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**Identification and Documentation of
Underutilized Crops in Mondulkiri Province
with Emphasis on Socio-Economic Aspects**

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List of Abbreviations

ADB	:	Asian Development Bank
CARF	:	Cambodian Agricultural Research Fund
CARDI	:	Cambodian Agricultural Research and Development Institute
CBD	:	Convention on Biological Diversity
CWR	:	Crop wild relatives
EU	:	European Commission
FAO	:	Food and Agriculture Organization of the United Nations
FGD	:	Focus group discussion
GFU	:	Global Facilitation for Underutilized Crops
GPA	:	Global Plan of Action
IPGRI	:	International Plant Genetic Resource Institute
IUCN	:	International Union for Conservation of Nature
JIRCAS	:	Japan International Research Center for Agricultural Science
MAFF	:	Ministry of Agriculture, Forestry and Fisheries
MI	:	Mekong Institute
MINZAS	:	Mekong Institute-New Zealand Ambassador Scholarship
MPF	:	Mondulhiri Protected Forest
MoE	:	Ministry of Environment
NIAS	:	National Institute of Agrobiological Science
NGO	:	Non Government Organization
NTFP	:	Non Timber Forest Product
NUS	:	Neglected and Underutilized Species
ODC	:	Open Development Cambodia
PGR	:	Plant Genetic Resource
PGRFA	:	Plant Genetic Resource for Food and Agriculture
PRA	:	Participatory Rural Appraisal
SBCA	:	Seima Biodiversity Conservation Area
RRA	:	Rapid Rural Appraisal
RUA	:	Royal University of Agriculture
UNDP	:	United Nation Development Program
WFP	:	Wild Food Plants

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Abstract

Underutilized crops including wild plants for foods represent a rich portfolio of crop genetic resources that are particularly overlooked in the agricultural development agenda. They show significant potential to enhance food security, improve nutrition, diversify income options and recover marginal lands into food production, which strengthen social, economic growth, and ecological services. However, their role is often ignored or underestimated by crops researchers, planners and policy makers, donor agencies, public and private investors, extension services and economists. Therefore, reintroduction, management and promotion of underutilized crops are highly important for future food security, agricultural diversification and economic growth. To fulfill these gaps, crop surveys, including information on ethnobotany and socioeconomics were done together, and the threats and the strategies to safeguard them were identified. There were 50 species of underutilized crops and 32 species of wild food plants documented and their roles in Trang Teh and Romonea were described in terms of food security and economic growth opportunities. Many underutilized crops as well as wild food plants still remain important to these two local communities; however, farmers may no longer be able to grow their own traditional varieties and landraces due to changing climate as shown by recent droughts, pest attacks and crop failure. Together, biodiversity status in the research areas has decreased due to fire, pests and diseases, lumbering, mining encroachment, economic land concession and infrastructure development. Therefore, the conservation of plant genetic resources (PGR) will attempt to provide the background, current research, some approaches to develop potential strategies and to conserve underutilized crops which are the keys for sustainable food security and poverty alleviation.

1. Introduction

1.1 Background of the Study

In many rural areas around the world, Plant Genetic Resource for Food and Agriculture (PGRFA), particularly underutilized crops and wild food plants are an essential component of the livelihoods strategies of indigenous and local communities (IPGRI, 2002). Although these crops continue to be maintained by cultural preferences and traditional practices, they remain inadequately characterised and neglected by research and conservation. Lack of attention has meant that their potential value is underestimated and underexploited and places them in danger of continued genetic erosion and disappearance which would further restrict development options for the poor (Joshi et al, 2002).

However, the natural populations of many species of underutilized crops and crop wild relatives are increasingly at risk of extinction or genetic erosion. They are being threatened primarily by the replacement of farmer's varieties/landraces, land clearing, overexploitation, reduced water availability, population pressures, changing dietary habits, environmental degradation, changing agricultural systems, overgrazing, legislation and policy, pests, diseases and weeds (FAO, 2011). Therefore, there is an urgent need to document and identify priority species, and areas for conservation and to develop integrated *in situ* and *ex situ* conservation strategies to ensure that the existing species are protected for the future economic growth and development.

Cambodia, especially its Mondulakiri province, is rich in PGRFA. The local/landrace/traditional varieties known as underutilized crops have not been completely replaced with improved varieties. Therefore, this province may still harbour primitive landraces and wild relatives of many different crops and other genetic resources that evolved in Cambodia. High genetic diversity of these crop plants in cultivated and wild related forms can be found abundantly in this region. Thus, this region is considered a biodiversity hotspot in Cambodia. However, the role of underutilized crops is often ignored or underestimated by crops researchers, planners and policy makers, donor agencies, public and private investors, extension services and economists.

The current development of agriculture in Mondulkiri poses threats to underutilized crops. Infrastructural construction, deforestation, intensification of agriculture, and adoption of a few modern cultivars, together with the impact of climate change, are resulting in the loss or fragmentation of habitats for underutilized crops and crop wild relatives. At the same time, agricultural sustainability is threatened by factors such as population growth, poverty, hunger, deprivation and degradation of natural resources base. In addition, loss of agrobiodiversity and increased farmer dependence on a few highly selected crops resulting in narrow food baskets have also caused food and nutrition insecurity and poverty in rural and urban communities. Research on underutilized crops holds promise to attain sustainability, profitability and diversification in agriculture and to identify priority species in genetic resources hotspots in order to develop an integrated in situ and ex situ conservation strategies to protect them for use in the future.

The research presented here provides a background on the socio-economics of the Phnong minority communities associated with underutilized crops, current research, constraints for sustainable production, approaches to research and potential strategies which I hope will be helpful in leading the strategic development of underutilized crops for sustainable food and nutrition security and poverty alleviation.

1.2 Objective of the Study

The overall objective of the research is to identify and document underutilized crops in Mondulkiri province with emphasis on socioeconomic aspects including local's people perception concerning threats in order to develop an integrated in situ and ex situ conservation strategy to protect them for use in the future.

The specific objectives of this study are:

1. To identify and document the underutilized crops in the research areas.
2. To assess the contribution of underutilized crops to socio-economic benefit of the communities.
3. To discuss the threats to underutilized crops and identify appropriate strategies to safeguard them.

1.3 Limitation of the Study

The research on underutilized crops with information on socioeconomics was done in two districts in Modulkiri province. One commune is selected from each district and four villages were used for clustered random sampling in the research areas. Due to limitations in time, finance and human resources, the study was focused on the species familiar with local people and crop list are done only with available resources.

The documentation of underutilized crops in the research areas were compared with INFOODS List of underutilized species contributing to the Nutritional Indicators for Biodiversity adopted by the Global Facilitation Unit for Underutilized Crops on December 2010, and NUS list in Cambodia adopted by project Agrofolio: Benefiting from an Improved Agricultural Portfolio in Asia. Similarly, wild food plants were documented by using the information from focus group discussions and checked with main references including (1) Plant Used in Cambodia authored by Dy Phon, (2) the database of local vegetables in Thailand referenced by JIRCAS, (3) Lao Non-Timber Forest Products Wiki, and other sources. However, the entire list of wild food plants given by farmers could not be documented due to lack of information on them. This disparity indicates the remaining gaps in these studies that require further research on ethnobotany associated with wild food plants.

1.4 Site of the Study

The study was conducted in one of the Northeastern provinces of Cambodia, which is a region of high biodiversity for wild food plants in Cambodia. Mondulkiri is the most sparsely populated province in the country while also being the geographically largest province in Cambodia. This province has abundant natural resources, with thickly forested mountains, powerful waterfalls and the lush green rolling hills on the western side. This area is believed to still harbour primitive landraces and wild relatives of many different crops and other genetic resources that evolved in Cambodia. Based on these criteria, two communes namely, Trang Teh and Romonea were selected and four villages were randomly selected in the sub-areas based on altitude.

The geographical position of the Romonea commune is between 12°33'04.7"N to 12°29'28.1"N latitude and 107°21'15.9"E to 107°14'38.9"E longitude. For the Krang Teh commune is between 12°39'59.9"N to 12°39'23.4"N latitude and 107°21'17.7"E to

107°21'06.9"E longitude. The altitudinal range of the communes is from 445 m (Pu Robet) to 727 m (Pu Tang) above mean sea level. Mondulkiri's average temperature throughout the year is lower than in other areas of Cambodia. The province has 3 seasons including a rainy season from June to October (<25°C), a cool season from November to February (>20°C) and a hot season from March to May with temperatures ranging from 20°C-30°C.

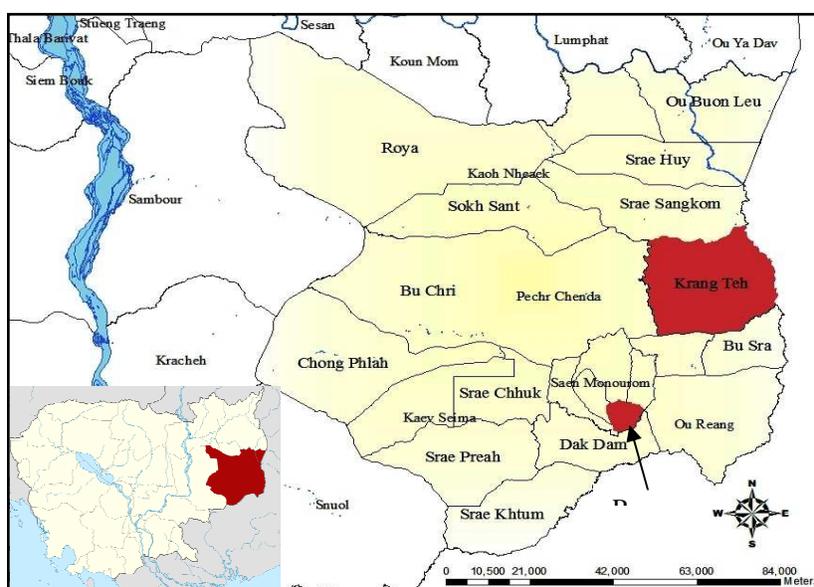


Figure 1. Map of study site

2. Review of Literature

2.1 Flora of Cambodia

As a tropical country, Cambodia has highly diverse flora and fauna. However, botanical studies in Cambodia have been limited. Until recently, understanding of the country's flora and vegetation reflected activities of a small number of botanists and foresters.

There is no accurate assessment of the floristic diversity in Cambodia (Smith, 2001). Dy Phon (1982) suggested a known flora of 2308 species of seed plants and these species belong to 852 genera in 164 families, and include Gymnosperms (7 genera 14 species), Monocotyledons (219 genera 488 species) and Dicotyledons (626 genera 1,806 species), but this total seems far too small given more reasonable estimate of about 12,000-15,000 species for Laos, Cambodia and Vietnam (Schmid, 1989). The full list for Cambodia is expected to exceed 3,000 species (Dy Phon, 2002), with expectations that at least 700 additional species

will be described as new to science in the country. It may be assumed that a minimum of ten percent of these species will be endemic to the country. The World Conservation Monitoring Centre in 2000 estimates there are 8260 plant species in Cambodia, 10% of which are thought to be endemic. Therefore, there is still considerable scope for further documentation of the flora of Cambodia. Cambodia has never had a systematic, national inventory of its flora. Cambodia is not estimated to have a high level of endemic plants; however, the wet forests of the Cardamom and Elephant Mountains and swamp forests of the Tople Sap floodplain might be expected to harbor endemic species.

At the generic level, Dy Phon suggested the following bio-geographic affinities for the Cambodia flora:

Genera	Percentage
Indomalesian/Sino-Indomalesian genera	30%
Pantropical genera	24%
Australian/Pacific genera	15%
African/Malagasy genera	14%
Comopolitan genera	10%
Continental genera	7%

Source: Cambodia's Biodiversity Status Report, 2001

2.2 Food Plant Species in Cambodia

According to the Derleth report on Useful Plants in Cambodia for the IUCN which was used by Ashwell (1997) to write a section on useful plant species in the Cambodia Biodiversity Prospectus, Derleth highlighted the background to his findings as follows:

“Cambodians habitually utilized at least 931 species of Cambodia’s 2,304 plant species. Of the 849 species for which life forms are described, 34.8% are trees of various sizes, followed by 21.7% herbs (including bamboo and bananas) and 15.1% shrubs. The remaining 28.4% include shrubs, palm trees, lianas and ferns...Habitats are known for 62.7% of these species. The main classes are the cultivated plants (23.6%), then species coming from primary evergreen (dense) forest (14.3%) and secondary formations habitats. Thus, wild plants appear to be at least as important as cultivated plants”. (p. 72)

Food plants are an obvious sign of Cambodia’s rich diversity of plant life (Smith, 2001). There is an extensive variety of fruits, grains and vegetables grown throughout the country and food plants collected in the wild further supplement this. Derleth’s estimates for the percentage of food plants based on the 2,304 known plant species are as follows:

“Food plants constitute 37.9% (353 species) of the total number. These plants are used daily though dependency may be greater during months when there is food deficit in an area. Food plants include species, vegetables, fruits, nuts, leaves, flower, roots, tuber, etc” (Derleth in Aswell, 1997). (p. 72-73)

Cambodia falls within Indochinese-Indonesian megacentre of cultivated plant diversity, which includes the major crops of rice, banana, bamboo, coconut, yam, and mango (Smith, 2001). The customary significance of rice as the major staple food in Cambodia is emphasized by the fact that 75-80% of the average human caloric intake is derived from rice, followed by maize and cassava (Jan-Peter Mund, 2010). Among legumes, soybean is significant followed by mungbean; and for oilseed crops, groundnut and sesame are important. Among commercial crops, sugarcane followed by jute and tobacco is commonly grown (FAOSTAT, 2012). Vegetables mostly occupy only village gardens and small fields around Phnom Penh, while economic cultivation of cassava and sweet potato is rising on large scale concessions (Jan-Peter Mund, 2010).

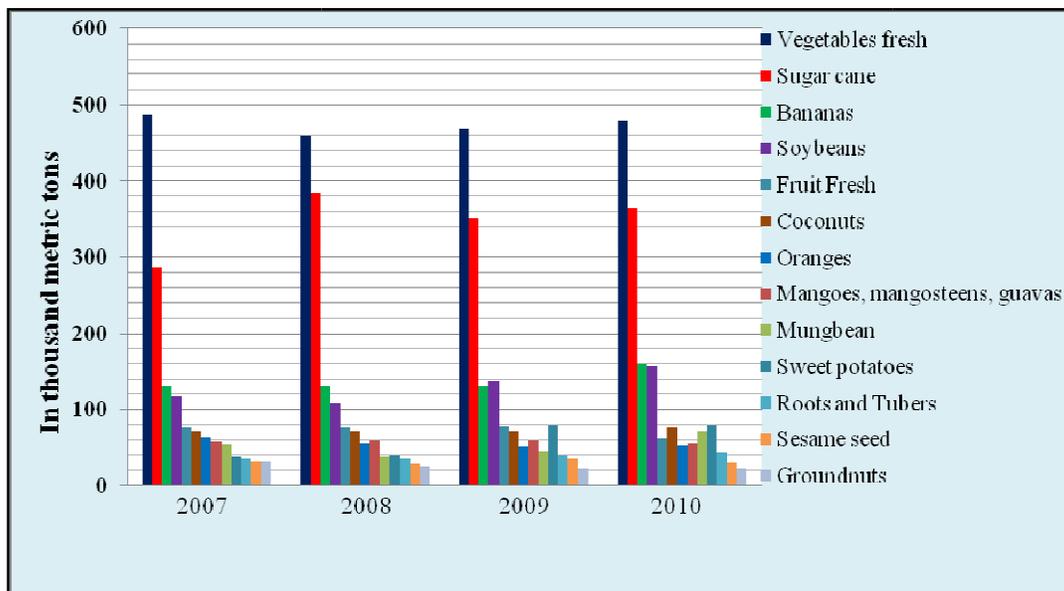


Figure 2. Total Production in Cambodia of Some Agrarian Products 2007-2010

Source. FAOSTAT 2012 (<http://faostat.fao.org/>)

2.3 Cambodia: Trends, Challenges and Opportunities of Underutilized Crops

Underutilized crops have a potential that needs to be exploited to our benefit. Most of these species do not require high inputs, can be grown in marginal and degraded lands and at the same time contribute to increased agricultural production, crop diversification and a better environment. Additionally, such efforts will help in conserving and using the genetic resources of underutilized crop species. In turn, agricultural production and food security is improved; underutilized crops are fundamental resources for agricultural diversification. Together, indigenous farming knowledge and modern agro-ecological research can provide useful conceptual and technical tools for agricultural diversification (UNDP and FAO, 2004). Positive policy conditions lie at the core of alleviating poverty and sustainably managing natural resources. To achieve sustainable agriculture, one has to look at the immediate needs of farmers and the future needs of society, which requires a broad analysis of people and the environment (Joshi et al, 2002).

Agriculture plays the most important role in Cambodian society by ensuring food security at the community and national level as well as in the provision of employment and income opportunities for a growing population. Rainfed rice is mainly grown in the lowlands but also in many upland areas. Besides rice, there are some varieties of other crops grown for home-consumption, local markets or industrial use (Ouk *et al*, 1995). Further research on underutilized crops is therefore important to Cambodian food security and diversification of agriculture.

Table 1. List of Criteria to Assess and Select Underutilized Crops

Criteria	Including the following aspects
Economic and agronomic competitiveness	Potential generated income, changing abiotic and biotic conditions (e.g. climate, pests), attractive traits, lack of market/poor commercialization
Local and national use, cultural acceptance	Attractive traits
Traditional knowledge	Knowledge on cultural practices, propagation techniques, knowledge on uses
Scientific Knowledge	Research on genetic diversity, propagation

Criteria	Including the following aspects
Policy & legislation	techniques, knowledge on uses Extension and research activities by Government and NGO's, favorable policies or government support
Opportunities for national/ export niche market	

Source: Agrofolio- Benefiting from an Improved Agricultural Portfolio in Asia, 2010

The project Agrofolio (Benefiting from an Improved Agricultural Portfolio in Asia) funded by European Commission (EU) was conducted in 2007 to improve the agricultural portfolio by identifying neglected and underutilized species with a high agronomic and economic potential for selected regions in Cambodia, China, Thailand and Vietnam. The master list¹ of neglected and underutilized crops was developed with 260 species in total. In Cambodia, 78 underutilized crops were identified and documented based on farmer interviews and literature review. To select the priority underutilized species, six criteria adapted by Padulosi were used for the evaluation (Padulosi et al. 1999). In addition, trans-disciplinary assessment was conducted by involving many stakeholders such as scientists, farmers, NGOs and policy makers from the four Asian countries. Based on the assessment so-called priority underutilized crops were identified for Cambodia (13 species), China (9 species), Thailand (7 species), and Vietnam (7 species).

Table 2. Priority Underutilized Crops in Four GMS Counties Listed by Agrofolio Project

Country	Species name	Family Name	English name
	<i>Anacardium occidentale</i>	<i>Anacardiaceae</i>	cashew
	<i>Arachis hypogea</i>	<i>Leguminosae</i>	groundnut, peanut
	<i>Citrus spp.</i>	<i>Rutaceae</i>	citrus
Cambodia	<i>Colocasia esculenta</i>	<i>Araceae</i>	taro

¹ A compilation of an extensive list of neglected and underutilized plant species for Cambodia, China northeast Thailand and northern Vietnam with information on scientific name, botanical family name, common name, kind of use, part of plant used and type of plant.

Country	Species name	Family Name	English name
	<i>Cymbopogon citratus</i>	<i>Gramineae</i>	lemon grass
	<i>Ipomoea batatas</i>	<i>Convolvulaceae</i>	sweet potato
	<i>Musa spp.</i>	<i>Musaceae</i>	yellow, sugar and green banana
	<i>Zingiber officinale</i>	<i>Zingiberaceae</i>	ginger
	<i>Piper nigrum</i>	<i>Piperaceae</i>	black pepper
	<i>Cocos nucifera</i>	<i>Arecaceae</i>	coconut
	<i>Durio zibethinus</i>	<i>Bombacaceae</i>	durian
	<i>Vigna radiata</i>	<i>Leguminosae</i>	mungbean
	<i>Nephelium lappaceum</i>	<i>Sapindaceae</i>	rambutan
	<i>Actinidia spp.</i>	<i>Actinidiaceae</i>	chinese gooseberry, kiwifruit
	<i>Anacardium occidentale</i>	<i>Anacardiaceae</i>	cashew
	<i>Cajanus cajan</i>	<i>Leguminosae</i>	pigeon pea
	<i>Canarium album</i>	<i>Burseraceae</i>	Chinese olive
P.R. China	<i>Citrus medica</i>	<i>Rutaceae</i>	citron
	<i>Eriobotrya japonica</i>	<i>Rosaceae</i>	loquat
	<i>Fagopyrum esculentum</i>	<i>Polygonaceae</i>	buckwheat
	<i>Hemerocallis citrina</i>	<i>Liliaceae</i>	citron daylily
	<i>Panicum miliaceum</i>	<i>Gramineae</i>	common millet
	<i>Gossipium sp.</i>	<i>Malvaceae</i>	cotton
	<i>Hibicus sabdariffa</i>	<i>Malvaceae</i>	roselle
	<i>Hibicus cannabinus</i>	<i>Malvaceae</i>	kenaf
Thailand	<i>Vigna umbellata</i>	<i>Fabaceae</i>	ricebean
	<i>Calamus merillii</i>	<i>Araceae</i>	rattan (Wai)
	<i>Ricinus communis</i>	<i>Euphorbeaceae</i>	castor bean
	<i>Sesamum indicum</i>	<i>Pedaliaceae</i>	cotton

Country	Species name	Family Name	English name
Vietnam	<i>Colocasia antiquorum</i>	<i>Araceae</i>	taro
	<i>Cucurbita pepo</i>	<i>Cucurbitaceae</i>	pumpkin
	<i>Diospyros kaki</i>	<i>Ebenaceae</i>	kaki
	<i>Ilex kaushue</i>	<i>Aquifoliaceae</i>	bitter tea
	<i>Mangifera indica</i>	<i>Anacardiaceae</i>	mango
	<i>Panax vietnamese</i>	<i>Araliaceae</i>	Ngoc ling ginseng
	<i>Sesamum indicum</i>	<i>Pedaliaceae</i>	sesame

Source: Agrofolio- Benefiting from an Improved Agricultural Portfolio in Asia, 2010

3. Methodology

3.1 Data Collection

Focus Group Discussion

The focus group discussion (FGD) is a rapid assessment, semi-structured data gathering method in which a purposively selected set of participants gather to discuss issues and concerns based on a list of key themes drawn up by the researcher (Kumar, 1987). As the tool of Participatory Rural Appraisal (PRA), time-related methods, mainly Trend Analysis and Seasonal Analysis, were used to assess the information on availability of underutilized crops and trends of natural resources in the research areas. Supplemented by Village Walk method, the Provincial Department of Agriculture staff and knowledgeable people were asked to take the researcher on a walk, covering the range of farming systems and natural resources in the areas. Altogether, 30 knowledgeable farmers (15 from each village) belonging to different economic status, ethnicity, and gender were selected for the documentation of local knowledge associated with underutilized and neglected crops and wild species using purposive sampling methodology. All the crops were listed, questions were asked about them, and comparison was made with information derived from literature review.

Socioeconomic Survey

Two communes namely Krang Teh and Romonea were targeted for this study. In order to understand the contribution of underutilized crops, 86 households were selected from four

villages of 599 households by using Yamane formulating ($n = \frac{N}{1 + Ne^2}$), and the respondents carefully selected to present the perception and knowledge of male and female headed households. The data was collected through a structured interview. Beside the interviews, the observations were also made and used as primary data. Thus the respondents were interviewed at their home and in their fields.

Table 3. The Sample Selection

Communes	Village name	Number of household	Selected household
Romonea	Pou Loung	166	24
	Pou Tang	171	25
Krang Teh	Krang Teh	164	23
	Pou Robet	98	14
Total		599	86

3.2 Data Analysis

Underutilized crops including wild plant species for food were identified by scientific name, botanical family name, common names in English and local name in Khmer, plant description and part of plant used. Identification and documentation of underutilized crops in the research areas were carried out based on the available crops grown by the villagers in their upland farm and home gardens. Wild species for food or edible wild plant were documented based on the data gathered from local people using focus group discussions. The study focused only on the wild plant species used by villagers. Descriptive statistics were used to describe the socioeconomic status of households. Otherwise, rich descriptive and Seasonal Analysis were used for qualitative data mainly for PRA and RRA.

4. Results and Discussion

4.1 Annual Cultivated Crop in Mondulakiri Province

Rice was the primary agricultural product for the communities and they grow both paddy (lowland) and upland rice. Currently, villagers grow paddy rice in permanent sites. They say this change was primarily due to population growth and the fact that the harvest from their

shifting agriculture was not enough to feed the increased population. Only one rice harvest a year is possible as it depends solely upon rainwater. The fields are dry for about six months each year. Villagers use traditional agricultural tools for cultivation.

Cassava plantations were also being introduced to the area and several farmers had tried planting cassava varieties that are used for flour production. According to the farmers, however, and much to their disappointment, this had not been profitable due to lack of market and low price. Despite this cassava is being quickly adopted by famers to grow on a large scale in Krang Teh, Pu Robet and Pu Tang villages.

Other important crops were maize and groundnuts, but these were planted mostly in upland fields (chamka) or farms near houses, streams or rivers. Maize is planted in small quantities and mostly as a subsistence crop. Groundnuts, on the other hand, were planted on a larger scale as a cash crop, and found abundantly in Krang Teh and Pou Robet villages. Groundnuts were grown during the early rainy season from May to July.

Vegetables were mostly planted on upland farms and along the stream banks. The vegetables that were commonly planted were pumpkin, cucumber, gourd, wintermelon, eggplant, cowpea/long bean, tomato, chilies, and sesame seed. Similar to maize, these were grown in small quantities and mainly for household use and sold in the local markets. Villagers also planted papaya and banana in their chamkars to generate income. Taro and sweet potato growing has become popular in Pu Loung and Pu Tang due to for market demand. Rubber and cashew are being grown, therefore more and more forests along the roads were being cleared for rubber and cashew plantations

Table 4. The Annual Crops Produced by Farmers,
 Green-rainy (May to October), Brown-dry (November to April)

Annual crops grown by farmer throughout the year	Months (Cropping calendar)												
	Jan-Mar			Apr-Jun			Jul-Sept			Oct-Dec			
Upland rice													
Lowland rice													
Maize													
Cassava													

Annual crops grown by farmer throughout the year	Months (Cropping calendar)											
	Jan-Mar			Apr-Jun			Jul-Sept			Oct-Dec		
Banana	█	█	█	█	█	█	█	█	█	█	█	█
Winter melon				█	█	█	█	█	█			
Pumpkin				█	█	█	█	█	█			
Sweet Potato							█	█	█	█	█	█
Taro				█	█	█	█	█	█			
Eggplant				█	█	█	█	█	█			
Groundnut				█	█	█						
Soybean							█	█	█	█	█	█
Cowpea/Long bean							█	█	█	█	█	█
Mungbean							█	█	█	█	█	█
Cucumber				█	█	█	█	█	█			
Gourd				█	█	█	█	█	█			
Papaya	█	█	█	█	█	█	█	█	█	█	█	█
Sesame										█	█	█
Chilies	█	█	█	█	█	█	█	█	█	█	█	█
Tomato										█	█	█

Source: Data from focus group discussion in Krang Teh and Pu Loung Villages

4.2 Identification and Documentation of Underutilized Crops

Throughout the communes, many of the plant species are cultivated and underutilized while they play an important role in the food security, nutrition and income generation of the poor communities. Whereas these crops continue to be maintained by traditional practices, they remain inadequately characterized and neglected by research and conservation due to lack of human resources and fund inputs. Lack of attention has meant that their potential value is underestimated and underexploited. It also places them in danger of continued genetic erosion and disappearance which would further restrict development options for the poor. Therefore, identification and documentation of underutilized crops will address a gap in knowledge and promote their value.

NTFPs are contained in the group of underutilized crops and refer to those plant species that can be found wild in forest areas and rangelands, which grow spontaneously and are harvested by local communities for various uses, but not exploited for wood. The following

discussion on underutilized crops is the results of focus group discussion and survey that were conducted in the four villages in Mondulhiri province. The data was double checked with the list of underutilized crops² documented by FAO and Global Facilitation Unit for Underutilized Species (GFU) and underutilized crops listed by the project Agrofolio³. The crop groups were identified and scientific name, botanical family name, common name and part of plant used are provided.

4.3 Underutilized Cereal and Oil Crops

Rice is the cereal staple crop and the Department of Agriculture in Mondulhiri province reported a positive food balance in the study area from 2005 to 2010. However, the data from survey indicated that farmers continually experienced poor production in rice and most respondents claimed not to get sufficient food to feed their family (74.4%). Maize is the second cereal crop in the research areas and in the whole country as well. Maize was planted in small quantities and mostly as a subsistence crop.

The underutilized cereal crops in the research areas are Job's tears and *Sesbania grandiflora* (Phka Angkea Dey name in Khmer). Job's tears grow naturally and not appreciated by the local people however the grains are useful as source of food and folk medicine. *Sesbania grandiflora* known as Phka Angkea Dey in Khmer is grown in home gardens and used as vegetable-fruit, leaf, stem and bark. For oil crop, sesame was planted in a small scale in forested areas on the plateau and along the stream banks containing hard wood trees and dense tree species. These areas are rich in natural fertilizers and close to water sources that easily to grow.

Table 5. Underutilized Cereal and Oil Crops

Scientific name	Family name	Common Name	Part use of plant
<i>Coix lachryma jobi</i>	Poaceae	job's tears	grain/seeds
<i>Sesamum indicum</i>	Pedaliaceae	sesame	grain/seeds
<i>Sesbania grandiflora</i>	Fabaceae	Phka angkea dey	fruit, leaf, stem/bark

² There are 924 plant species were identified as the underutilized crops by FAO and the Global Facilitation Unit for underutilized species across the world

³ There are 260 of underutilized crops were listed by Agrofolio project and 78 of them were documented in Cambodia

4.4 Underutilized Legume Crops

A group of legume species are used by all the people in the local community including Krang Teh and Romonear commune. Mungbean, rice bean, cowpea, yard long bean, and black eyed pea were found and distributed in all upland farms along stream banks or near the water sources and in home gardens around the farmer's houses. The young fruit of these species are used as vegetable in many dishes while the seed use in several types of sweet. The Phnong minority group often storage the seeds inside bamboo containers and keep them under the roof to protect them from insects. Due to poor marketing conditions, these species were grown in small quantities for the local use only. Among the legume crops, groundnut was planted in large scale in Krang Teh and Pu Robet villages because of good market conditions.

Table 6. List of Underutilized Legume Crops

Scientific name	Family name	Common Name	Part use of plant
<i>Arachis hypogaea</i>	<i>Fabaceae</i>	groundnut	grain/seeds
<i>Tamarindus indica</i>	<i>Fabaceae</i>	tamarind	fruit, flower leaf, stem/bark
<i>Vigna radiata</i>	<i>Fabaceae</i>	mungbean	grain/seeds
<i>Vigna umbellata</i>	<i>Fabaceae</i>	rice bean, red bean	grain/seeds
<i>Vigna unguiculata</i>	<i>Fabaceae</i>	cowpea	Fruit, grain/seeds
<i>Vigna unguiculata</i> <i>subsp.sesquipedalis</i>	<i>Fabaceae</i>	yard-long bean	Fruit, grain/seeds
<i>Vigna unguiculata subsp.</i> <i>unguiculata</i>	<i>Fabaceae</i>	black-eyed pea	Fruit, grain/seeds

4.5 Underutilized Vegetables

A large number of indigenous vegetable crop species are used, particularly, by the minority group in Krang Teh and Romonea communes. Wide range of *Cucurbitaceae* species is found in various parts of the areas such as winter melon, pumpkin, chayote and bitter gourd and most have multiple uses. In their upland farms, papaya (*Carica papaya*), a tropical fruit is used as vegetable (young fruit) and is also grown consumed as a sweet (ripe) fruit in many local dishes and is found in local markets as both young and ripe fruits.

Some of the legume species, *Vigna unguiculata*, *Vigna unguiculata subsp. sesquipedalis*, and *Vigna umbellata* are grown by Phoung minority groups used as a vegetable. These species are rich in carbohydrates and minerals. Star gooseberry (*Sauropus androgynous*) known as the semi-wild species is one of the most common of multipurpose vegetables. Another vegetable growing in upland farms particularly in home garden, and popular among the people, is *Coccinia grandis*, locally called Slerk Bah.

Table 7. List of Underutilized Vegetable Species in Mondulkiri Provinces

Scientific name	Family name	Common Name	Part use of plant
<i>Benincasa hispida</i>	<i>Cucurbitaceae</i>	winter melon	fruit, leaf
<i>Calamus sp.</i>	<i>Arecaceae</i>	rattan	flower, leaf, stem/bark
<i>Carica papaya</i>	<i>Caricaceae</i>	papaya	Fruit, grain/seeds leaf root/tuber
<i>Cucurbita moschata</i>	<i>Cucurbitaceae</i>	pumpkin	Fruit, grain/seeds, flower leaf
<i>Cucumis sativus</i>	<i>Cucurbitaceae</i>	cucumber	fruit, leaf
<i>Ipomoea aquatica</i>	<i>Convolvulaceae</i>	water spinach	leaf, stem/bark
<i>Momordica charantia</i>	<i>Cucurbitaceae</i>	bitter gourd	fruit
<i>Sauropus androgynous</i>	<i>Phyllanthaceae</i>	star gooseberry	young leaf
<i>Sechium edule</i>	<i>Cucurbitaceae</i>	chayote	fruit, leaf

4.6 The Underutilized Root and Tuber Crops

Dioscoreaceae known as yam species (with over 600 accepted species names worldwide) are found in temperate and tropical regions, with the highest diversity being in the seasonally dry tropics including Indochina (Wilkin & Thapayai, 2009). Many species of the genus *Dioscorea* are sources of food and medicine. The tubers of at least 50 species are sources of dietary starch in both subsistence and an economic context (Coursey, 1967).

Regarding data collected from focus group discussion in Krang Teh and Pu Loung villages, Dioscorea or wild yam are essential food sources for local communities, especially when staple grains run out. Phnong minority group have experienced in food shortage throughout the year especially during the drought, so in this context they harvest *Dioscorea* such as *D. alata*, *D. esculenta*, *D. brevipetiolata*, *Dioscorea pentaphylla* and *D. hispida*. Among them *D. hispida* requires special cooking to remove toxic alkaloids before it can be eaten safely.

Alpinia galangal L. (wild galangal) and *Kaempferia galangals* (wild ginger) used as an ingredient in the food basket and mostly used in traditional medicine. *Colocasia esculenta* (taro), *Ipomoea batatas* (sweet potato), *Canna edulis* and *Xanthosoma sagittifolium* are commonly grown in upland farms (Chamkars) with other crops. Taro and sweet potato are not only used as a food source but also to generate income in minority group communities.

Table 8. List of Roots and Tuber Underutilized Crops

Scientific name	Family name	Common Name	Part use of plant
<i>Alpinia galangal</i> L.	Zingiberaceae	galangal (wild)	root/tuber
<i>Canna edulis</i>	Cannaceae	canna	leaf, root/tuber
<i>Colocasia esculenta</i>	Araceae	taro	root/tuber, stem/ bark, whole
<i>Dioscorea alata</i>	Dioscoreaceae	winged yam, Purple yam	root/tuber
<i>Dioscorea brevipetiolata</i>	Dioscoreaceae	yam	root/tuber
<i>Dioscorea hispida</i>	Dioscoreaceae	yam	root/tuber
<i>Dioscorea pentaphylla</i>	Dioscoreaceae	wild yam, Chinese yam,	root/tuber
<i>Ipomoea batatas</i>	Convolvulaceae	sweet potato	root/tuber, whole
<i>Kaempferia galanga</i>	Zingiberaceae	wild ginger	root/tuber, whole
<i>Manihot esculenta</i>	Euphorbiaceae	cassava	root/tuber
<i>Maranta arundinacea</i>	Marantaceae	arrow root	root/tuber
<i>Xanthosoma sagittifolium</i>	Araceae	arrow leaf elephant ear	root/tuber, leaf

4.7 Underutilized Fruit and Nut Species

Southeast Asia is represented by more than 500 species of fruits (Arora and Rao, 1995). Southeast Asia is the center of origin of many tropical fruit species, most of which are still growing in the wild or semi-wild state. Many of them have remain underexploited due to the lack of awareness of their potential, lack of market demand and low and unpredictable yield in many cases. These species have multipurpose uses as fruits, vegetables and also have beneficial and medicinal properties.

The list of underutilized fruit species resulted from focus group discussion with farmers in Krang Teh and Pou Loung with concluded by walking in the villages to observe some upland farms and famer's home garden. Among underutilized fruit species, banana (*Musa spp*) commonly planted in upland farm (Chamka) used as food sources and income generation. Avocado (*Persea Americana*) is a high value fruit tree and people sold these fruit to Senmonorom or Phnom Penh market at high price, however, this plant is cultivated on a small scale in home gardens commonly 3 to 5 in average each households. Only, cashew is being planted in large areas in Krang Teh due to good in market conditions. Other underutilized fruit species include sapodilla, soursop, custard apple, mango, milk fruit, jackfruit, passion fruit and pomegranate that are raised in Chamkars and in home gardens to support their livelihoods and generally having less economic importance but are familiar to local people.

Table 9. List of Underutilized Fruit Species

Scientific name	Family name	Common Name	Part use of plant
<i>Anacardium occidentale</i>	<i>Anacardiaceae</i>	cashew	fruit, flower, leaf, stem/bark
<i>Ananas comosus</i>	<i>Bromeliaceae</i>	pineapple	fruit, leaf
<i>Annona muricata</i>	<i>Annonaceae</i>	soursop	Fruit, leaf, stem/bark
<i>Annona squamosa</i>	<i>Annonaceae</i>	custard apple, sugar-apple	Fruit, grain/seeds root/tuber, stem/bark
<i>Artocarpus heterophyllus</i>	<i>Moraceae</i>	jackfruit	fruit, grain/seeds, leaf, stem/bark
<i>Averrhoa carambola</i>	<i>Oxalidaceae</i>	star fruit, Carambola	fruit, flower, stem/bark

Scientific name	Family name	Common Name	Part use of plant
<i>Baccaurea ramiflora</i>	<i>Phyllanthaceae</i>	Burmese grape	fruit
<i>Chrysophyllum cainito</i>	<i>Sapotaceae</i>	milk fruit	fruit
<i>Citrullus lanatus</i>	<i>Cucurbitaceae</i>	watermelon	fruit, grain/seeds
<i>Citrus limon</i>	<i>Rutaceae</i>	lemon	fruit
<i>Durio zibethinus</i>	<i>Malvaceae</i>	durian	fruit, grain/seeds, leaf root/tuber, stem/bark
<i>Mangifera indica</i>	<i>Anacardiaceae</i>	mango	fruit, grain/seeds, leaf, stem/bark
<i>Manilkara zapota</i>	<i>Sapotaceae</i>	sapodilla	fruit, stem/bark
<i>Musa spp.</i>	<i>Musaceae</i>	banana	fruit, flower
<i>Passiflora edulis</i>	<i>Passifloraceae</i>	passion fruit	fruit, grain/seeds,
<i>Persea americana</i>	<i>Lauraceae</i>	avocado	fruit
<i>Phyllanthus emblica</i>	<i>Phyllanthaceae</i>	Indian gooseberry	Fruit, leaf
<i>Punica granatum</i>	<i>Lythraceae</i>	pomegranate	Fruit, leaf, root/tuber stem/bark
<i>Zizyphus mauritiana</i>	<i>Rhamnaceae</i>	jujube, Indian plum	fruit

4.8 Wild Food Plants

The term ‘wild food’ is used to describe plant resources outside of agricultural areas in forests, savannah and other bush land areas, that are harvested or collected for the purpose of human consumption (Guinand and Lemessa 2000). Wild food plants are very important to supplement subsistence agriculture in the developing world during times of drought and food shortage. Generally, wild food plants have been and still are being underutilized. Rural people of Cambodia have a deep knowledge concerning the use of wild plants. Elders and other knowledgeable community members are the key sources of information on wild uses. Wild food consumption is still very common in rural areas of Cambodia, particularly among minority ethnic groups in northeastern provinces of Cambodia.

In parts of northeastern Cambodia, the consumption of wild food plants seems to be one of the important local survival strategies and appears to have intensified due to the repeated

climatic shocks hampering agricultural production and leading to food shortages. Increased consumption of wild food plants enables people to cope better with unpredictable rains and drought without facing severe food shortages. Local people in Krang Teh and Romonea communes still have knowledge of these plants. The Phoung minority group is well known for its hard labor and complex agricultural that has been affected by drought recently. In this period they have faced repeated significant harvest losses and even have complete crop failure. Nevertheless, they cope with these harsh conditions and survived by increasing their consumption of wild food plants. Damaged, reduced or even lost crop harvests have been partly compensated by the collection of wild foods.

A total of 32 plant species belonging to 25 botanical families were recorded from the study areas. The list of table 7, wild edible fruit made the highest proportion of the wild food species (17) followed by wild vegetable (8), and root and tuber (7).

Table 10. List of Wild Food Plants

*1=whole 2=root and tuber, 3= stems, 4=young shoots/leaf, 5=flower, 6=fruit

Scientific Name	Family Name	Common Name	Local Name In Khmer	Part use of plant*
Root and tuber wild food species				
<i>Alpinia galangal</i> L.	Zingiberaceae	galangal	Rumdaeng Prey	2,3
<i>Dioscorea alata</i> L.	Dioscoreaceae	purple yam /white yam	Damloong Chhiem Moen/Damloong Phluk	2
<i>Dioscorea brevipetiolata</i>	Dioscoreaceae	N/A	Damloong Tien	2
<i>Dioscorea esculenta</i>	Dioscoreaceae	Chinese yam, Asiatic yam, Lesser yam	Damloong Sya/ Damloong Dong/ Daloong Chhvie Prey	2
<i>Dioscorea pentaphylla</i> L.	Dioscoreaceae	N/A	Damloong Tuk	2
<i>Dioscorea hispida</i> Dennst.	Dioscoreaceae	N/A	Khuech	2
<i>Kaempferia galangal</i>	Zingiberaceae	wild ginger,	Khnhy Prey	2

Scientific Name	Family Name	Common Name	Local Name In Khmer	Part use of plant*
<i>Linn.</i>		sand ginger		
Wild vegetable				
<i>Azadirachta indica</i>	<i>Meliaceae</i>	Neem tree, Indian lilac	Phak sdau	4,5
<i>Bambusa vulgaris</i> <i>/Phyllostachys edulis</i>	<i>Poaceae</i> <i>Bambusoideae</i>	bamboo	Tumpuamng/ Russey	4
<i>Coccinia grandis</i>	<i>Cucubitaceae</i>	scarlet-fruited gourd, perennial cucumber	Sleuk Bah	4
<i>Calamus spp.</i>	<i>Arecaceae</i>	rattan	Phdau	4
<i>Cratoxylum formosum</i>	<i>Guttiferae</i>	N/A	Longieng	4,5
<i>Melientha suavis</i>	<i>Opiliaceae</i>	Pak-Wanpa in Thai, Phak van in Lao	Slerk Prich	5,6
<i>Oenanthe javanica</i>	<i>Umbelliferae</i>	water dropwort, water celery	Phouv Kangkep	1
<i>Vigna minima</i>	<i>Fabaceae</i>	wild cowpea	Sanneak Prey	5,6
Wild Fruits				
<i>Acronychia pedunculata</i>	<i>Rutaceae</i>	N/A	Seda Prey/ Tramal	6
<i>Artocarpus rigidus</i>	<i>Moraceae</i>	monkey-jack	Khnao prey	6
<i>Baccaurea ramiflora</i>	<i>Phyllanthaceae</i>	Burmese grape	Phnhiew	6
<i>Dialium cochinchinensis</i>	<i>Leguminosae</i>	velvet tamarind	Lralanh	6
<i>Dillenia indica L.</i>	<i>Dilleniaceae</i>	elephant apple	Dak Chan/Phlul vieng	6
<i>Dillenia ovate</i>	<i>Dilleniaceae</i>	Ovate Dillenia	Phul Thom	6
<i>Diospyros hasseltii</i>	<i>Ebenaceae</i>	N/A	Tubloab Prey	6
<i>Garcinia cowa</i>	<i>Guttiferae</i>	N/A	Tromoung/Tromeng	6
<i>Garcinia schomburgkiana</i>	<i>Guttiferae</i>	N/A	Sandan prey	6
<i>Mangifera duperreana</i>	<i>Anacardiaceae</i>	wild mango	Svay Prey	6

Scientific Name	Family Name	Common Name	Local Name In Khmer	Part use of plant*
<i>Nephelium hypoleucum</i>	<i>Sapindaceae</i>	Korlan	Se moen	6
<i>Passiflora foetida L.</i>	<i>Passifloraceae</i>	passionflower, wild water lemon	Saou maou prey	6
<i>Phyllanthus emblica L.</i>	<i>Phyllanthaceae</i>	Indian Gooseberry	Kantuet Prey	6
<i>Spondias malayana</i>	<i>Anacardiaceae</i>	N/A	Mkak Prey, Puen	6
<i>Syzygium spp.</i>	<i>Myrtaceae</i>	Java plum, Jambolan	Pring dahs krabei	6
<i>Terminalia chebula</i>	<i>Combretaceae</i>	Chebolic myrobalan	Sramar	6
<i>Willughbeia edulis Roxb</i>	<i>Apocynacea</i>	Kuy in Khmer	Kuy	6

Socio-Economic Aspect Associated with Underutilized Crops

4.9 Household Characteristics

In the research areas, the mean of household size was found to be larger at 6.3 persons per household. Among the Phnong minority group, most households were extended composed usually of two to three families living under one roof. This was mainly for cultural reasons; the new couples were required to stay with either the wife's or husband's parents for about two to three years before they were allowed to live in a separate house. Another reason is the economic impact because of the need for labor for farming activities.

Firewood is the most commonly used fuel for cooking for 94% of household and kerosene was 93% of lighting energy. Access of households to electricity is generally low 5.6% for battery and only 1.2 for electricity from generator. 48.8% of the surveyed households depend on pond, river and stream, following by 36% depended on village tap which was established by community livelihood supported NGOs.

4.10 Farm Characteristics

There were three major types of land holdings among the respondents include residential land and paddy rice field and upland farm (Chamka). 100% of the respondents owned a portion of residential land and upland farm. Around 30% of households claimed not have paddy land and they used the upland farm to grow rice and many underutilized crops. Paddy land was commonly planted only to rice.

Table 11. Land Type Properties

Land Type	Frequency	Percentage	Ave. Areas
Residential (include housing and home gardens)	86	100	0.6
Paddy rice field (usually lowland rice field)	60	69.8	1.8
Upland farm (both non and permanent chamkars)	86	100	2.5

Acquiring land is very informal in almost all of the villages and was dependent on getting permission from the village or commune chief. There was, however, a perceived openness in accessing land as the majority of respondents claimed land without securing permission from the commune chief or village chief and this represents a problem in land violation. This was common for upland farm (Chamka), where most of land was acquired without permission. This problem occurred to their practices in upland farms which are commonly non permanent farms. Non permanent farm use shifting cultivation and fields are used for a number of years then left fallow. This type of farm is diminishing as trends slowly shift towards permanent cultivation. According to villagers, few families are practicing shifting agriculture at present. Fruits, tubers and vegetables are the main crops but some are planting rice. A reason to conserve the diversity of underutilized crops in these areas is to allow their evolution to continue and permit the sustained generation of adaptive traits.

The average size of land owned by each household was about 0.6 hectares for residential land, 1.8 hectares for paddy rice and 2.5 hectares for upland farms. Upland farms were usually large, mostly ranging from 3 to 5 hectares per household but they were less

productive compared to lowland farms. Upland rice had lower yields compared to lowland rice but these areas much suitable to plant fruits, tuber crops and vegetables.

Table 12. Size of Land

Size of Land	Residential		Paddy rice field		Upland farm	
	N ^o	%	N ^o	%	N ^o	%
Non	0	0	26	30.2	0	0
0.5 hectares and below	64	74.4	10	11.6	22	25.6
> 0.5 hectare but less than 2	20	23.3	32	37.2	52	60.5
2 – 5	2	2.3	18	20.9	10	11.6
> 5 but less than 10 hectares	-	-	-	-	2	2.3

4.11 Type and Source of Seed Used

Seed is an important component and input in crop production. It should be available on time with good germination capacity and sufficient quantity for higher yield. The survey showed that around 78% of the households in Pou Loung (22.09%), Krang Teh (22.09%), Pou Tang (20.93%) and Pou Robet (9.3%) respectively planted local seed in the 2011 cropping season (Figure. 3). Large scale cultivated areas were covered or planted with local seeds of rice, maize, legumes, root and tuber crops and indigenous vegetables. The majority of the farmers used local seeds because of insufficient knowledge about improved seeds resulting from lack of adequate demonstration trials on farmer's plots of new agricultural technology packages.

The Phnong minority group has a traditional subsistence way of life and has a high dependence level on natural resources from the area. Subsistence activities included chamkar farming; hunting and NTFP collection including wild vegetable and fruits. They have continued keeping traditional practices in agriculture only slowly adopting new technology from outsiders. A diversity of underutilized crops was found commonly in research areas especially in the wet season. Many local crops are outstanding in yield such as pumpkin, wintermelon, taro, sweet potato, legume and banana. However some improved seed are being introduced by MAFF and NGOs such as rice, maize due to low in yield caused by many factor of local seeds.

Farmers reported that they obtain their seeds (both local and improved) from different sources including the market, their own seed, borrowing from relatives and neighbours, and MAFF which distributes some improved seeds. Slightly over 70% of the respondents said that they stored seeds by themselves and they borrow from their relatives or neighbours in case they are faced with seed shortage. All improved seeds were distributed by MAFF and some NGOs to those that face seed shortages.

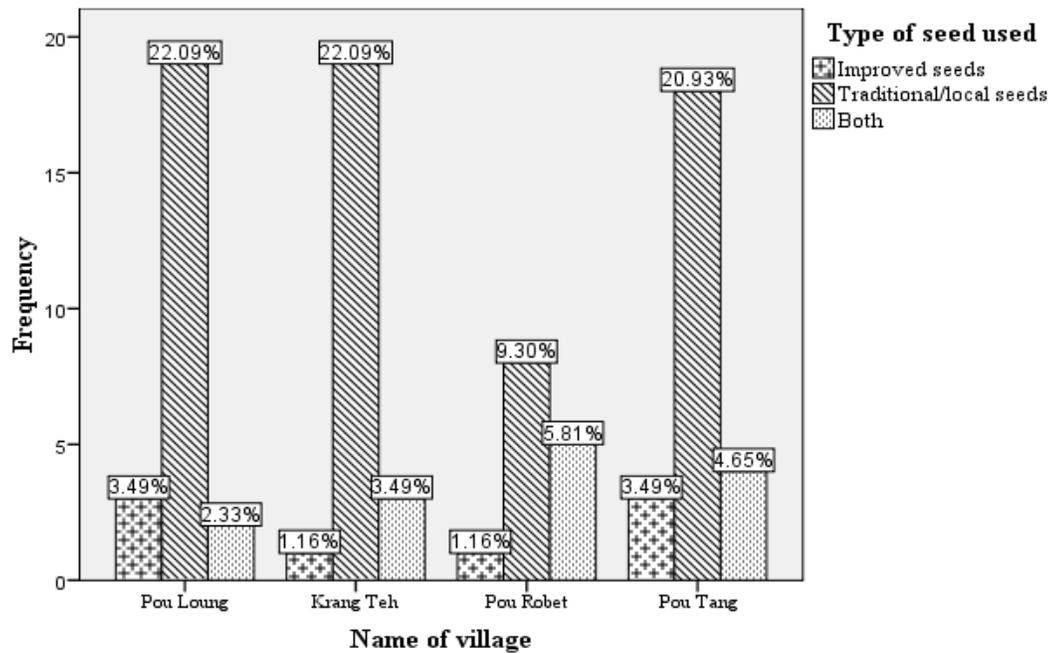


Figure 3. Type of Seed Used

4.12 Livelihood Activities and Sources of Income

Farming (100%) and collecting of non timber forest products (80.2%) were considered the most important livelihoods in Krang Teh and Romonear communes, following by farm labor (60.5%), collecting resin (50%) and hunting (48.8%). These results indicated that the communities have remained dependent on agriculture and the forest for their economic survival. However, agricultural production has continued to decrease causing by many constraints such as drought. In this context, wild food is usually considered as an addition to farmers’ daily food consumption pattern and to augment their cash incomes, generally based on their crop harvest, domestic livestock products and food purchases on local markets.

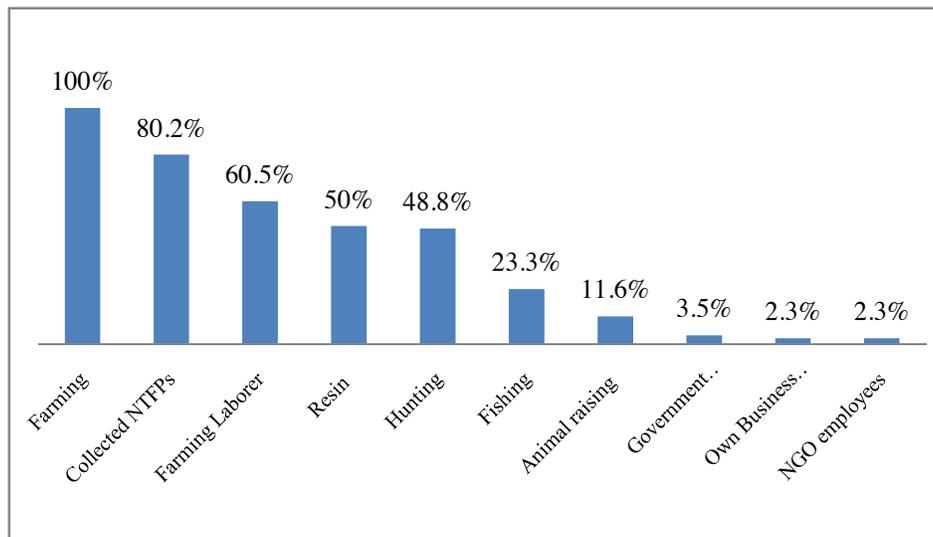


Figure 4. The Livelihood Activities in the Research Areas

The important non-timber forest products collected to supplement cash income were resin, wildlife, honey, orchids and sleng seeds (collected from *Strychnos nux-vomica* L.) wild vegetables and some fruits. For fuel wood, grass, bamboo, and wood for house construction were other products collected for non-commercial purposes. The other 8.1% of the households that were not farming were engaged own business or employed in private or government offices.

Farming is the main source of income which contributed 48% of the total household revenue. Rice both upland and lowland is the predominant crop following by maize and cassava while vegetables, legume crops and taro and sweet potato are also among the important sources of income for farming activities. The households interviewed (82.2%) gathered Non Timber Forest Products (NTFPs) for both trading and household use. Harvesting and processing of NTFPs are also a major source of income which contributed 24% to the total household income across all villages throughout a year. Such activities include collection of sleng seeds from *Strychnos nux-vomica* tree is sold for uses as a bitter flavoring in pharmaceuticals. Labor-for-rent in farms indicates that it contributed 12% to the total income. The large household size usually have experienced in food shortage so they respond by seeking employment in farming activities to the large scale of industrial crops mainly to harvest coffee, cassava and work in rubber farms. A range price is 15,000 Riel (US\$3) to 20,000 Riel (US\$5) per day and the jobs were available from October to February for harvesting coffee and cassava.

It is worth noting that the true income of surveyed households could be higher than what is given in above description as respondents generally show unwillingness to provide accurate information about their income for various reasons. Consequently, the data on household income needs to be cautiously interpreted.

4.13 The Hidden Economic of Underutilized Crops

Many of the rural households use traditional underutilized crops to meet their needs but these crops are being displaced because of pressure from imported species, demography and household structure changes. Underutilized crops play a vital role in the lives of the rural poor, because they contribute to livelihoods, poverty alleviation and sustaining the environment. Many products are produced at the household and small-scale level offering opportunities for income generation and employment. Habitually, underutilized crops make a significant contribution to the diet of rural households, particularly during drought, food crisis and the dry season.

Table 13. The Top 10 of Underutilized Crops that Contribute to Income Generation

Rank	Underutilized crops	Scientific name	N^o of households	Percentage (%)
1	Banana	<i>Musa spp.</i>	46	53.5
2	Papaya	<i>Carica papaya</i>	44	51.2
3	Sweet Potato	<i>Ipomoea batatas</i>	42	48.8
4	Pumpkin	<i>Cucurbita moschata</i>	42	48.8
5	Winter melon	<i>Benincasa hispida</i>	38	44.2
6	Taro	<i>Colocasia esculenta</i>	36	41.9
7	Cucumber	<i>Cucumis sativus</i>	28	32.6
8	Long bean	<i>Vigna unguiculata</i>	25	29.1
9	Cow pea	<i>Vigna unguiculata</i>	22	25.6
10	Avocado	<i>Persea americana</i>	18	20.9

The survey results indicated that among 50 underutilized crops list by this research, there were 10 species commonly used as the main products in local markets throughout the year in Mondolkiri province. Banana (53.5%), papaya (51.2%), sweet potato (48.8%) and pumpkin (48.8%) were commonly grown by Phnong minority groups for food consumptions and to generate income. Although, rice is the main crop most respondents have experienced rice production deficiency due to low in yield and challenged weather conditions. Other underutilized crops include winter melon, taro, cucumber, yard long bean, cowpea and avocado are commonly used for their livelihood and available in local markets. Other underutilized crops continue to be cultivated, competing with other crops that are more extensively grown. However, the money generated is used to buy ingredients for meals, clothes and other household goods.

4.14 Mondulkiri Province: Threats and Conservation Status of PGR

Underutilized crops play a fundamental role in the livelihoods of poor rural communities, representing a source of income, nutrition and medicinal remedies managed using traditional knowledge. However, the role of underutilized crops is often ignored or underestimated by crops researchers, planners and policy makers, donor agencies, public and private investors, extension services and economists. As discussed earlier, Mondulkiri province provides an example of an area where many underutilized crops as well as wild food plants remain important to the local communities. The Phnong minority group continues to maintain significant crop genetic diversity in their fields by using a traditional seeds and landrace crop varieties; hence allowing for the continued generation of adaptive traits in these materials. However, farmers may no longer be able to grow their own traditional varieties and landraces due to changing climate as shown by recent droughts, pest attacks and crop failure. The discussion on the threats and conservation of PGR will attempt to provide the background, current research, some approaches to develop potential strategies and to conserve underutilized crops which are the keys for sustainable food security and poverty alleviation.

4.15 The Threat of PGR

The second Global plan of Action (GPA) mentioned that genetic erosion is reported to continue in many regions of the world and the genetic vulnerability of crops has further increased. The main causes of genetic erosion include the replacement of farmer's varieties/landraces, land clearing, overexploitation, reduced water availability, population

pressures, changing dietary habits, environmental degradation, changing agricultural systems, overgrazing, legislation and policy, pests, diseases and weeds. Changes in the seed sector and production methodologies have an impact on the vulnerability of crops. This vulnerability applies in particular to underutilized species that do not find much support from research, plant breeding and/or development/marketing, and are increasingly neglected by farmers. Yet these species have great potential in the context of climate change, eco-agriculture, dietary diversity and the sustainability of agricultural production systems (FAO 2011).

The study on perception based of indigenous people, the biodiversity is overwhelmed with numerous stresses include fire (82.6%), disease or pest (75.6%), lumbering (60.5%), mining encroachment (37.2%), economic land concession (24.4%) and infrastructure (37.2%). These disturbances were the main threats to their livelihood assets over the last 5 year. They are direct contributors to loosing genetic diversity of plants which the basic livelihood strategies of local people. Other main threats are population growth, climate change and the newly introduced plant species. In overall, about 62% of respondents stated that the biodiversity has decrease in the last five years but most people (64%) declared that underutilized crops situation in their area was stable particularly in Pou Loung, Krang Teh and Pou Tang villages.

4.16 Conservation status of PGRFA in Mondulkiri province

In many parts of the world, the effects of climate change are likely to require changes in the adaptability of many crops and forages, increasing the interdependence of countries on PGRFA. Climate change will also lead to changes in production areas and practices as well as in the occurrence of pests and diseases of crops and livestock. Agriculture will need to continue to reduce its negative impact on the environment and biodiversity and to adopt more efficient and sustainable production practices (FAO, 2011). To sustain PGRFA, *In situ* conservation is considered the most desirable conservation strategy but sometimes it cannot be done. The destruction of rare or endangered species habitats also requires *ex situ* conservation. Some believe both types of conservation are required to ensure sound preservation. Both methods of preservation should ensure the perpetuity and guarantee the quality of a large gene pool, not just of “useful” genes but also including highly diversified resources that are capable of providing for future needs that cannot be predicted.

4.17 *In situ* Conservation

In situ conservation allows populations of plant species to be maintained in their natural or agricultural habitat, tolerating the evolutionary processes that shaped genetic diversity and the adaptability of plant populations to continue to operate (Frankel and Soule, 1991). *In situ* conservation includes the specific conservation measures for crop wild relatives and wild food plants, particularly in protected areas, and conservation and sustainable utilization of landraces or traditional crop varieties on-farm and in home gardens. In Cambodia, however the direct activities related to *in situ* conservation of plant genetic resource or on farm conservation of native landraces diversity and CWR are almost nonexistent but protected areas play a significant role in preservation of plant genetic resources. The detailed discussion on the conservation of PGR in protected areas is stated below.

Most of Mondulkiri's forest and land areas are located in the conservation areas. Two conservation areas, Mondulkiri Protected Forest (MPF) and Seima Biodiversity Conservation Area (SBCA) are categorized as Protection Forests and are part of the Permanent Forest Reserve under the Forestry Law of 2002. Protection forests are those maintained primarily for protection of forest ecosystems and natural resources but not specifically to protect genetic diversity of plants. Regularly user rights to NTFP collection are allowed as long as they have minor impacts on the forest. The law requires that a National Forest Management Plan be approved by the Forestry Administration to determine appropriate use and management of forest resources at all levels.

Mondulkiri has Phnom Prich and Narm Lear wildlife sanctuaries. Phnom Prich wildlife sanctuary was declared by the Royal Decree and covers a total land area of 222,500 hectares, while Phnom Narm Lear covers 47,500 hectares. Mondulkiri shares portions of Snoul Wildlife sanctuary with Kratie Province, and Lumphat Wildlife Sanctuary with Ratanakiri Province. The channel of the Protected Area Law of 2008 provided a framework for the management, conservation and development of protected areas. The wildlife sanctuary is among the eight categories of protected areas identified by Royal Decree.

However, these examples are rare despite the meaning of wild and semi-wild food plants to the livelihood of many poor communities. Moreover, various problems exist in protected areas including inadequate knowledge of the distribution of wild relatives, a lack of clear

research priorities and methodologies and insufficient management tools for ensuring minimum viable population sizes of target species. As a result, PGR conservation in protected areas is not really safe unless special measures are taken to ensure the active participation and involvement of local communities in the selection, establishment and management of such areas. Most importantly, this approach requires large amounts of public funding and continued political support to sustain long term conservation.

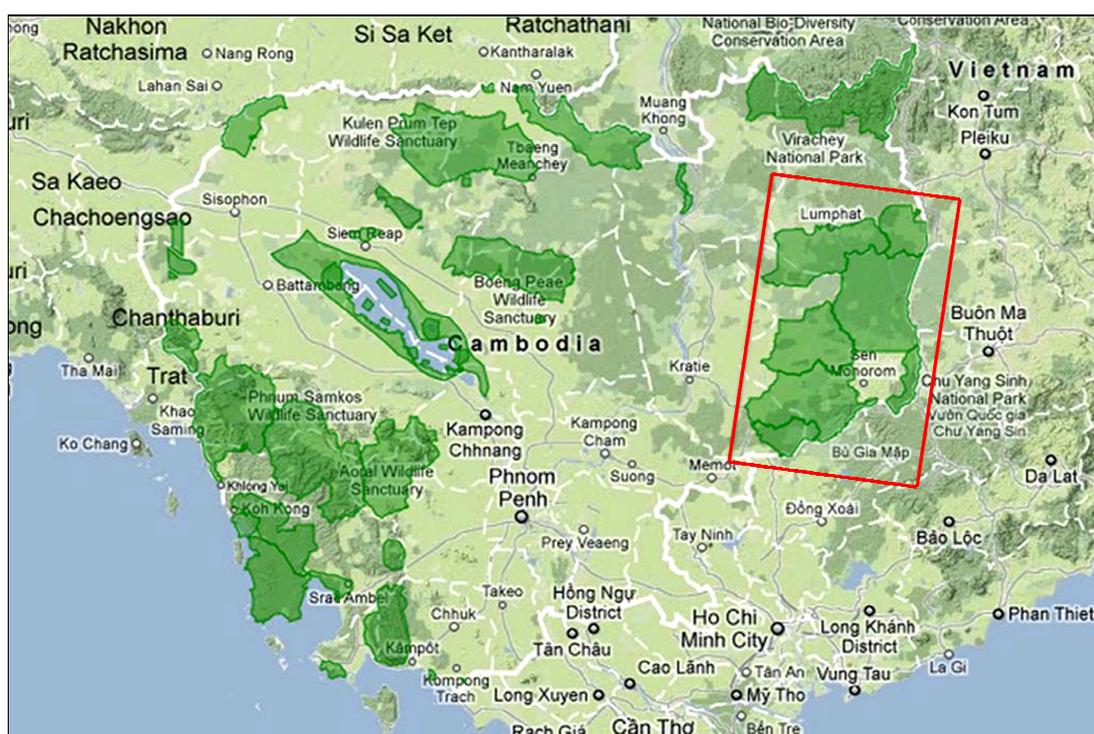


Figure 5. Map of Protected Areas in Mondulakiri Province

Source. Open Development Cambodia (<http://www.opendevdevelopmentcambodia.net/>)

4.18 *Ex situ* conservation

Cambodia has a lack of facilities for an *ex situ* conservation of PGR such as botanical garden, seed and gene banks. At CARDI there is a small gene bank holding 2557 accessions of local rice germplasm (CARDI, 2011). For other crops, the current project conducted by CARDI and funding by the Cambodian Agricultural Research Fund (CARF) is playing a significant role in collecting underutilized crops in Mondulakiri province. The project has also collaborated with National Institute of Agrobiological Science (NIAS), Japan, to survey PGRFA in Cambodia over 5 years (Thorng, 2011). This will enhance Cambodian PGRFA materials conserved *ex situ*. However, in the case of Cambodia, *ex situ* conservation needs additional facilities, personnel and especially sustainable financial resources. Accessions in

genebank need to be regenerated and multiplied to maintain the genetic viability. There is also a serious lack of contextual knowledge about the material stored in seed banks. Without information about the farming systems in which these crops were grown and the planting rotations they are from, these varieties cannot be of use to future farmers. So gene banks effectiveness could be limited due to genetic drift of small-sized populations and limited adaptability to future environments as well as the lack of capacity by institution to reproduce or multiply seeds regularly, on a sufficient scale to preserve variability and adaptability.

The needs to conserve and sustainably use the world's heritage of plant genetic resources are more significant in a world facing many challenges (FAO, 2011). Therefore, policies and regulations which promote conservation and sustainable use of PGRFA including underutilized crops must be considered at the international and national levels. As the results, The threat to biodiversity, including PGRFA, was among the main subject mentioned in many global reference documents which were initiated by the awareness-raising process started by the United Nations Environment Program (UNEP) Convention on Biological Diversity (CBD, 1992) and then the 1996 Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture (PGRFA) and lead to adopt the International Treaty on Plant Genetic Resource for Food and Agriculture (ITPGRFA) in 2002. The conservation of biodiversity has become a global concern including Cambodia.

5. Conclusion and Recommendation

5.1 Conclusion

A diversity of underutilized crops was found in Mondulkiri province. Farmers continue to keep in traditional practices in agriculture and maintain significant crop genetic diversity in their fields. Rice is the main crop following by maize, cassava and cashew, however the Phnong indigenous people have experienced in food insufficient in rice production due to faced many challenges. Therefore, underutilized crops play an important role in food security, nutrition and income generation for their livelihood strategies. In this study, 50 species of underutilized crops were identified and classified by crop groups and 32 species of wild food plants were recorded in Mondulkiri province. Biodiversity status in the research areas has decrease due to fire, pests and diseases, lumbering, mining encroachment, economic

land concession and infrastructure development. To sustain PGRFA, *in situ* and *ex situ* conservation should be done and collaboration among stakeholder is needed.

5.2 Recommendation

With the empirical evidence of the study, the recommendations are made which might prove useful for the sustainable use and conservation of PGRFA diversity.

1. Indigenous knowledge should be recognized as an important component of survey and inventory of PGRFA, especially research on wild crops relative and wild food plants;
2. To develop local and export markets for a wider range of traditional and new products originating from plant varieties, primarily farmers' varieties/landraces and priority underutilized species through partnership between public, private sectors and local farmers;
3. To develop national action plan strategies and promote policies that are consistent with the sustainable use, management and development of underutilized species, as appropriate, identify their potential and the contributions to local economies and food security.

The future research should be done:

1. Research and extension studies for underutilized crops, including species classification, identification, production and distribution;
2. Ethno-botanical and socio-economic research to understand and analyse farmers' knowledge, use and management of PGRFA, consistent with the approval of the farmers involved and with applicable requirements for protection of their knowledge and technologies;
3. Research should be undertaken to develop sustainable management practices for underutilized species and improve marketing possibilities for all products.

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Annex

I. Questionnaires and Guide Questions for Focus Group Discussion

“Identification and Documentation of Underutilized Crops in Mondulkiri Province with Emphasis on Socio-Economic Aspect”

Questionnaire N ^o	Date	Name of Interviewer

I. Respondent Profile

Name of respondent	:.....
Sex :.....	Age :.....
Village :.....	Commune :.....
District :.....	Province :.....
Ethnic group :.....	Tel N ^o :.....

II. Household Characteristics

1-Total of household memberNumber of female

N ^o	Name of household member	Sex ¹	Age ²	Relationship with household leader ³	Status ⁴	Education ⁵
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

(3) 1=Not good, 2=Average, 3=Good, 4=Very Good

5-What type of fuel mostly use for cooking?

- 1=Firewood 2=Coal 3=Gas 99=Other

6-What type of lighting arrangements you have at home?

- 1=Battery 2=Kerosene 3=Electricity 99=Other

7-What is the main source of drinking water?

- 1=Private Tap 2=Village Tap 3=Pond/river/well 99=Other

III. Main Source of Household Incomes

8- In the last 12 months, what are the main sources of income of your household?

Main Source of income	Source of cash income?	Cash income last 12 months ¹
Farming (crop cultivation)	<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
Collected NTFPs (WFP, resin, hunting)	<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
Fishing	<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
Animal raising	<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
Farming labourer	<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
Own business (trading)	<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
Government employee	<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
NGO employee	<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
Other (.....)	<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	

(1) Ask respondent to estimate the amount of cash income for past year (ranges are acceptable)

IV. Farming Characteristics

9-Please indicate the type and size of the current land properties, the 5 most important crops you grown last years? The 5 most important crops you plan to growth for the next 5 year?

Type of land property	Size (ha)	5 main crops you growth last year?
Residential (include home garden)		
Paddy field (lowland rice)		
Upland farm (Chamkars)		
Other land use.....		

10-Are your land property change in the last 5 year?

- 1=Yes (Increase) 2=Yes (Decrease) 3= Stable (Move to Q13)

11-In case changed how much its change?(Hectare)

12-The reasons why its changed?

Reason for changing of land properties
(1)
(2)
(3)
(4)

13-What the type of seed are usually used by your household?

- 1=Improved varieties
 2=Traditional varieties/landraces
 3=Both

14-Did you face seed shortage of seed last year?

- 1=Yes
 2=No

15 –What is your main source of seed for 2011?

- 1=Markets
 2=Storage by own
 3=Borrow from neighbors
 4=Improved seed from MAFF
 5=Improved seed from private company
 6=Seed Aid
 7=Other (.....)

16-Did you store seed last year?

- 1=Yes
 2=No (Pass to Q19)

17- What is the technique you used for storage the seed last year? (List all the crops you storage last year)

Storage technique	Type of crops
(1)	
(2)	
(3)	

18-Did you produce any crop last year?

- 1=Yes (Pass to Q20)
 2=No

19-Why not?

- 1=Drought/low rainfall
 2=Pests/Disease/Weeds

- | | |
|--|--|
| <input type="checkbox"/> 1=Drought/low rainfall | <input type="checkbox"/> 2=Pest/disease/weed |
| <input type="checkbox"/> 3=Poor soil condition | <input type="checkbox"/> 4=Flood (only short time) |
| <input type="checkbox"/> 5=Shortage of farm implements | <input type="checkbox"/> 6=Insufficient labour force |
| <input type="checkbox"/> 7=Lack of appropriate seeds | <input type="checkbox"/> 8=Low market for farming products |
| <input type="checkbox"/> 9=Lack of fertilizer | <input type="checkbox"/> 10=Non exist |
| <input type="checkbox"/> 99=Other (.....) | |

27- During which months of the year do you experience food shortages in the household? _____
 _____ (Code: 1=January, 2=February, 3=March ...etc (Multiple answer)

28- Does your household use wild food plant in your daily diet? Yes No

29- If yes, please indicate the wild species for food that are collected to supplement household food supplies during periods of food shortage? (Use chart) (Please list the top 5 species for each group)

Wild Food Plants	Season availability ¹ ?	Did you sell?	Cash income ²
(1)		<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
(2)		<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
(3)		<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
(4)		<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
(5)		<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
(6)		<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
(7)		<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
(8)		<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
(9)		<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	
(10)		<input type="checkbox"/> 1=Yes <input type="checkbox"/> 2=No	

(1) 1=January 2=February 3=March 4=April 5=May...etc

(2) Estimate or cash from selling per time is accepted

30- Reasons to collect wild food plant for daily diet.

Reason (1):
Reason (2):
Reason (3):
Reason (4):
Reason (5):

31- Reasons do not sold wild food plants in market.

Reason (1):
Reason (2):
Reason (3):
Reason (4):
Reason (5):

VI. People Perspectives on Threats to Underutilized Crops and How to Overcome

32- In the last 5 years have there been any major disturbances to the local forests that decreased the availability of wild species for food? Yes No *please go to Q34*

33- If yes, what were these events and how did your household cope with this shortfall?

Events/Threats	Exists	
Fire	<input type="checkbox"/> 1=Yes	<input type="checkbox"/> 2=No
Disease/Pest	<input type="checkbox"/> 1=Yes	<input type="checkbox"/> 2=No
Lumbering (cut down tree)	<input type="checkbox"/> 1=Yes	<input type="checkbox"/> 2=No
Mining Encroachment	<input type="checkbox"/> 1=Yes	<input type="checkbox"/> 2=No
Land concession (clear forest to grow industrial crops)	<input type="checkbox"/> 1=Yes	<input type="checkbox"/> 2=No
Infrastructure	<input type="checkbox"/> 1=Yes	<input type="checkbox"/> 2=No
Other (specify.....)	<input type="checkbox"/> 1=Yes	<input type="checkbox"/> 2=No

34-How do you think the changing of biodiversity of your areas in the last 5 year?

1=Increase 2=Decrease 3=Stable

35- Based on your opinion, how do you think about the crop diversity in your area if compare in the last 5 years?

35a.main crops

1=Increase 2=Decrease 3=Stable

35b. Underutilized crops

1=Increase 2=Decrease 3=Stable

Thank you so much!

II. Guide Questions for Focus Group Discussion

1- Trend Analysis (Natural Resources including biodiversity, diversity of crops and forest/wild life and water availability) (Using Score)

	Biodiversity	Diversity of crops	Forests /wildlife /Water	Cause of
Before 1980				
1980				
1990				
2000				
Present				
What can be done to improve situation?				
Who will do it? What when the time frame be?				

2- Seasonal Calendar of Livelihood Activities

Livelihood Activities (Sources of income from)	Seasonality calendar (Months)											
	Jan-Mar			Apr-Jun			Jul-Sept			Oct-Dec		
Farming Activities												
Upland rice												
Lowland rice												
Maize												
Cassava												
Banana												
Legume												
Vegetables												
Taro												
Sweet potato												
Livestock												
Fishing												
NTFPs												
Rattan												
Resin												
Wild yam (<i>Dioscoreaceae</i>)												
Wild vegetables												
Wild fruits												

Hunting												
Honey												
Sleng seed (<i>Strychnos nux-vomicae</i>)												
Handicraft												
Farm Laborer												
Others (Governing/NGOs employees												

3-Annual crops grown by farmer throughout the year (cropping calendar)

Annual crops grown by farmer throughout the year	Months (Cropping calendar)											
	Jan-Mar			Apr-Jun			Jul-Sept			Oct-Dec		
Upland rice												
Lowland rice												
Maize												
Cassava												
Banana												
Winter melon												
Pumpkin												
Sweet Potato												
Taro												
Eggplant												
Groundnut												
Soybean												
Cowpea/Long bean												
Mungbean												
Cucumber												
Gourd												
Papaya												
Sesame												
Chilies												
Tomato												

4-Table format for wild food plants used by villagers

Crop name		Time to collect	Who Harvest/collect?	Sold?	Part of Plant and Use
Common Name	Local Name				
(1)					
(2)					
(3)					
(4)					
(5)					
.....					

General Questions on indigenous knowledge of villagers on underutilized crops (wild food plants)

1. Which do you prefer, cultivated crops or wild one? Reasons.
2. Which one is you consumed more in your household (wild plant for food)?
3. How often do you eat wild plant for food?
4. How do you prepare (cook) wild plants for food?
5. Do you preserve or store wild plant for food?
6. Who collect wild plant for food in your household?
7. Do you collect wild plants for food for sale?

More detailed question concerning each of the plant named/pointed by information

1. Why do you use this plant?
2. Which part/parts of the plant is/are edible?
3. Does this plant demand any special cooking methods?
4. Where does this plant grow?
5. Is this plant common or rare?
6. Is this plant for sale at the market?
7. Does the plant have any other use?
8. When do you collect this plant? (when it is available)
9. How important is this plant for your household? (Reason)

About MINZAS

MINZAS program is a partnership program of Mekong Institute and New Zealand Embassy in Bangkok. The objective of this program is to enhance research capacity of young GMS researchers by providing a structured learning and field research application program for 36 master's degree students from provincial universities in Cambodia, Lao PDR, Myanmar and Thailand.

Through a comprehensive supports – trainings, roundtable meeting, constructive advices from MI advisors including financial supports – which are to be and have been provided to scholarship grantees, students' research skills and conduction of research deem to be developed. The completed research works will be published in 'MI Working Paper Series' and disseminated to related agents among the GMS.

The MINZAS Program is designed for 3 cycles; each cycle lasts for one year with 4 phases:

- Phase One: Training on Research Methodology
- Phase Two: Implementation of Sub-regional Research in Respective Countries
- Phase Three: Research Roundtable Meeting
- Phase Four: Publication and Dissemination of Students' Works in 'MI Working Paper Series'

The research cycle involves:

- One month training course on GMS Cooperation and ASEAN Integration, research development and methodology. The students will produce their research designs and action plans as training outputs;
- Technical assistance and advisory support to MINZAS scholars by experienced mentors and academicians in the course of the research process;
- The scholars will present their research papers in a round table meeting attended by subject experts and their peers;
- Scholars will revise their research papers and improve as necessary, based on experts and peer review during the roundtable meeting;
- Publication of reports as MI working paper series.

The Mekong Institute (MI) is an intergovernmental organization with a residential learning facility located on the campus of Khon Kaen University in the northeastern Thailand. It serves the countries of the Greater Mekong Subregion (GMS), namely, Cambodia, Lao P.D.R., Myanmar, Thailand, Vietnam, Yunnan Province and Guangxi Zhuang Autonomous Region of PR. China.

MI is the only GMS-based development learning institute, chartered by the six GMS Governments, offering standard and on-demand capacity development programs focusing on regional cooperation and integration issues.

MI's learning programs services caters to the capacity building needs of current and future GMS leaders and policy makers on issues around rural development, trade and investment facilitation, human migration, with good governance and regional cooperation as cross cutting themes.

Vision

Capable and committed human resources working together for a more integrated, prosperous, and harmonious GMS.

Mission

Capacity development for regional cooperation and integration.

MI Program Thematic Areas



