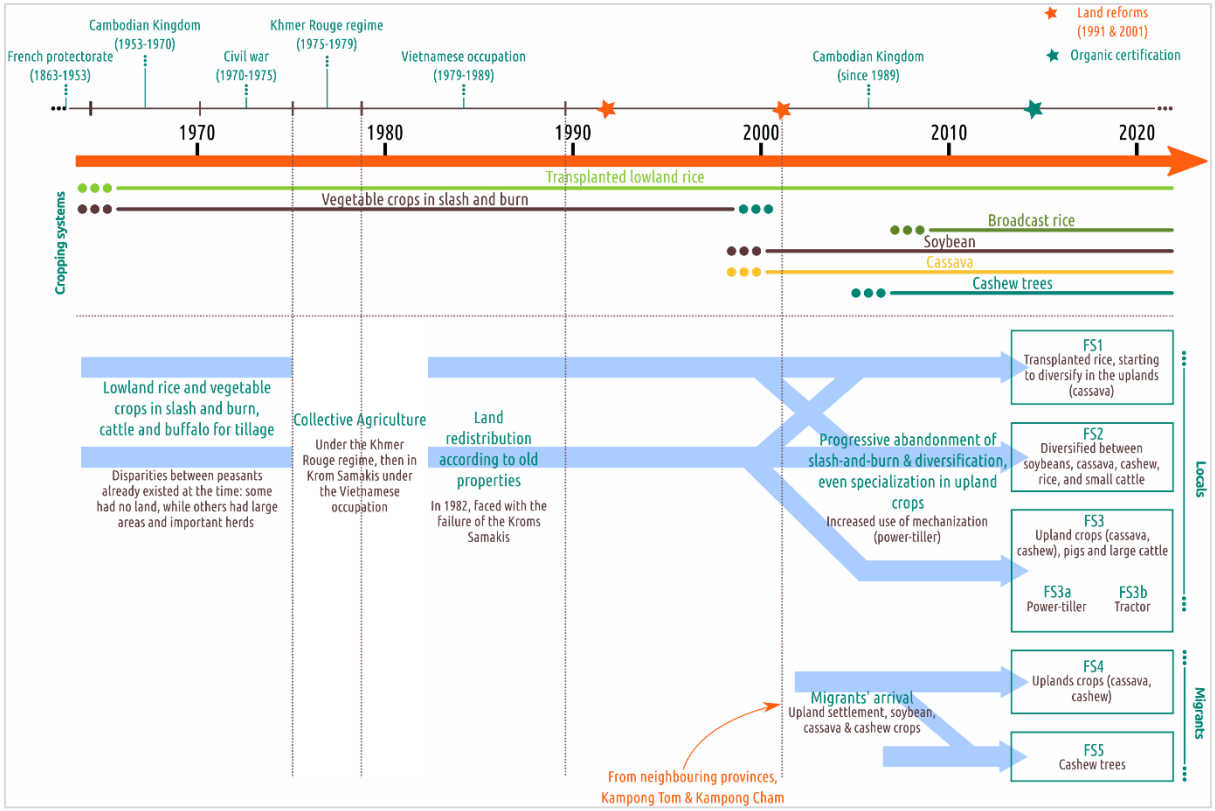


Figure 8. Household trajectories and farming system typology
Source: Dayet, 2021

<u>Farming System 1 (FS1)</u> is a group of farms run by non-migrant families who did not, or could not, receive much forestland before or during the Krom Samaki. The size of their agricultural landholding is relatively small (2-3 ha). Farmers of this type are essentially engaged in lowland rice cultivation (+/- 2 ha) and enjoy a small agricultural landholding in the upland (+/- 0.5 ha) that they use for cassava and/or cashew. Their expansion into the uplands, albeit very recent (1-3 years), is barely possible because, for a start, there is no land available. Another problem that constrains them relates to labour management. Due to the small size of their agricultural landholding and the relatively low land/labour productivity of rice production, they need to diversify their activities outside of agriculture. They do this through local wage labour but increasingly through labour mobility. This movement of labour away from agriculture creates tension in labour management between farm and non-farm activities. The incidence of job-related migration is the highest in FS1 and is rising (Figure 9). Likewise, rice landlessness increased from four to 25 households between 2008 and 2019 (NCDD) and this particularly hit FS1. This occurs through distress sales (often associated with unsuccessful management of over-indebtedness) or by choice (to allocate labour to more remunerative jobs). Families who fall under the FS1 type are definitively the most vulnerable families in the Rik Reay commune.

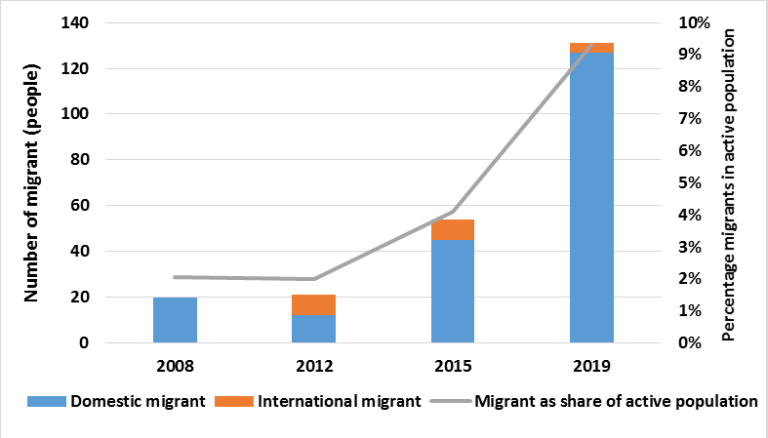


Figure 9. Evolution of the number of job out-migrants in Rik Reay commune
Data source: NCDD

Farming system 2 (FS2) constitutes a group of local (non-migrant) individuals who own lowland rice farms (equivalent to FS 1, i.e., 2-3 ha, and use power tillers) but who could acquire more agricultural land in the upland region (4-5 ha). As far as their labour management is concerned, rice-based (lowland) and chamcar-based (upland) activities are complementary. Rice cultivation is a rainy season activity while the labour peak for chamcar occurs in the dry season (i.e., the harvesting and drying of cassava takes place in January-February). In addition to agricultural land, these households manage a small herd (five to 10 heads of cattle). The animal herd is usually not parked in pens, and feed availability is a key constraint. The source of cattle feed is crop residues during the dry season, grazing where possible, and cut-and-carry fodder in the rainy season. The families of this type occasionally diversify their labour to non-farm activities, but agriculture normally ensures their food security and allows them to make ends meet.

Farming system 3 (FS3) includes a group of local (non-migrant) households who run diversified and large farms and own rice landholdings in the lowland region equivalent in size to FS1 and FS2 (i.e.,2-3 ha). But they have larger upland landholdings (8-10 ha) that are used for cassava and cashew and rely heavily on mechanization. FS3a rely on rental services while FS3b possess their own equipment (i.e., tractors) and usually cultivate large surfaces. As upland crops weigh more in their income portfolio, they limit workloads and adopt labour-saving practices on rice lowland (broadcasting, etc.). A characteristic of these households relates to livestock. They often manage a large herd of cattle (up to 50 heads), buffaloes (10-20 heads), or sometimes pigs. They park herds in pens, usually located in upland regions. The animals graze in the cashew plantation of their owner or the interstitial forest (*Prey Kbal Srae*).


Large herds of cattle and buffaloes parked in pens

Farming systems 4 and 5 (FS4 and FS5) relates to a group of migrants that, for the most part, live in new settlement areas located in the northern part of the commune. They barely have any rice landholding, nor do they raise any livestock. FS4 households run substantial cashew plantations (10-15 ha) - intercropped with cassava if trees are young - and large cassava mono-cropping areas (15-20 ha). Usually, it is the profit made from cassava production that allows them to progressively invest in,

and establish, cashew plantations. FS5 is an evolution of FS4 as it relates only to cashew production (15-20 ha) and is highly specialized. But given the poor soil quality of the uplands and the very high temperatures in March-April, cashew plantation is difficult and is, in fact, far less profitable than similar plantations in Kampong Cham or Kampong Thom where the migrants come from. Peaks of labour occur during the dry season (harvesting and drying of cassava), the early rainy season (cashew harvest), and July-August (cashew tree pruning). Both farming systems are highly mechanized (i.e., they rely on tractors) and function merely as entrepreneurial exploitation with paid wage labour).

Large cashew plantation intercropped with cassava

4.3.3 Constraints faced by farming systems in engaging with an agro-ecology transition

An obvious problem at watershed scale is the use of chemical fertilizers and pesticides for upland crop production and the siltation into reservoirs whose long term effects are difficult to predict. With surface run-off and infiltration to groundwater flow, the chemicals will trickle downstream to the reservoirs and organic rice production areas. The risk is particularly acute considering that the use of chemicals is likely to increase in the future due to the growth in the use of the hybrid variety of cashew - M23 - which is quite demanding in respect of fertilizers (to reach its potential yield) and insecticides (against the tea mosquito bug).

The differential in labour input between organic and conventional rice already incentivizes some farmers to use labour-saving broadcasting techniques rather than rice transplanting. Erratic rainfall at the onset of the rainy season also encourage farmers to opt for broadcasting. For FS1, this is due mainly to the limitation in the availability of labourers resulting from labour diversification outside of agriculture. For FS2 and FS3, it is because rice accounts for relatively less in their income structure than upland crops (FS2) and livestock (FS3), so families give less priority to rice cultivation. One of the issues at stake here relates to weed management. Unlike transplanted rice-based systems, the competition between weeds and young rice seedlings is important. To deal with this, the use of chemical weedicides is tempting but is incompatible with organic certification.

As indicated above, rice-based and cassava-based systems are complementary from a labour point of view. The peak times of labour need in each system are distinct: dry season for the planting, the harvest and drying of cassava and in the rainy season for rice. Yet irrigation brings the promise of a second short cycle rice cycle harvest in the early rainy season or more likely non-rice crop diversification as water won't probably be sufficient for a two rice cycles (Schiele, 2021). In this case, competition with the harvesting and drying of cassava will be accrued, and, with it, the risk of shifting to labour-saving broadcasting. Short-cycle rice also requires herbicides to control weeds which complicates still further the production of organic rice.

5 Institutional arrangements towards an agro-ecological transition

Before going into the detail about the planning process conducted in Rik Reay commune, it is useful to review the institutional arrangements of the public sector that frame resource management in the commune (agriculture, water, forest and land tenure). Institutional arrangements refer here to the legal framework in place and the actual practices of implementation.

Figure 10 offers a snapshot view of these institutions, differentiated into two streams. On the one hand, we present, for each sector, institutions that are potential allies and could be mobilized in support of an agro-ecological transition in Rik Reay commune (inward looking). On the other hand, those that go in the opposite direction and presents risks/threats that need mitigation (outward looking)

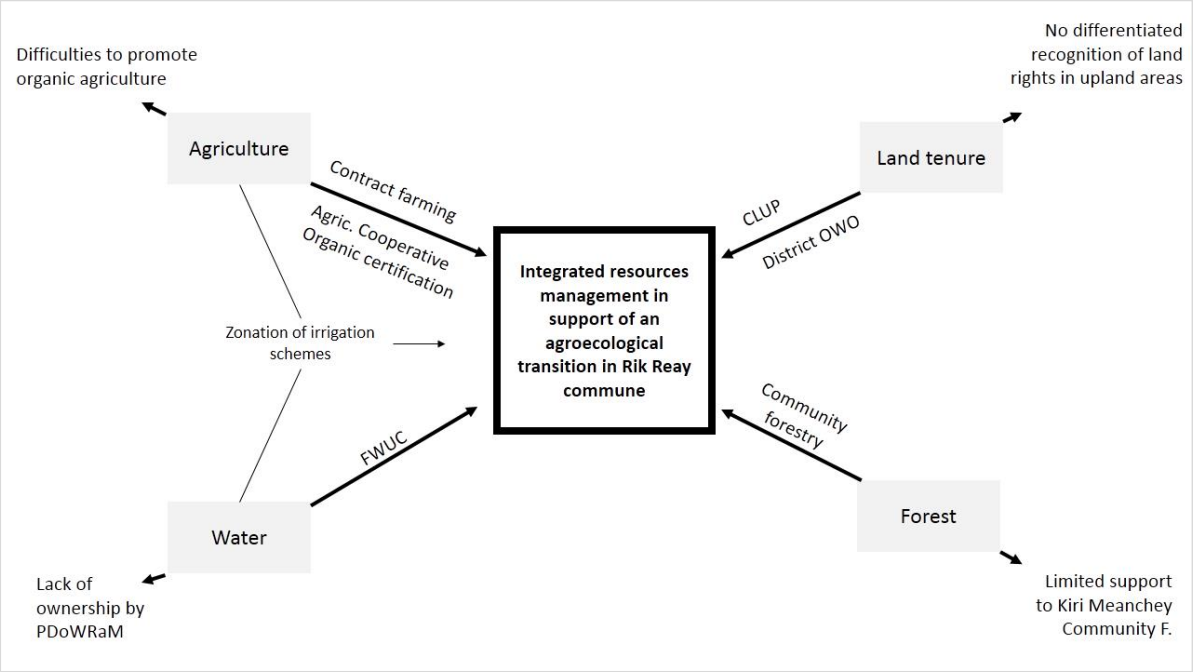


Figure 10. Institutions from the public sector mobilized in land, water and forest resources management in Rik Reay commune

5.1 Agriculture

The provincial department of agriculture, forestry and fisheries (PDAFF) is central as it plays a role in contract farming (CF) and well as in the recognition of, and support for agricultural cooperatives.

5.1.1 Agricultural cooperatives

In Cambodia, contract farming has largely been promoted in tandem with the establishment of agricultural cooperatives - farming-based enterprises voluntarily formed by farmers to jointly manage services related to agricultural production (RGC, 2013). The Royal Government of Cambodia strongly promotes agricultural cooperatives as an intermediary between farmers, agribusiness companies and other service providers, in particular in their contract farming policy (MAFF, 2019; RGC, 2019).

To strengthen the role of farmers in the contract farming partnership and to raise their voices in negotiation processes, it is essential that they are federated and represented by an organization they have mandated to negotiate on their behalf. Agricultural cooperatives also play a role in coordinating the work of service providers involved in the contract farming project (legal advice NGOs, technical support, production monitoring, credit for farmers, and so on). Yet the intervention of an agricultural cooperative raises the question of management (professionalism) and representation (inclusiveness, equity). Building trust between farmers and their representatives is essential to ensure that farmer-based organizations have a meaningful role in the contract farming project. When information is not

transmitted from the cooperatives representatives to their members in a timely and transparent manner, problems can emerge. Studies have pointed to the need for individual farmers to have direct engagement with the company focal person, even if an agricultural cooperative acts as mediator (MRLG study on contract farming in Preah Vihear, upcoming).

5.1.2 Contract farming

The release of the Contract Farming Sub-decree in 2011 (RGC, 2011) marks the official endorsement of contract farming by the Royal Government of Cambodia, MAFF having a lead role in its supervision and monitoring. The sub-decree includes prescriptions on the obligations of farmers and contractors, the role of the State, and the mechanism for implementation. Contract farming first re-emerged in support of the 2010 policy on the Promotion of Paddy Rice Production and Export of Milled Rice. It was a reaction to Cambodia's lack of an efficient and transparent spot market, which is largely the result of the massive informal exports of rice paddy to Vietnam and Thailand (Kramer, 2017).

The Contract Farming Coordination Committee (CFCC) was established in 2017 as a mechanism to ensure the implementation of the sub-decree and to manage CF activities in the country. The committee is an inter-ministerial body, consisting of members from 18 ministries and institutions and all 25 and provinces and the capital of Cambodia. It is chaired by MAFF and assisted by the Department of Agro-Industries (DAI). Key roles of the committee include the development of the CF policy and strategic plan, facilitating the implementation of CF between parties, and reconciling CF conflicts when needed. A contract farming law and relevant policy are now being developed to further regulate the sector and provide additional incentives to companies to engage in so-called 4P initiatives (Private, Public and Producers Partnerships).

To make contract farming work, PDAFF has a role to play in shaping an enabling environment that balances the interests of both parties (farmers and companies). Public sector interventions are necessary to inform, train, and raise awareness, to provide overall guidance about how contracts should be designed, and to monitor their implementation (including taking part in conflict resolution when needed).

5.1.3 Organic rice certification

In 2010, a process of organic rice certification was initiated by the NGO Adventist Development and Relief Agency Cambodia (ADRA). Most of the farmers supported the project not only because of the premium prices offered but also because it was unlikely to impose many changes to their farming practices (they did not use chemical fertilizers or pesticides) (Dayet, 2021).

The investment model is structured as multipartite contract farming in which the contractual arrangements between farmers and the company are mediated by several stakeholder groups including a farmers' organization.

In this case, the company was AMRU, which buys jasmine rice (Phka Rumduol) for export to EU markets. AMRU works through ECOCERT certification that offers certain guarantees to EU consumers: climate and environment protection, conservation of soil fertility, preservation of biodiversity, respect for natural cycles and animal welfare, absence of the use of chemicals and synthetic products, absence of genetically modified organisms, and transparent labelling for consumers) (ECOCERT website). The farmers' organization is Women's Support for Agricultural Cooperatives (WSAC) (Sahakhum Kasekam Leuk Kompou Settrey) that was registered as a cooperative at the PDAFF in 2014 and includes farmers from five communes in Rovieng district (Rik Reay, Romoneiy, Robiab, Reaksmei, and Rung Raeung). The cooperative comprises about 700 members including 500 farmers from Rik Reay commune. WSAC works closely with the Cambodian Organic Agricultural Association (COAA), which provides organic farming extension services for farmers. WSAC is not yet a member of the Preah Vihear Mean Chey Union of Agricultural Cooperatives (PMUAC) but plans to become one in the coming months. The membership might help WSAC to comply with the organic standards and negotiate premium prices of organic rice with AMRU. Prices, varieties, and quantities of organic rice are negotiated and set at the

beginning of the cropping season (March) between the cooperative and AMRU. In the last two years, however, due to the COVID 19 situation and the economic downturn in Europe, contracts were negotiated during production and harvest in a more flexible way. The certification works through a double system of verification; an internal control system (ICS) is instituted by the WSAC and PMUAC and the farmers, and the services are paid by the farmers. This ICS is then certified by the ECOCERT expert. In fact, in both cases, verification is conducted on a random basis. And due to several difficulties, which we will examine later (see section 5 on the planning process), the organic nature of rice production cannot be certified 100 percent.

The management of WSAC is problematic for many farmers (for reasons also discussed below). So in 2019, another cooperative – Farmer Support for Agricultural (FSAC) (Sahakhum Kasekam Leuk Kompous Kaseka) - was created with 40 members. This cooperative is engaged in organic rice contract farming with two other companies, namely, Signatures of Asia and Golden rice. FSAC has been a member of PMUAC since 2019.

5.1.4 Growing competition between organic and conventional agricultural markets

Despite a clear mandate to facilitate and support contract farming and agricultural cooperatives, PDAFF does not have sufficient resources to meet these obligations. And it is clearly more difficult to fix the problems when they occur rather than anticipate them with proper contract farming design. In the organic rice contract farming with AMRU, for instance, the contract specifies that farmers must use the organic fertilizer that the company provides, whereas more efficient and affordable organic fertilizers exist in spot markets. This situation of quasi-monopoly is problematic and should be addressed during contract negotiation.

PDAFF recognizes the fragility of the organic rice commodity chain. The department points to the wide expansion of markets for agricultural produce and inputs but notes that the development of the organic sector falls behind the growth of the conventional rice value chain, resulting in growing tensions and risks.

5.2 Irrigation water management

The Sub-decree on Farmer Water User Communities (FWUCs) is the legal mechanism implemented to organize water resources in and outside of the irrigation command area (RGC, 2015). A FWUC is a mechanism that delegates the responsibilities for the management and development of some parts of an irrigation system from the Ministry of Water Resources and Meteorology (MoWRaM) to a local user group. Yet MoWRaM retains a leading role in the management of the FWUC and responsibilities over the larger infrastructures.

One FWUC has been established in the Rik Reay commune, including two different management structures, one for each reservoir and the command area associated with it. The process to establish the FWUC has been overseen by a technical assistance group of the WAT4CAM project following MoWRaM guidelines. The Provincial Department of Water Resources and Meteorology (PDoWRaM) has been associated merely in the capacity of observer rather than key implementer, which limits the sense of ownership the provincial authorities have over the process.

Several consultations and events have been held, covering the wide dissemination of information about the FWUC, the registration of members, the election of the FWUC management structure (totalling 24 people), the inventory of land ownership in the command area, and the drafting and approval of regulations. The FWUC membership fee is 20,000 KRH/household while an additional contribution for maintenance is 20,000 KHR/ha of irrigated land. Given that the irrigation scheme is not yet operational, water fees are not currently being collected.

The area managed by each FWUC is divided into specific blocks (#1-2-3-4-8 in O'Kambor and # 7-5-6 and 5 in O'Sakarach) (Figure 11). A discrete group of people is in charge of each of these blocks. In the perspective of promoting an agro-ecological transition in the area, it could be recommended that this

existing structure could be used and built on in organizing agricultural extension and the dissemination of R4D findings and experience.

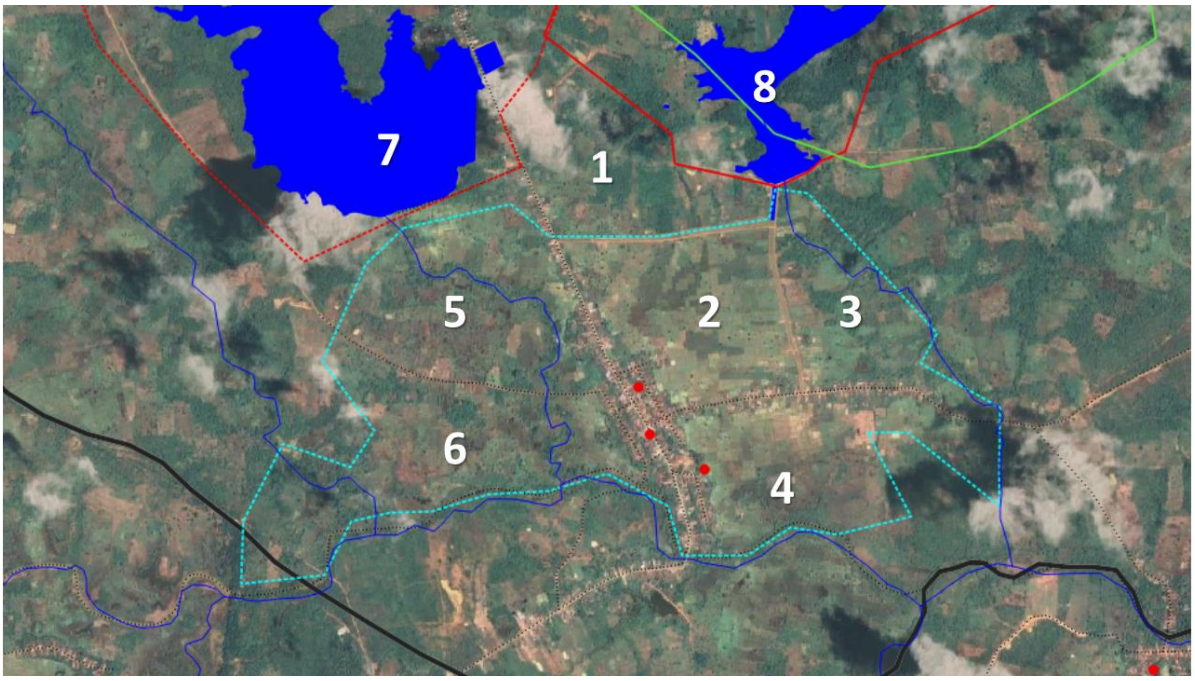


Figure 11. Delineation of blocks managed by the FWUC covering the O'Kambor and O'Sakarach reservoirs and the command areas

5.3 Community forest management

Rik Reay commune is located outside any protected areas, so forests are managed under the authority of the Forestry Administration. As mentioned above, the sub-decree on community forestry management (RGC, 2003) is the legal mechanism implemented to manage the forest in the commune. The cantonment of the Forestry Administration, with the support of RECOFTC, mainstreams the development of Community Forestry (CFo) across the province.

The protection of forest resources by villagers dates back to 2002 in Rik Reay commune. Their efforts were originally supported by the organization Ponlok Khmer, then by the Regional Community Forestry Training Center for Asia and the Pacific (RECOFTC) through EU funding. The community signed the official co-management agreement with the Cantonment of the Forestry Administration in 2014 (Forestry Administration, 2019).

The area agreement concerns a total area of 1,262 ha, as shown in Figure 12. In principle, the Community Forestry initiative is mainly divided into three areas, each managed by a village committee. In practice, however, the three groups work together with the same interests and motivation. Apart from those three areas, the remaining parts of the (1,262 ha) community forest are located in two blocks totalling 171 ha (referred to as CFo1 and CFo2 in Figure 12). The first block (CFo1) has an area of 102 ha and the second (CFo2) 69 ha.

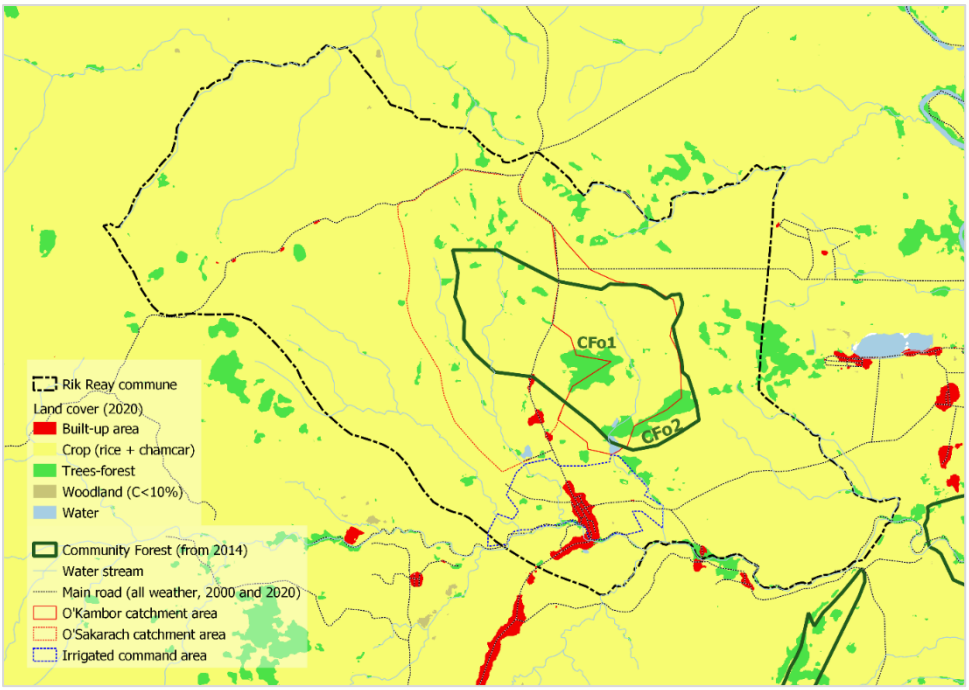


Figure 12. Kiri Meanchey Community Forestry in Rik Reay commune

People assign different values and meaning to their community forest. It provides access to non-timber forest products and plays a role in terms of watershed management (helping to stabilize the water cycle and limit surface run-off). At times, villagers organize traditional music festivals in the forest. It also provides a shelter for bonzes of neighbouring pagodas who practice mediation on top of the mountain (see the photographs in the Annex 10.3). It is, therefore, a cultural symbol of the communal territory.

The community forest is managed and protected by dedicated villagers who conduct monthly patrolling visits to the area identified as CFo. The context in which they work is demanding (and sometimes even violent) because enforcing the Community Forestry bylaws and ensuring its integrity exposes them to illegal loggers and land-hungry farmers. The economic power imbalances at stake are such that the actors involved are not evolving on a level playing field. The allies of the CFo are the commune council and the Forestry Administration but, for the time being, their support is insufficient to protect the forest.

In terms of support, Kiri Meanchey Community Forestry group have received equipment (walkie-talkies, GPS, etc.) and has been invited to join a Community Forestry network meeting organized every three months in Preah Vihear municipality. The network meeting offers an opportunity to share experiences, raise issues, and to identify solutions and follow-up actions. This support is relatively limited given the magnitude of the deforestation at work in Rik Reay.

At the same time, the Forestry Administration has been perfectly aware of forest clearance movements in the area since early 2000 and were in full swing when the CF agreement was signed in 2014: it adopts a rather pragmatic approach to the problem. If a farmer encroached on forestland before 2014 and the creation of the Community Forestry initiative, the FA considers that person to be the land's owner, entitled to individual and exclusive possession rights. But if the farmer cleared forest after that date, he/she should enjoy usufruct rights at the utmost.

5.4 Land tenure management

5.4.1 Recognition and formalization of land rights in Rik Reay commune

The formalization of land rights in Rik Reay commune follows the prescription of the 2001 Land Law according to which land cultivated before 2001 is eligible for titling. In reverse, land not cultivated before 2001 is ineligible (RGC, 2001). The 2002 forest cover is used as the reference to determine the limit of the adjudication area for titling. The commune authorities apply this rule in issuing land certificates, which are a prerequisite for titling. Land considered to be non-forest in 2002 (i.e., lowland areas inside and outside the command area and a small part of the upland region - see Figure 13) is eligible for titling. In this case, the commune authorities will agree to issue a land certificate, and the farmers can use this certificate as collateral to obtain credit. But if the land falls within forestland (i.e., most of the upland region), no land certificates are granted.

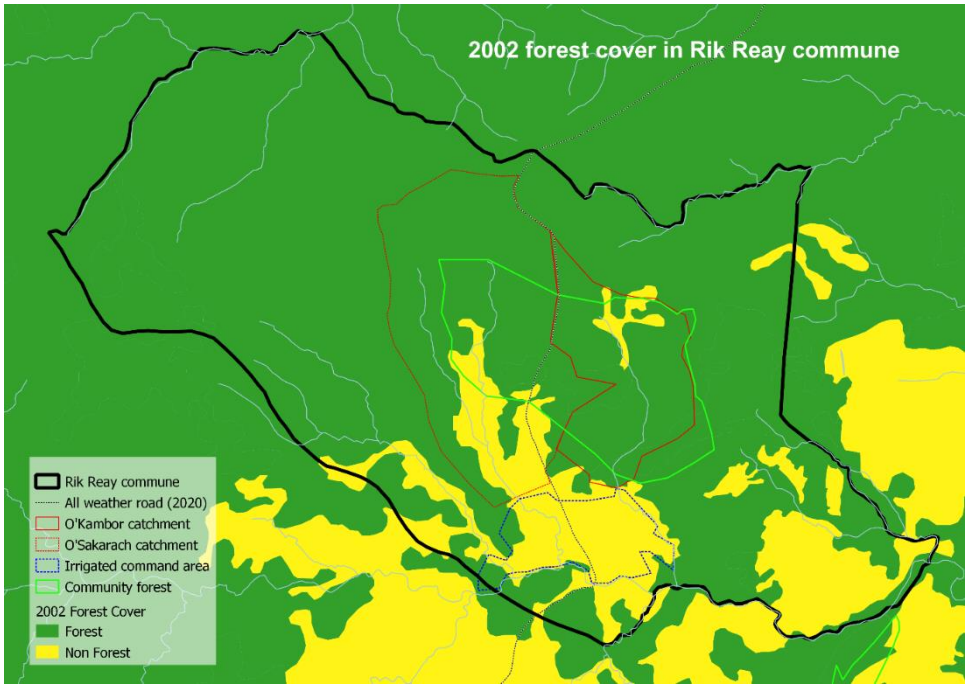


Figure 13. Forest cover in Rik Reay commune as of 2002

Unlike the pragmatic approach promoted by the Forestry Administration, the commune authorities and the cadastral administration do not differentiate land rights based on the creation of the Community Forestry. This remains an unsettled issue and gives rise to multiple interpretations between the local people.

It should be noted that, since 2019, the work of land surveys, the issuance of land certificates, and the transfer of land ownership has been organized by a multi-sector district working group that consists of the district, commune, and village authorities along with some technical line offices. This activity is coordinated under the 'One Window Office' based at the district administration premises of Rovieng.

5.4.2 Communal Land Use Planning

The commune/sangkat land use plan (CLUP) refers to a land use plan within the respective communes/sangkats and covering both State and privately owned land (RGC, 2009). These plans were conceived to support the design and the implementation of the Commune/Sangkat 5-year Development Plan (CDP) and the Three Year Rolling (Commune) Public Investment Programme (CIP). As such, CLUP is conceived as an integrated plan. It is expected to comply with the development plans of the commune/sangkat and indicate the spatial dimension of development initiatives and projects that are foreseen in the CDP/CIP, and is based on the specific resources or characteristics of the areas. A CLUP is a tool for the commune/sangkat council to effectively manage and use natural resources and land resources in order to support sustainable and equitable socio-economic development.

A commune land use plan comprises an analysis of the existing situation in the commune based on an up-to-date land cover/use map including infrastructure, concessions, protected areas, community forestry, and so on. The so-called Problem/Cause/Solution (P/C/S) map is central to the CLUP process (Dummer, 2008), displaying the range of problems identified by the commune and villagers during the problem/cause/solution analysis. CLUP also includes the proposed land uses of the commune and an implementation plan (as part of CDP/CIP) where future development projects are identified on a current land use map, linked to proposed implementation steps and timing

According to the Sub-decree 77 (RGC, 2012), the Provincial Committee for Land Management and Urban Planning review and give advice to guide the CLUP process, and the plan itself is approved by the provincial council. The Provincial Department of Land Management, Urban Planning and Construction is already engaged in spatial planning activities, and is currently developing the Municipal

Land Use Master Plan and creating detailed land use plans in two sangkats. The department has not been involved yet in land use plans for rural communes but is supportive as long as they follow the legal and policy framework for CLUP.

6 Participatory planning processes

We used all of the above information to inform two planning workshops aiming to: 1) identify the main problems experienced by local stakeholders concerning agricultural development in the commune: and 2) chart out solutions towards an agro-ecological transition. We presented the methodological approach above (see section 3) and focus now on the results.

6.1 Key elements of agricultural systems in Rik Reay commune

Figure 14 presents the results of the problem-causes mapping as obtained in the first workshop. The mapping follows a fuzzy cognitive logic that includes the component/elements of the agricultural and natural resources system in the Rik Reay commune and the relationship between these elements. The qualitative assessment of these relationships is not presented here but was used when developing the scenario (see below).

In total, the workshop participants identified 29 components with 41 connections. There are nine driver-components (i.e., elements of the system that only influence others and are not influenced by any) and, in reverse, four receiver-components.

A first lesson learned from the experience is that the workshop's participants have a holistic understanding of issues, their causes, and consequences. They could articulate these different elements and their relationships across dimensions (social, economic, technical), within the nexus of development/conservation, and between upland and lowland issues. Seven components are central in the system: the forest; the agricultural expansion; the use of chemical pesticides in upland production; the water quality; the income of farmers; the production of organic rice; and the yield of this produce.

For the participants, the role of the **forest** in managing water resources (maintaining quality and quantity) is crucial for organic certification in lowland rice areas. Participants are aware of the threat that is posed by the run-off of water loaded with chemicals from upland areas to lowland organic rice paddies. In turn, they identify **agricultural expansion** into the upland as the main direct driver of forest loss. This expansion is itself driven by in-migration but also incentivized by low income from upland crops and fertility of upland soil as compared with income obtained for the same crops in Kampong Cham and Kampong Thom where most migrant come from. The feedback interaction identified by the participants between the income from upland crops and the agricultural expansion suggests that if the former decreases, the latter increases. So working on improving income from upland crops (or livestock activities) without increasing the use of chemicals, might help to contain deforestation.

The component **income of farmers** is nodal because it integrates returns from organic rice, conventional, and other income (upland crops and livestock). It also helps to articulate the tensions between organic and conventional agriculture in the area. According to the participants, the increase in income pushes farmers to increase their use of pesticides, particularly in uplands, thus impacting water quality and the organic process. What is less apparent in the mapping, but discussed by stakeholders during the workshop, is the trade-off between labour-saving farming/harvest and the monetary costs of production. Farmers consider both aspects in their decision. They rely on labour-saving techniques (e.g., a rice harvester, herbicides) based on a calculus that ponders costs of these techniques and the opportunity cost of the labour (i.e., income that would be gained if labour were allocated to other remunerative activities).

These elements reveal the pressures on organic rice production and the fragility of organic certification. But the participants also pointed to other issues related to organic rice production and rice yield. Market factors such as price and demand and also the management of the contract farming

by the agricultural cooperatives (namely SWAC) influence the **organic production processes**. The volume of organic produce also depends on the **yield of organic rice,** which is influenced by water quantity (thus the need to protect the forest), soil fertility in organic rice farming, farming techniques, and the loss incurred during the harvest.

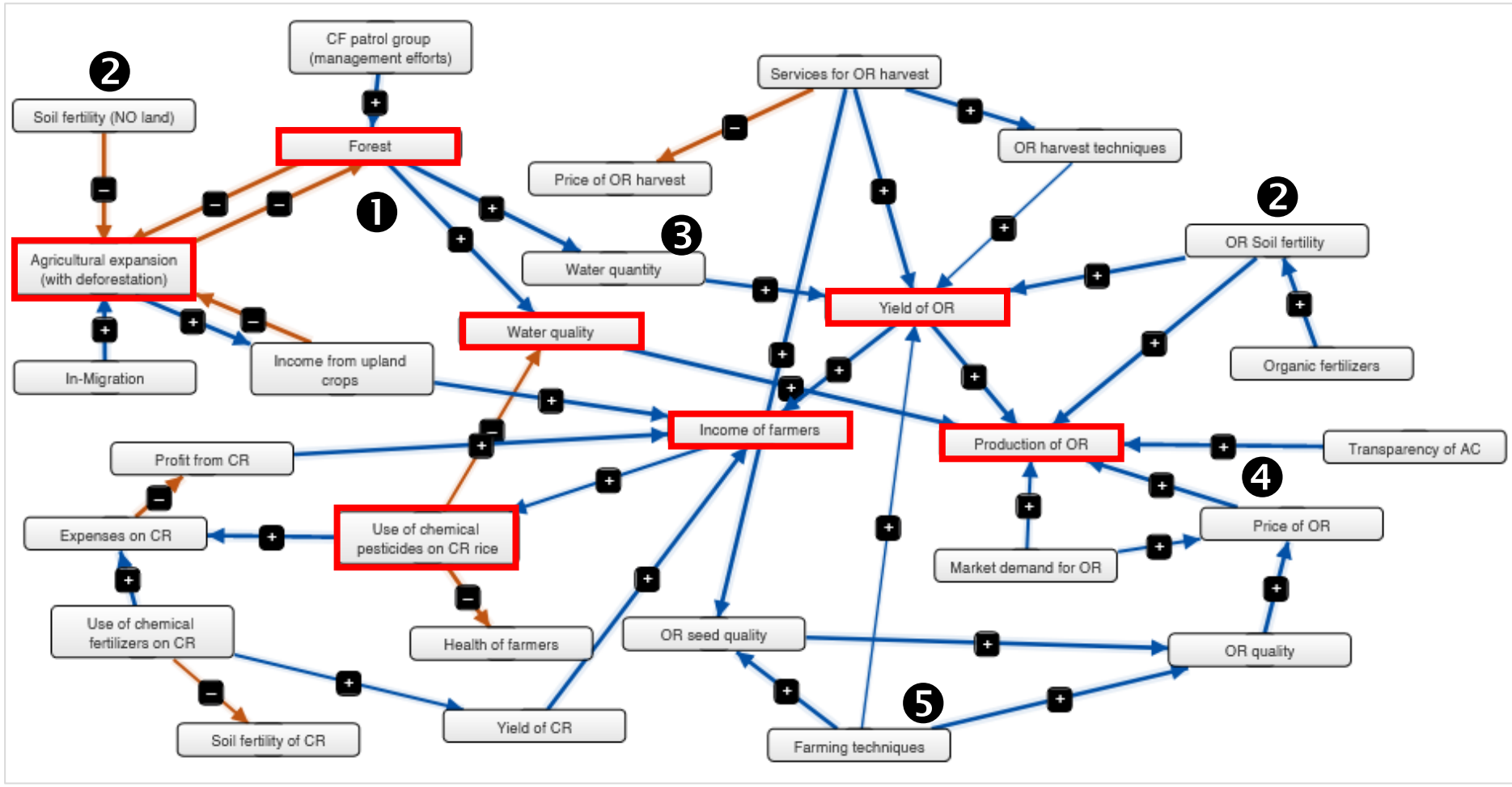


Figure 14. Key elements of agricultural development and their inter-relationships in Rik Reay commune (a fuzzy cognitive map)

Note: OR= Organic Rice, CR= Conventional Rice, NO=Not organic, AC=Agricultural Cooperative, Central component of the system, ❶❷❸❹❺=Ranking of problems identified

6.2 Problems identification and ranking

Based on the mapping and inter-relationships, and the detailed record of the discussion that led to it, the participants voted to rank the problems they identified in Table 1. Only local stakeholders were invited to vote, and not the NGOs and development projects who were in attendance. Voters included representatives of CBOs (FWUC, AC, and CFo), local authorities, and public sector representatives at the district level.

In conjunction with Figure 14, this exercise helps to hierarchize the issues, understand the articulation between their proximate/distant drivers and impacts, identify the leverage point that can be activated to address them and how.

Table 1. Ranking of problems facing agricultural development in Rik Reay commune

	Voting	Ranking
Decrease of forest cover	10	1
Decline of soil fertility	9	2
Lack of water	9	3
Price of organic rice is low	7	4
Lack of farming techniques (cultivation)	7	5
Decline in demand for organic rice	6	
Patrol of Community Forestry is limited	4	
Use of chemical pesticides increases	3	
Low income from crops	1	
Decline in the production of organic rice	1	
Lack of [appropriate] techniques for rice harvest	1	
Lack of rice harvesters	1	
Low quality of organic rice seeds	0	
Agricultural cooperative lacks running capital	0	
Expenses for conventional rice production are high	0	

The five problems ranked above provide a large spectrum of inter-dependent issues. As such, they emphasize the systemic nature of agricultural development and natural resources management in Rik Reay commune. Overall, problems raised by the participants are consistent with the results presented in sections 4 and 5 of this report.

6.2.1 Decrease in the forest cover (❶)

It was not entirely surprising, given its nodal position in the mapping, that the decline of the forest is considered the topmost problem in the commune due to its impacts on water quality and quantity, and, downline on organic certification. Participants perceive forest decline through deforestation but also through the degradation of remaining forest resources (i.e., illegal logging). The proximate driver is agricultural expansion, but participants pointed to the role of several intervening variables. First, the boundaries of the remaining forest are not demarcated and visible. Second, there are no clear land tenure and land use regulations inside the Community Forestry (CFo) area. Third, the limited support given to the CFo management group contrasts with the multiple tasks they undertake - patrolling, reporting cases of encroaching, taking action, representing Kiri Meanchey community forestry in wider alliances, and in particular, participation in the provincial CFo network.

6.2.2 Decline in soil fertility (❷)

The second most significant problem identified relates directly to the decline in soil fertility and, more generally, the lack of appropriate soil fertility management. Participants mentioned mono-cropping, limited diversification, and depletion of soil organic matter content (and limited use of organic fertilizers). People who joined the workshop also indicated that the limited use of the cover crop

negatively impacts soil fertility. The problem occurs differently in lowland and upland regions but is perceived everywhere in the commune. It limits yield and incentivizes further expansion into forestland.

6.2.3 Lack of water (❸)

The lack of water refers to not only limited water availability but also to the unreliability of rainfall and the changing patterns of rainfall that are well documented in other parts of the country. The latter concerns the increase of the dry spell and the risk of drought and intensification of rainfall in September-October and the increased likelihood of floods.

Participants attributed the problem to the decline in forest cover, which limits soil water retention and increases surface run-off. These micro-climate effects have been documented elsewhere in the country (Doch, Diepart, & Heng, 2015; Nut et al., 2021).

Other causes include the accumulation of alluvium and waste in ponds, lakes, and streams that limits water availability for supplemental irrigation in case of drought. Participants also mentioned a lack of experience in farming techniques to save water.

6.2.4 The price of organic rice is low (❹)

The problem with the low price of organic rice relates not only to economic, but also to institutional difficulties, which we unpacked during the workshop and follow-up discussions.

The price of organic rice is crucial in maintaining a differential in labour productivity due to the additional work input needed to grow organic rice as opposed to conventional rice. There is a conjuncture element to it insofar as the economic downturn due to the COVID 19 crisis has considerably limited the demand for organic rice in EU markets.

The question of price hides several problems concerning the management of the agricultural cooperatives (SWAC). First, there is a representation deficit between the management committee and the members; a total of 500 out of 700 members of SWAC live and work in Rik Reay, whereas the AC committee had no representative from that commune (up until early February). Farmers have the impression that the AC does not represent them and work for their benefit. Second, most farmers mistrust members of SWAC and the management committee. There is a convergence of testimonies pointing to irregularities in the internal control system and a lack of management transparency:

- Profit from the cooperative is not communicated and re-distributed to shareholders during annual assemblies as it contractually should
- The AC management committee grades quality. Oftentimes, it downgrades the quality of rice purchased from farmers and then sells it to AMRU at a higher grade of quality
- The AC sometimes reduces the rice quota from members and buying mostly conventional rice from non-member farmers at a lower price to reach the quantity agreed with AMRU
- Another general problem is the delayed payment to farmers. While the company pays the cooperatives within one or two weeks, it takes one to two months for farmers to receive payment. Sometimes the money is used to purchase the production of other non-member farmers.

The resentment farmers feel about these problems was perceptible at the time the survey was conducted. This puts organic certification at risk.

On February 14, 122 members of the SWAC voted to elect a new representative council. According to a communication from the PDAFF, three of the 10 council members and two of the 10 inspecting committee members are now from Rik Reay. This is certainly a step in the right direction for Rik Reay farmers.

6.2.5 Lack of farming techniques (cultivation) (❺)

In general, limited knowledge about, and skills in farming techniques are considered to be a problem. This a common statement for anyone involved in participatory assessments and agriculture-related planning in Cambodia. Participants are aware of the different research and experiments conducted in the commune (cover crop, hardpan breakup, etc.) and are keen to learn lessons through demonstration events, open forums, and so on. In general, there is a demand to learn about labour-saving techniques (small-scale and appropriate mechanization) and agro-ecological practices (crop protection, cover crops, and suchlike).

6.3 Developing scenarios to chart out an agro-ecological transition

Based on the modelling of the agricultural systems and the analysis of current agricultural development problems by participants, we developed different sets of scenarios to identify possible pathways towards an agro-ecological transition in the Rik Reay commune.

For each of the top five problems identified, we examine innovations being tested and other affordable solutions that could help to tackle them. We introduced these 'solutions' in the model (Figure 15) to envisage and visualize their systemic outcomes. To facilitate the discussion, we grouped the solutions related to soil fertility and farming techniques in one category, in which we differentiated between 'soil fertility/farming techniques' in lowland and in upland regions

Running such scenarios to answer the questions '*what would/could happen if ….?*' was instrumental in organizing the discussion with the participants about their preferences for an agro-ecological future.

Decrease in forest cover

- → Enhance the efforts and patrol groups of the community forest management group
- → Improve the protection of private forest (*Prey Kbal Srae*) and riparian forest along streams and water bodies in upland regions
- → Promote the sylvo-pastoralism initiative in the upland region

Soil fertility and farming techniques in lowland areas

- → Scale-up the use of cover crops. This supposes the availability of seeds, which imply the organic seed production and the establishment of pulse value-chains.
- → Scale-up the breaking of hardpan in rice fields
- → Increase the use of organic fertilizers
- → Promote non-rice crop diversification in the dry season and organic certification
- → Improve organic rice seed quality

Lack of water

- → Enhance forest protection (see above)
- → Develop irrigation from O'Kambor and O'Sakarach reservoirs

Soil fertility and farming techniques in upland areas

- → Promote the use of cover crops
- → Promote the use of organic fertilizers
- → Promote plant protection with agro-ecological techniques
- → Promote the sylvo-pastoralism initiative in the upland region

The price of organic rice is low

- → Increase the transparency and efficiency of AC management

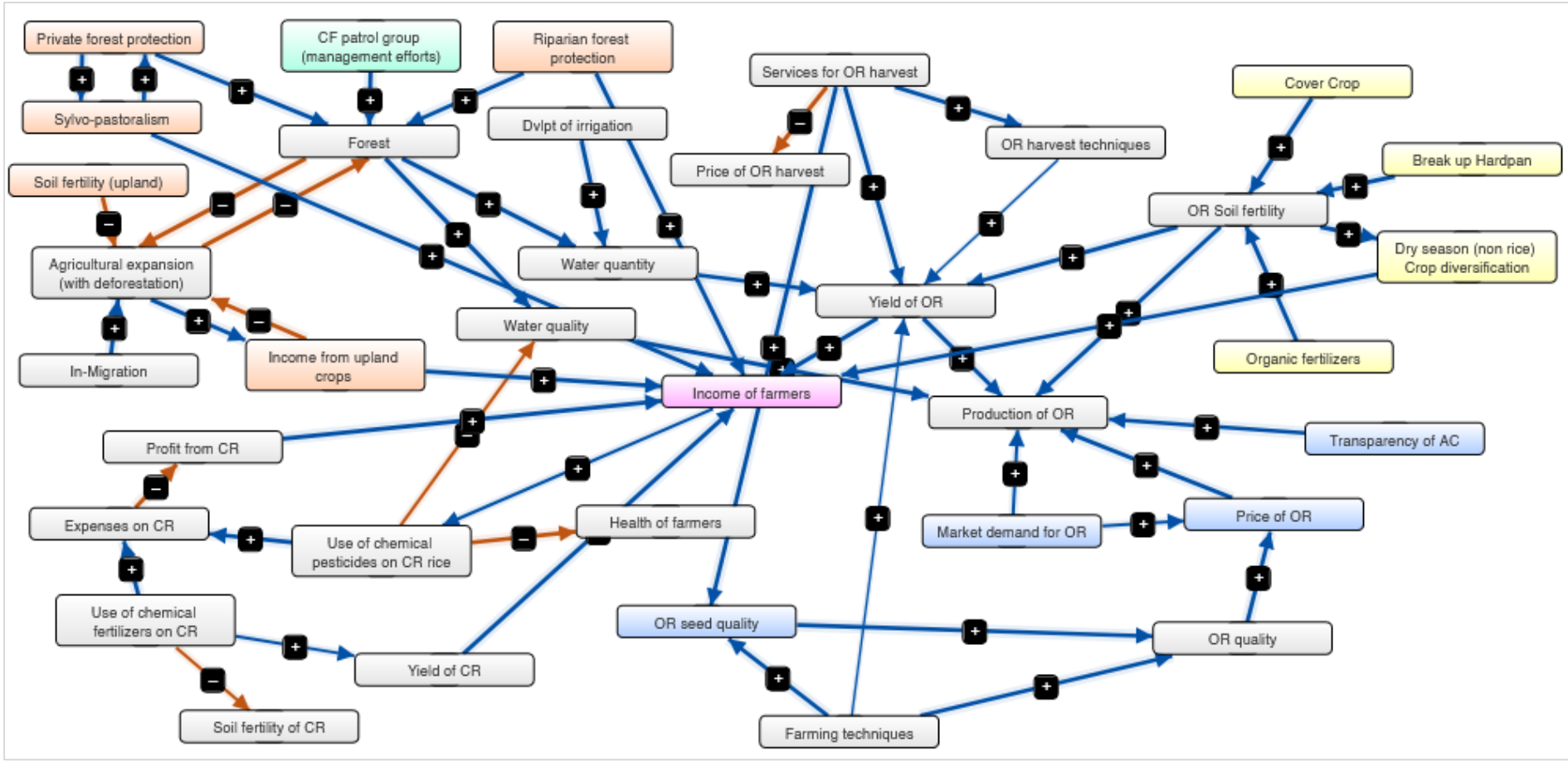


Figure 15. Key elements of agricultural development and their inter-relationships including the scaling-up of existing innovations and other measures

This model offers an option to visualise the systemic outcomes of these scenarios (Figure 16). The results are semi-qualitative as the relationships between components are not measured and weighed based on scientific knowledge but on people's perceptions. This is the reason why it is difficult to give a scientific meaning to the value in the x-axis - 'Measures of change in component'. Yet the figure offers a useful visual of what would happen if all of these innovations and solutions were jointly implemented.

Several positive impacts are noted not only on the organic rice elements (quality, price, soil fertility) but also at the watershed scale, such as an increase in forest cover, and a decline in agricultural expansion. Altogether, the actions could have a positive impact on farmer income.

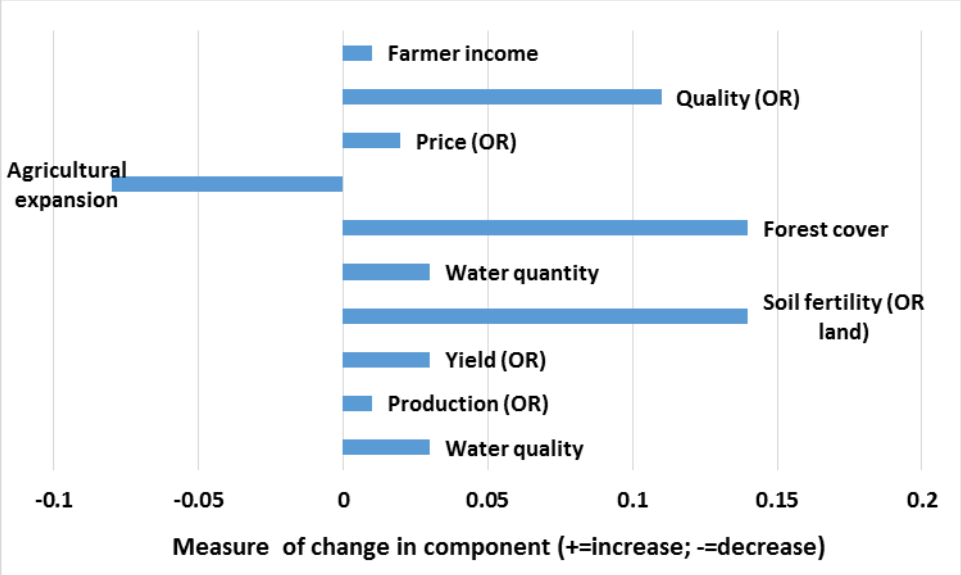


Figure 16. Integrated outcomes of scenarios ('agro-ecological transition in Rik Reay commune')
Source: Results obtained with Mental Modeller based on the model presented in Figure 15
Note: OR=Organic rice

6.4 Strategic orientations for an agro-ecological land-use plan

Based on the agricultural system model, the problem analysis, and scenarios, we identify four strategies contributing to the agro-ecological transition in O'Kambor and O'Sakarach watersheds. Each strategy consists of activities that are organized around a specific objective:

1. Protect the remaining forest in the CFo area and promote multifunctional riparian forest management
2. Improve soil fertility and promote agro-ecological innovation in lowland areas
3. Enhance the management of the AC and contractual arrangements for organic rice production
4. Improve soil fertility and promote agro-ecological innovations in upland areas

During the second planning workshop, the participants validated these strategic objectives and outlined more specific activities. The exercise included a description of specific actions, targets, locations, responsibility for implementation, and support needed (both financial and technical). The detailed results of the exercise are given in Annex 10.4.

In this section, we offer a synthesis of activities under each strategic objective, the rationales, and general recommendations for implementation. We do not suggest prioritizing specific strategies over others. Given the interdependence of the system components, the greatest impact will be achieved by implementing the four strategies jointly. However, given that resources are somewhat limited, it is key to prioritize activities under each strategy.

6.4.1 Protect the remaining forest in the CFo area and promote multifunctional riparian forest management

We believe that enhancing the protection and management of the remaining forest area covered by the CFo is important in many aspects. There are obvious reasons related to water management (maintaining quality and quantity), but the protection of the CFo area is also meaningful given the importance of these forests in the social and cultural life of the commune. Efforts to protect the remaining forest could create a collective mobilization among villagers in the commune around a common goal, an assembly point that would be potentially beneficial for the whole initiative (Table 2):

1. The demarcation of the remaining forest area (Phnom Chaom CFo1 and Phnom Kan Meas CFo2) with cement and wooden posts would present a quick-win. It would help to kick start ASSET activities in the commune, at least symbolically. Before the demarcation *per se*, local stakeholders would survey each CFo area to identify the location of posts and address any problems landowners might have. This survey would involve local authorities and representatives from the One Window Office of Rovieng district - including FA triage and division - the district office of agriculture, and the district cadastral office
2. ASSET could initiate the activities but it should be part of an informal 'alliance' yet to be created, e.g., the Kiri Meanchey CFo Alliance. This alliance would involve local authorities, the public sector, and like-minded organizations such as RECOFTC with a longer-term commitment to support the CF management group (training, organization of the public forum, patrolling groups, participation in the provincial CF network meetings, etc.)
3. Further, the Kiri Meanchey CFo Alliance could engage in a CFo management plan: forest inventory, reforestation plan and phasing (including with high-value timber[6]), and the establishment of a locally managed tree nursery. This activity would require significant training and capacity development activities for the local CFo management group
4. Moving beyond the CFo area *per se*, there is an opportunity to tackle the management of riparian forests along and around the main water streams and bodies in the catchment areas. These forests have a strategic importance in protecting water and limiting the contamination of surface water with pesticides. A specific feasibility study is needed to understand opportunities and constraints (land use and land tenure) and envisage the governance structure for such a project. Ideally, it could be conducted in collaboration with the FWUC (blocks 7 and 8), which is responsible for water management at the reservoir level.

[6] Example: Rosewood (Dalbergia oliveri), Beng (Afzellia xylocarpa), Chambak (Irvingia malayana), Choeu Teal (Dipterocarpus alatus)

Table 2. Activities relevant to strategic objective 1 (forest protection)

Priority	Activity	Rationale	Where	Who
1	Demarcation of the remaining forest inside the community forest area	• Prevent further encroachment and illegal logging • Mobilize people around a collective action to kick start the project	Phnom Chaom and Phnom Kan Meas (see Figure 12)	'Kiri Meanchey CFo Alliance' including - CFo management group - ASSET - FA - Local authorities, - Supporting organization such as RECOFTC
2	Support and capacity development for the CFo management group	Enable them to work more efficiently and within an alliance of like-minded supporters	Rik Reay commune	'Kiri Meanchey CFo Alliance'
3	Support the forest and reforestation management plan + tree nurseries	Develop local capacity to study and promote forest rehabilitation within the CFo area	Phnom Chaom and Phnom Kan Meas (see Figure 12)	'Kiri Meanchey CFo Alliance'
4	Riparian forest management (feasibility study → implementation)	Avoid or limit contamination of water resources with pesticides and other chemicals	Streams and areas around both reservoirs	Tbd Collaboration with FWUC (blocks 7-8)

6.4.2 Improve soil fertility and promote agro-ecological innovation in lowland areas

Under this strategic objective, it is crucial to build the activities in alignment with the ongoing research and extension by TA-AGRI/CIRAD efforts to develop agro-ecological innovations in the lowland rice area of Rik Reak commune (Table 3):

1. These efforts (and indeed promising results) could be documented and consolidated as an integrated set of practices that includes: breaking up the hardpan, promoting cover crops and organic fertilizers, diversifying to non-rice crops in the dry season and livestock integration. Given the relevance of labour productivity in organic rice production for several farming systems (FS1, FS2 and FS3), it is important to promote labour-saving techniques and practices. This also includes small-scale and affordable mechanization to limit post-production loss
2. Dissemination of the results of such experiments, and sharing and learning, are in demand. The extension and vulgarization of research is essential to scale-up innovations. This could be organized in creative ways - including public forums - in conjunction with the FWUC management structure established for different blocks across the command area (Figure 11).

Table 3. Activities relevant to strategic objective 2 (improve soil fertility and agro-ecology in lowland areas)

Priority	Activity	Rationale	Where	Who
1	Consolidate the lowland rice innovations and labour-saving practices (including small-scale affordable mechanization)	Enhance the aspects of organic rice production	Lowland rice area	ASSET + WAT4CAM (TA-AGRI + R4D)
2	Disseminate and share R4D results in public forums	Scale-up the uptake of agro-ecological innovations at the command area level	Lowland rice area	ASSET + WAT4CAM (TA-AGRI + R4D) in conjunction with block-based FWUC management groups

6.4.3 Enhance management of the AC and contractual arrangements for organic rice production

Market conjunctures for organic rice and other agricultural commodities are mainly beyond the control of farmers and their organizations. Yet a defining element in market and contractual arrangements has to do with the role that the SWAC plays in the certification process and in facilitating the market links between farmers and AMRU.

The recent election of the new SWAC council is a step in the right direction in addressing the representation deficit between the council and the members of the agricultural cooperative. But election is only the first step. There is a need to provide support and enable the new representative body to work efficiently and in a transparent way. The role of PMUAC and the AC promotion office of PDAFF is central in training SWAC committee members and in monitoring and evaluating its performance (Table 4)

Table 4. Activities relevant to strategic objective 3 (enhance the management of the AC)

Priority	Activity	Rationale	Where	Who
1	Provide support for the newly elected SWAC committee to put in place a strong M&E system, in connection with other organic value-chains	Transparent management is key for the certification and development organic rice production	Rik Reay commune (+Romoneiy, Robiab, Reaksmei, and Rung Raeung communes where SWAC is involved)	ASSET PMUAC PDAFF

6.4.4 Improve soil fertility and promote agro-ecological innovations in upland areas

The scope of the work needed to promote agro-ecological transition in the upland area is immense. This is the reason why it is important to choose specific and practical entry points. Quick-win projects would help to mobilize farmers for a more substantial transformation of their farming practices (Table 5):

1. Identifying and supporting a network of demonstration plots/farmers in the use of cover crops is probably a good entry as some farmers have already tested them in the lowland areas and would be appropriate candidate to adapt and transfer the practices to upland areas (for main crops of peanut, soybean, and mungbean, or inter-cropped with cashew). Land classified as barren is good entry point to reboost soil fertility and start and agro-sylvo–pastoralism initiative.
2. But if the use of cover crops is to be scaled-up to lowland and upland areas, there is a need to produce seeds. This requires land that is most easily found in upland regions.
3. Based on the same network of demo plots/farmers, continuing the development of innovations to improve soil fertility and farming practices in upland areas:
    a. Intercropping organic cassava-soybean with young cashew
    b. Providing training in the production of organic fertilizers e.g., composting
    c. Testing plant protection against the tea mosquito bug
4. Piloting an agro-sylvo–pastoralism initiative in upland forest patches (Prey Kbal Srae), including improving the pasture, grazing, fencing, penning and embedding a see production scheme of fodder species.

Table 5 Activities relevant to strategic objective 4 (soil fertility and agro-ecology in upland areas)

Priority	Activity	Rationale	Where	Who
1	Identify and support a network of demonstration plots and farmers to test, adopt, produce and market cover crops	Improving soil fertility through agro-ecological practices in uplands is key to the sustainable intensification of upland crops	Demonstration plots/farmers	Demo farmers ASSET Smart Agro
2	Disseminate and share R4D results relating to cover crops in a public forum	Scale-up the uptake of agro-ecological innovations at the watershed area level	Upland rice area	Demo farmers ASSET
3	Enlarge R4D activities to other innovations and practices (intercropping, organic fertilizer use and production, plant protection)	An integrated set of agro-ecological practices has more impact than individual ones	Demonstration plots/farmers	Demo farmers ASSET
4	Pilot an agro-sylvo–pastoralism initiative in upland forest patches (Prey Kbal Srae), including improving pasture, grazing, fencing and penning	Multi-functional forest management is beneficial to the farmers and aligned with sustainable intensification	Demonstration plots/farmers	Demo farmers (FS3) ASSET

7 Institutionalization of the agricultural land use plan

The overall strategies for an agricultural land-use plan in Rik Reay commune need to be discussed with the existing and potential partners to determine priorities, responsibilities, and a more specific course of action.

This also raises the question of institutionalizing the agricultural land-use plan within the local administration. Three non-exclusive options could be considered as a sequenced process:

1. The strategic agricultural land-use plan proposed here calls upon a variety of institutions and community-based organizations (CFo, CF, AC, FWUC, etc.). Each of these community-based management committees is embedded within a specific sector but coordination is essential. The commune council (with support from the One Window Office) is probably the most pertinent entity to play this role. However, the commune council carries a heavy work burden, and needs to be supported in the coordination role. ASSET could start with setting up a reporting system from different initiatives to commune councils and the one-window office. The project could also facilitate the intervention of commune council and OWO as required. The support needed is relatively simple and not resource-demanding. It would consist of preparing a report template with local stakeholders, enabling them to fill it on a regular basis (e.g once every 3 months) and communicate it to the commune council and OWO. Meeting and field visit could be organized alongside to enhance commune council participation in and oversight over the different activities.
2. The identification of mechanisms to grant land tenure security to farmers could be part of these coordination efforts. In conformity with decentralization and de-concentration policies, the commune and the OWO, in which the district-level cadastral administration is represented, could agree on an overall approach and eligibility criteria to recognise land possession in the commune, i.e determine a cut-off date according to the dynamic of deforestation.
3. Improved coordination mechanisms by the commune council would help to integrate the various AE initiatives into the development and investment planning process of the commune. Each year, the commune update its investment plan and prioritize the activities they would like to see implemented. It takes several steps and lead to the presentation of the plan in a so-called district integration workshop to district authorities, provincial departments and development partners who could be interested in supporting/financing the proposed activities. ASSET could support the commune council in this process: support their investment planning, i.e integrate the different initiatives of the agro-ecological transition into the annual investment plan, and identify ways to mobilize a budget (from provincial departments and/or NGOs) to co-finance specific projects. Intervention is required at some key moments in the planning process, following the schedule of meeting and workshops set by the district authorities under the overall guidance of the National Committee for Sub-national Democratic Development (NCDD)[7].
4. Spatial planning institutions in place in Cambodia would allow the progression of one step further in the institutionalization of the plan. To gain further recognition, it is possible to upgrade the agricultural land-use plan into a Commune Land Use Plan (CLUP, see above). This

[7] NCDD is an inter-ministerial mechanism for promoting democratic development through decentralization and de-concentration reforms throughout the country

requires going beyond agriculture and forest and embracing other sectors such as security, the development of the non-farm economy, and the management of public and private education and health services. It requires a long(er) process of consultation and integration of the existing CDP and CIP into it. The outcomes of this planning would probably not change much in respect of the realization of the agro-ecological transition (or lack thereof) but would improve a sense of ownership among local authorities over the entire process.

8 Conclusion

Rik Reay commune is in a good position to initiate an agro-ecological transition but the leeway is limited. Ongoing initiatives - CFo, organic certification and irrigation - are excellent as a basis for coordination and to build upon, but they are fragile. All the people consulted during this survey shared an enthusiasm to shape a better and more agro-ecological future in Rik Reay but they were also realistic about the feasibility of such an initiative. Shaping an agro-ecological transition is not just about adopting an integrated set of innovative practices. It is also about showing that these practices offer a credible alternative to the *status quo*, and are shaped by a solid network of actors and practices that are also rational to the farmers.

The conception and realization of the action that will unfold from this study is a collective endeavour. It requires working in alliances with like-minded actors who share the same strategic interests to ASSET. This is a unique way to make the best use of limited resources and to maximise the chance for sustainable success.

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10 Annexes

10.1 List of people consulted and activities conducted during field work

Date	Activities Interview	Place	Participants	Facilitators
29/11/2021	PDAFF	Preah Vihear municipality	4	2
30/11/2021	PDLMUPC	Preah Vihear municipality	2	2
30/11/2021	PDoWRaM	Preah Vihear municipality	2	2
1/12/2021	PDoE	Preah Vihear municipality	2	2
1/12/2021	FA Cantonment	Preah Vihear municipality	1	2
1/12/2021	RECOFTC	Preah Vihear municipality	1	2
2/12/2021	Unified district administration	Rovieng district hall	3	3
2/12/2021	Rik Reay commune council	Rik Reay	4	3
3/12/2021	Agricultural Land Use Planning Workshop (1of2)	Rovieng district hall	21	3
4/12/2021	Reconnaissance of CF area (GPS)	Community Forest area		
4/12/2021	Community Forestry	Own House	2	2
4/12/2021	FWUC	Own House	1	2
5/12/2021	Reconnaissance in/out catchment areas (GPS)	Commune		
5/12/2021	Villagers during field trip	Kaoh Lung	1	2
5/12/2021	Farmers (Cashew) during field trip	Kaoh Lung	1	2
6/12/2021	Rovieng Cadastral office	Phum Daek	2	2
6/12/2021	Rik Reay commune council	Rik Reay	3	2
6/12/2021	Reconnaissance in/outside of catchment areas (GPS)	Commune		
6/12/2021	Sitha (TA Water, WAT4CAM)	Rovieng (guesthouse)	1	2
17/12/2021	Agricultural Land Use Planning Workshop (2of2)	Rovieng district hall	15	6
Total			66	

10.2 Land, herd and labour productivity of main cropping and livestock systems

	Gross product ($/ha or $/herd)	Intermediate inputs ($/ha or $/herd))	Gross Value Added ($/ha or $/herd)	Labour (man-days/per year)	Gross Value Added ($/man-days)
Pig (fattening) - 5 heads	2,340	1,467	873	228	4
Pigs (breeding/fattening) - 1 female	3,393	1,162	2,231	228	10
Pig (breeding) - 2 females	3,351	775	2,576	228	11
Cattle (50 heads)	4,870	0	4,870	125	39
Cattle (10 heads)	913	0	913	125	7
Cashew > 6 years (high intensification)	2,000	384	1,616	39	41
Cashew <6 years (low intensification)	500	126	374	23	16
Cassava (fresh) with tractor	1,500	235	1,265	39	32
Cassava (dry) with tractor services	1,600	321	1,279	134	10
Cassava (dry) with power tiller	1,600	125	1,475	144	10
Soy bean	450	107	343	50	7
Conventional rice (broadcast)	225	84	141	49	3
Organic rice (transplanted)	800	100	700	97	7

10.3 Kiri Meanchey community forest

10.4 Detailed identification of activities for each main strategic objective

10.4.1 Protect the remaining forest in the CFo area and promote multifunctional riparian forest management

No.	Activity	Objectives	Location	Who's in charge	Support (technical and financial)
1	Demarcating the boundary of existing forest area by GPS with a proposed surrounding road for protection	- Protection of remaining forests - Ending the forest clearance	The remaining forests of Community Forestry are located in two mountains: Phnom Chaom and Phnom Kan Meas	- CFo increases to 2 patrols per month - FA - Villagers, commune and district authorities - Police authorities	- Commune budget to propose the budget to build the surrounding road - FA (technical and budget) - NGOs: Ponlork Khmer, NTFP, RECOFTC - Projects: ASSET
2	Raising public awareness about the Forest Law (public forums / meetings with the villagers)	- Improving knowledge of villagers about the Forest Law, forestry community, riparian forest, and private forest - Raising awareness about the benefits of forests for people, animals, soil, and plants	- Forestry community, riparian forests, private forests	- CFo and FA - Local authorities - Police authorities and villagers	- Local authorities - NGOs: Ponlork Khmer, NTFP, RECOFTC - Projects: ASSET
3	Supporting the CFo's patrols	- Monitoring and protecting the forests	The remaining forests of the Community Forestry initiative located in two	- CFo increases 2 patrols per month - CFo committees	- Local authorities - FA (technical and budget)

			mountains: Phnom Chaom and Phnom Kan Meas	- Local authorities - FA and police authorities	- NGOs: Ponlork Khmer, NTFP, RECOFTC - Projects: ASSET
4	Building the capacity of CF committees on the Forest Law	- Improving the knowledge of CFo's committees on the forest law	Not specified	- FA - NGOs	- FA (technical and budget) - NGOs: Ponlork Khmer, NTFP, RECOFTC - Projects: ASSET
5	Ending the trading of bamboo	- Protecting the bamboo forests along the streams and in private forest	Riparian forest and private forest	- CFo - FA - Police authorities	- FA (technical and budget)
6	Reforesting high value timber species inclusing training, nursery and caring techniques	- Providing benefits: habitats for wildlife, incentives to improve the degraded lands, reduction of natural disasters, timber/NTFPs for the next generations	- Commune land (public area) for nursery establishment - Confiscated lands belong to the CFo - All areas of the CFo especially the Phnom Chaom and Phnom Kan Meas	- Villagers - Buddhist monks - Local authorities - FA	- Local authorities - FA (technical and budget) - NGOs: Ponlork Khmer, NTFP, RECOFTC - Projects: ASSET

10.4.2 Improve soil fertility and promote agro-ecological innovation in lowland areas

No.	Activity	Objectives	Location	Who's in charge	Support (technical and financial)
1	Providing training relating to innovations for restoring soil fertility	- Training local authorities and farmers - At least 2 training to AC per year from June to December	All villages in the commune	- Projects - Agricultural district office	- Local authorities - Projects - NGOs: World Vision
2	Promoting cover crops	- Increasing by 50% the area of using cover crops in 2022-2023 - Encouraging the farmers to participate	O'Sakarach command area of the irrigation system	- Projects	- Projects
3	Providing training in pests and disease control	- Training farmers and then they share that with 30% of the other farmers	All villages in the commune	- Projects	- Projects
4	Providing training in compost production (on-field training)	Two times per year with 5 farmers each time in 2022-2023	All villages in the commune	- Projects - Agricultural district office	- Projects

5	Ploughing to incorporate the rice straw / stubble into the soil after harvest	Raising awareness about the benefits of rice straw / stubble and the negative impacts of burning	All villages in the commune	- Local authorities - District agricultural office	- Projects - NGOs - Agricultural district office
6	Reducing / Stopping burning the rice straw / stubble	Raising awareness about the benefits of rice straw / stubble and the negative impacts of burning	All villages in the commune		
7	Selecting master farmers as model farmers e.g., for compost production	Selecting 5 model farmers to produce the compost and extend this practice to 85% in the commune in 2022-2025	All villages in the commune	- PDAFF - Agricultural district office - PMUAC, AC - Projects - Farmers	- PDAFF - Projects - Agricultural district office

10.4.3 Enhance the management of Agricultural Cooperative and contractual arrangements for organic rice production

No.	Activity	Objectives	Location	Who's in charge	Support (technical and financial)
1	Searching for more traders and companies for greater competitiveness in pricing	- Increasing the price of organic rice - Finding the traders / buyers before the cropping season	Command area of the irrigation systems in O'Kambor and O'Sakarach	- AC - Farmers - Local authorities	- Projects: WAT4CAM, ASSET - NGOs: NTFP
2	Improving the quality of organic rice (e.g., using pure and high seed quality, good water quality without any contaminants / pollution, well-timed harvest and post-harvest)	- Securing a market with more stable prices - Increasing market demand - Achieving a better price for organic rice than for conventional rice	Whole commune	- Farmers - AC - Agricultural district office	- WAT4CAM
3	Increasing the area of organic rice farming	- Producing to meet the market demand	Whole commune	- Farmers	- Projects: WAT4CAM, ASSET
4	Improving the transparency of contract farming implementation e.g., respecting the contract, acquiring from the same AC member as is registered in the contract	- Explaining the contract to AC members so that they are aware of all of the conditions and are happy to register with the contract - Paying as soon as possible	Whole commune	- Farmer - GDA and buyers	- PDAFF, agronomy office

5	Improving the rice quality by packing it in suitable bags for sale	- Building storage facilities - Accurate weighing without cheating - Improving the means of transportation	Whole commune	- AC - Local authorities - Farmers	- ASSET - NGOs
6	Signing the contract before the cropping season	- Producing to meet the market demand - Buying only from AC members	Whole commune	- Contracting company - PDAFF, AC - AC members	- Project - Company

10.4.4 Improving soil fertility and promoting agro-ecological innovations in upland areas

No.	Activity	Objectives	Location	Who's in charge	Support (technical and financial)
1	Raising the contour terracing/bunding around the hills and planting grass/crop species - e.g., lemon grass - as vegetative barrages	Selecting 5 model farmers to demonstrate different species	Catchment area of O'Kambor and O'Sakarach	- Agricultural district office - Model farmers	- Agricultural district office - Projects: ASSET
2	Using cover crops	Selecting 5 model farmers to demonstrate main crops e.g., peanut, soybean, mungbean	Catchment area of O'Kambor and O'Sakarach	- Agricultural district office - Model farmers - AC	- Agricultural district office - Projects: ASSET
3	Providing training in the production of organic fertilizers e.g., compost	Selecting 5 model farmers to demonstrate all crops especially vegetables	Catchment area of O'Kambor and O'Sakarach	- Agricultural district office - Model farmers - AC	- Agricultural district office - Projects: ASSET, CHAIN
4	Establishing improved pasture land with fencing	Selecting 5 model farmers to test integrated improved pasture – livestock activities	Catchment area of O'Kambor and O'Sakarach	- Agricultural district office on livestock - Model farmers - AC	- Agricultural district office - Projects: ASSET and others
5	Restoring the soil fertility of the cashew plantation by intercropping with cover crops and using organic fertilizers	Selecting 5 model farmers to demonstrate how degraded soil under cashew plantation could be improved	Catchment area of O'Kambor and O'Sakarach	- Agricultural district office - Model farmers - AC	- Agricultural district office - Projects: ASSET and others

6	Testing / promoting intercropping with cassava and soybean either for young cashew plantations and barren land	Selecting 5 model farmers to demonstrate how degraded (and abandoned) plots could be put to productive use	Catchment area of O'Kambor and O'Sakarach	- Agricultural district office - Model farmers - AC	- Agricultural district office - Projects: ASSET and others
7	Creating producer groups for seed of cover crops	Selecting the existing 8 groups of water users from the FWUC	Upland and/or lowland plots that are suitable for seed production for cover crops	- Agricultural district office - FWUC - 8 groups of water users	- Agricultural district office - Projects: ASSET, WAT4CAM…etc. - PDoWRAM
8	Providing training in growing techniques relating to cover crops for seed production and marketing for sale	Selecting the existing 8 groups of water users from the FWUC	Upland and/or lowland plots that are suitable for seed production for cover crops		- Agricultural district office - Projects: ASSET, WAT4CAM…etc.
9	Ploughing to incorporate the previous crop residues	Selecting all kinds of crop plots (upland rice, cassava, pulses, sesame) from each village as demonstration, preferably 3 plots/village	Catchment area of O'Kambor and O'Sakarach	- Agricultural district office - Model farmers	- Agricultural district office - Projects: various