Government of Lao People’s Democratic Republic

Executing Entity/Implementing Partner:
Ministry of Agriculture and Forestry, MAF, Vientiane, Lao PDR

Implementing Entity/Responsible Partner:
National Agriculture and Forestry Research Institute, NAFRI

United Nations Development Programme

Selected agriculture concepts, approaches, commodities for development of CLIMATE CHANGE TRAINING AND ADAPTATION MODULES FOR LAO PDR:
3. ON-FARM AND COMMUNITY LEVEL WATER MANAGEMENT

Improving the Resilience of the Agriculture Sector in Lao PDR to Climate Change Impacts (IRAS Lao Project)

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The MAF in collaboration with the UNDP and other Government of Lao (GoL) and Non-government Organisation (NGO) partners, has prepared five (5) modules or guides for extension officers/workers who will be involved in promoting good practices and technologies for climate change adaptation in the agriculture sector. Entitled the “Climate Change Training and Adaptation Module” or CCTAMs, these guides are part of the target outputs of the MAF – NAFRI project entitled “Improving Resilience in Agriculture Sector to Climate Change” or IRAS Project. The CCTAMs being developed are:

1. Overview of Climate Change Adaptation (CCA) for Upland farming conditions;
2. Overview of CCA for Lowland Farming Conditions;
3. CCA through On-farm and Community Level Water Management;
4. CCA in Crop Production;
5. CCA in Small Livestock

Process of preparation. Stakeholder consultations at the provincial and national levels identified the key issues as a result of the combined effects of natural resources degradation, inappropriate agricultural land use practices and climate change. Subsequent consultations identified possible measures that can be applied.

Objectives of the modules. The CCTAMs discusses the challenges posed by the combined effects of land degradation due to inappropriate land use practices and the effects of climate change. They then provide an overview of the range of practices and technologies that may be considered to adapt to climate change, at the same time addressing the issues of natural resource degradation.

The Climate Change Adaptation : On Farm and Community level Water Management The recommended practices and technologies for CCA in crop production are as follows:

- **Minimizing water runoff in the farm.** Actions that aim to manage the powerful force of surface runoff. Key measures include contour plowing, soil erosion control structures, diversion canals, gully checks and other forms of water and soil conservation. A labor saving and low cost technology called the natural vegetative strips or NVS is introduced.

- **Construction or improvement of village ponds and farm ponds.** Actions that aim to improve, construct and maintain the ponds to be able to store more water over longer periods of time. These are highly recommended in both upland and lowland farms.

- **Improving efficiency of water use.** Actions that make the most of the available water either from irrigation systems or underground water sources. An example would include
the Alternative Wetting and Drying (AWD) system and the small holder bucket micro-irrigation.

- **Improving the soil water holding capacity.** By ensuring soils can hold moisture for a longer period, the farmer can plant more crops in the same piece of land within a year.
- **Adapting to flooded situations.** These include various measures to allow farming to continue during floods.
- **Protecting the community’s natural water supply system.** These include recommendations for community level efforts to protect the headwaters of community watersheds and ensure groundwater is safe and sustainable though groundwater recharge

**This CCTAM contains two formats of information.** The first is the set of existing locally generated extension materials produced by NAFES, NAFRI, and other GoL agencies as well as NGOs that can contribute to climate change adaptation. These discuss entire production cycles. The second format would be the direct description of climate adaptation technologies that are not yet discussed adequately in existing extension materials. However, the second type would focus on specific adaptation practices that may be applied to address the effects of climate change. This CCTAM will occasional refer the reader to other CCTAMs which can discuss certain topics in detail.

**Benefits and Costs.** The major benefits are the avoided expenses due to crop damage from surface runoff, and cost of fertilizers to compensate for loss of soil nutrients due to soil erosion. From farm ponds, production yields can be at least maintained due to the ability to deal with dry spells during the wet season or early end of the wet season. Water from rainwater harvesting ponds will ensure that vegetable and livestock production can be saved from the harsh effects of lack of water. Alternative wetting and drying saves at least 30% of the cost of water especially if pumped from underground using fuel.

Contour plowing does not entail additional labor costs. NVS establishment only requires less than a day for establishing the contour lines. The major cost would come from the extra days needed for construction of water management structures (check dams diversion canals). These costs however should be compared to the costs of fertilizer purchases if erosion is uncontrolled...

**Applicability in IRAS Project Sites.** The technologies are generally applicable in all project sites of IRAS. However the exact combinations of technologies to be applied as well as timing will depend on the actual biophysical and socioeconomic situation in each village. Thus village conditions need to be studied first and priorities established by farmers (methods discussed under CCTAM #10).

Certain technologies are easy and can be applied immediately such as contour plowing and natural vegetative strips. Others require time but immediate actions need to be done in the first year. New varieties and species need to be tried out first in smaller plots for one to two seasons.
Technologies requiring new skills such as rainwater harvesting tanks would require familiarization of the technology in actual practice in other communities.

**List of Acronyms**

- **AWD**: Alternative Wetting and Drying
- **ATIK**: Agroforestry Technology Information Kit
- **BSWM**: Bureau of Soil and Water Management, Philippines
- **CCA**: Climate Change Adaptation
- **CCTAM**: Climate Change Training and Adaptation Module
- **DAFO**: District Agriculture and Forestry Office
- **DFID**: Department for International Development
- **FAO**: Food and Agriculture Organization
- **FFTC**: Food and Fertilizer Technology Center
- **FS**: U.S. Forest Service
- **GoL**: Government of Lao
- **ICRAF**: World Agroforestry Centre
- **ICRISAT**: International Crops Research Institute for the Semi-Arid Tropics
- **IFAD**: International Fund for Agriculture Development
- **IRAS**: Improving the Resilience of the Agriculture Sector in Lao PDR to Climate Change Impacts
- **IUCN**: International Union for Conservation of Nature
- **IWM**: International Water Management Institute
- **MAF**: Ministry of Agriculture
- **NAPA**: National Adaptation Programme of Action
- **NAFRI**: National Agriculture and Forestry Research Institute
- **NGO**: Non-government Organisation
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<td>Natural vegetative strips</td>
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<td>Provincial Agriculture and Forestry Office</td>
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<tr>
<td>PhilRice</td>
<td>Philippine Rice Research Institute</td>
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<td>PWMC</td>
<td>Philippine Watershed Management Coalition</td>
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<tr>
<td>UNDP</td>
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<td>United Nations Framework Convention on Climate Change</td>
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<td>United Nations Children’s Fund</td>
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<td>USDA</td>
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BACKGROUND AND INTRODUCTION

The need for Climate Change Adaptation

The Ministry of Agriculture (MAF) in collaboration with the UNDP, is presently implementing the Project entitled “Improving the Resilience of the Agriculture Sector in Lao PDR to Climate Change Impacts” or the IRAS Project. This project addresses the need to adapt to climate change in the agriculture sector.

The IRAS project document states that “the current and future climate-related risks to Lao PDR and key areas of vulnerability have been analyzed in the country’s First National Communication (STEA, October 2000) to the United Nations Framework Convention on Climate Change (UNFCCC) and the National Adaptation Programme of Action (WREA, April 2009).

According to the updated Koeppen-Geiger classification from 2006, as cited by the IRAS Project document, there will be more rainfall events in the centre and the north of the country during the first half of the century and an expansion of climatic conditions at present prevailing in the south, these slightly shrinking again in the second half of the century. These expected changes will require resilience and early gained adaptive capacity of the agricultural sector and the farmers to cope with the situation. Seen as a function of exposure, sensitivity and adaptive capacity, Lao PDR ranks as one of the most vulnerable countries in South East Asia.

Climate change is expected to change the frequency, intensity and location of existing climate hazards and challenge the existing coping mechanisms of the population; especially those living in rural and remote places. (IRAS Project Document, 2010)

The IRAS Project

The objective of the IRAS Project is to minimize food insecurity resulting from climate change in Lao PDR and to reduce the vulnerability of farmers to extreme flooding and drought events. There are four expected outcomes:

- Outcome 1: Knowledge base on Climate Change impacts in Lao PDR on agricultural production, food security and vulnerability, and local coping mechanisms strengthened;
- Outcome 2: Capacities of sectoral planners and agricultural producers strengthened to understand and address climate change-related risks and opportunities for local food production and socio-economic conditions
- Outcome 3: Community-based adaptive agricultural practices and off-farm opportunities demonstrated and promoted within suitable agro-ecological systems
- Outcome 4: Adaptation Monitoring and Learning as a long-term process
The Climate Change Training and Adaptation Modules or CCTAMs

Under the IRAS project, the MAF in collaboration with the UNDP and other Government of Lao (GoL) and Non-government Organisation (NGO) partners, is now preparing six (6) guides for extension officers/workers who will be involved in promoting good practices and technologies for climate change adaptation in the agriculture sector. Entitled the “Climate Change Training and Adaptation Module” or CCTAMs, these guides are part of the target outputs of the MAF – NAFRI project entitled “Improving Resilience in Agriculture Sector to Climate Change” or IRAS Project. The CCTAMs being developed are:

- Overview of Climate Change Adaptation (CCA) in Upland farming;
- Overview of CCA in Lowland Farming;
- CCA through On-farm and Community Level Water Management;
- CCA in Crop Production;
- CCA in Small Livestock; and
- CCA in Fisheries

Objectives of the CCTAMs

a. Provide an overview of the challenges posed by the combined effects of land degradation due to inappropriate land use practices and the effects of climate change;

b. Provide an overview of the range of practices and technologies that may be considered to adapt to climate change, at the same time addressing the issues of natural resource degradation; and

c. Serve as a quick reference to existing relevant extension materials and making the latter available to the extension officers/workers.

How were the CCTAMs prepared?

Stakeholder consultations at the provincial and national levels identified the key issues as a result of the combined effects of natural resources degradation, inappropriate agricultural land use practices and climate change. Subsequent consultations identified possible measures that can be applied. The CCTAM assembles the key knowledge from communities and researchers in the areas of natural resource management, sustainable agriculture and recent dialogue on climate change adaptation.

How will the CCTAMs be used?

The first step is to determine the location-specific needs of farming communities. PAFO and DAFO personnel may use CCTAM #1 on Upland Farming systems and the CCTAM #2 on lowland farming systems to obtain an overview of the upland and lowland situation as well as problems associated with drought and flood conditions.
The PAFO and DAFO, together with local authorities and local partners, can use Part 3 of the CCTAMs #1 and #2 to facilitate a simple community based action planning process for adaptation to climate change. Part 3 provides several participatory planning tools. The output will be priority issues and actions.

Based on the priorities set by farming communities, Extension Officers in consultation with local authorities will identify priority actions from among the options cited in the CCTAMs. Based on the agreement with communities, the selected options will then be tested and demonstrated on the ground. Results from several seasons of observation will be documented and used to revise the CCTAMs and/or develop more detailed local guides.
SELECTED AGRICULTURE CONCEPTS, APPROACHES, COMMODITIES FOR THE DEVELOPMENT OF CLIMATE CHANGE TRAINING AND ADAPTATION MODULES FOR LAO PDR # 3: ON-FARM AND COMMUNITY LEVEL WATER MANAGEMENT

Background and Objectives

Partly due to climate change, rainfall events have become more intense. One of the observations is that there is too much rain over shorter periods of time. This carries a lot of force that, if unaddressed, causes massive soil erosion, landslides and flooding of crop lands.

In other times of the year, dry spells happen within the wet season and sometimes the wet season ends earlier. In both cases (too much or too little water), the soil is not able to absorb and hold sufficient water.

What happens to the rain when it hits the ground? Some of the water infiltrates the soil. What the soil cannot absorb becomes water runoff or the water that flows on the soil surface and eventually into the river downstream. The water that infiltrates the soil undergoes further partition. Some of that water is retained in the upper portion of the soil near the root zone where the plant can use it. The other part drains further into the lower portions and into the aquifer where it becomes part of groundwater.

The ideal situation is that most of the rainwater is absorbed by the soil particularly near the root zone so that both the water and soil nutrients can be used by plants. However, in most situations where deforestation has happened and inappropriate land management is widely practiced, the soil is not able to absorb much water and most of the water becomes runoff. Water runoff brings valuable top soil downstream. Some of the soil is captured by lowland paddies. Most, however, flow further into rivers and seas.

Water from the rain must be conserved so that it can be used fully throughout the year. There are three ways on how water can be conserved – as surface water, as groundwater, or as water in the soil (called soil moisture).

Given the above conditions, the overall objectives of this CCTAM entitled “On–Farm and Community Level water management” as a strategy for adaptation are:

- minimize the destructive force of water runoff which contributes to destructive floods and landslides that cause long term production losses;
- arrest massive soil erosion so that soil can be used for successful farm production;
- store as much water as possible in the form of surface water (e.g. ponds), groundwater, and as soil moisture for yearlong water supply to the farmer;
- introduce agronomic practices that allow crop and animal production to adopt to situations of too much water or too little water;
• contribute to the sustainable management of the community’s natural water supply systems (forests, rivers, soils, groundwater) in order to provide and sustain local water supply and minimize, where possible, the impact of flooding.

Criteria and Overview of Key Practices and Technologies

Subsequent sections below briefly describe recommended good practices and technologies. The key criteria used in choosing them include:

• Priority attention to identify locally generated experience by the field extension personnel and research results (by local and international agencies); Where there are information gaps, adapt information from within the Southeast Asian region and among third world countries in the humid tropics with somewhat similar conditions were studied;

• Good practices and technologies are not overly dependent on external inputs and high labour inputs. Where there are existing locally generated extension materials to explain the topic further, these are listed together with sources of information. Where there is none, external sources of information are also provided.

The recommended set of practices and technologies are as follow:

• Managing surface runoff in the farm;
• Construction of village ponds and farm ponds;
• Improving efficiency of water use;
• Improving the soil water holding capacity;
• Adapting to flooded situations;
• Protecting the community’s natural water supply system

For purposes of presentation, there are two types of practices and technologies related to on-farm and community level water management for CCA adaptation. The first has to do with physical infrastructure as well as land preparation that guide the flow, storage and use of water. These types of interventions are discussed in this CCTAM. Those practices that involve adjusting agronomic practices are also cited in passing here but are discussed in more detail under the CCTAM on crop production.

At this point of time, there is not much documented material on the subject matter. However, local communities would certainly possess’ local knowledge on water management that would be worth documenting in the near future. In the interim information materials from ASEAN and Asian countries with somewhat similar biophysical conditions are utilized in most part in this CTTAM. Most of the locally prepared materials for climate change adaptation are found in the CCTAM for Crops and CTTAM for livestock.
1.0 MINIMIZING WATER RUNOFF IN THE FARM

1.1 RATIONALE FOR ACTION

Climate change is projected to increase the intensity of rainfall and the frequency of floods. This will likely increase surface runoff, which is generated by and dependent to the intensity, duration and distribution of rainfall. A case in point is the 2008 flooding that occurred in the Mekong basin that reached extreme levels resulting from a storm system that produced 100-150 mm, with locally recorded figures of as high as 250 mm. The soil can generally not absorb this huge amount of rainfall that falls in a very short period of time, causing intense runoff. The World Bank (2011) projected an increase in total annual runoff of 21% in the Mekong area.

Consequently, surface runoff causes erosion which will pose greater challenge to crop and livestock production. Thus, early and effective actions to prevent or minimize surface runoff and enhance soil conservation are needed. The following are cost effective practices to minimize runoff and conserve soil and water.

1.2 RECOMMENDED PRACTICES

1.2.1 Contour plowing

Plowing across the contour is the most important minimum step. This is much more desirable than plowing along the slope which causes massive soil erosion. Contour plowing is most useful in gentle slopes and is done with either machine, draft animal, or manually.

Some farmers who use the tractor hesitate to implement contour plowing due to the fear of the tractor losing balance due to tilting on one side. This is actually not a problem if done in gentler slopes. In the relatively steeper slopes, extra care is needed in order to avoid tilting the tractor.

1.2.2 Erosion control - Natural vegetative strips (NVS)

The farmer, with the help of neighboring farmers can establish biological structures across the slope that serves as barrier. One of the recommended methods is the natural vegetative strip or NVS. This involves leaving a half-meter-wide strip of land along the contour line during the plowing operation.

This strip, which has naturally occurring grasses (e.g. *Imperata cylindrical*) and herbs (e.g. *Chromolyana odorata*) on it becomes the initial soil conservation structure. This method does not involve too much labor nor does it require external planting materials (like materials for hedgerows). When the farmer has available time, he can then improve this strip by planting trees and other income generating crops in the strip.

There are two sets of steps involved: (1) establishing the contour line, and (2) establishing the soil and water conservation structure itself.

- **Determine the contour line.** A contour line is an imaginary line across a slope which is of the same height as all places along the slope. The soil conservation structure is established along the contour line. One is by the A frame, the other is by the U Tube.
• **Establish the soil conservation structure.** During the plowing operation, leave a half-meter-wide unplowed strip along the contour. The strip is called the natural vegetative strip composed of naturally occurring grasses and herbs. NVS can be 5-10 meters apart depending on the steepness of the slope. Each NVS can serve as initial soil conservation structure.

• **Maintenance and enrichment.** Prune the NVS 5 to 10 cm from the ground every 3 months. Use the pruning as mulch. When the farmer has the time, he/she can enrich the NVS by planting banana, pineapple, fruit trees and other biennial and other food or income generating perennial tree crops that can help hold the soil or provide biomass to help enrich the soil.

1.2.3 **Diversion canals**
If the area above the upland farm experiences high water runoff, the farmer needs to protect his farm from that source of forceful runoff by establishing a diversion canal. This diversion canal is usually established on the upper boundary of the farm and along the contour, to intercept the water runoff from the upper portion and divert it to a natural drainage (gully or ridge). It spares the farm from massive erosion or even landslide. The canal may be graded slightly (½ to 1 %) so that water will not overtop and can flow safely towards a nearby gully.

1.2.4 **Gully checks**
A gully is a deep ditch or channel cut in the earth by running water after a prolonged rainfall. Gullies increase the velocity of surface water runoff. A series of simple check dams may be established across the water course in order to slow down the velocity of water, enhance infiltration and minimize flash floods. They are also used to catch soil eroded from upper slopes so that this can be returned to the field.

Farmers in many parts of Asia know that the soil accumulated behind the gully check dam is usually has more moisture and more fertile than in other parts of the farm. During dry months plants can be planted on this area.

The height of simple, on farm gully checks can be between 0.5 and 1 meter. In gentle slopes, the distance between small gully check dams can be between 5 to 10 meters while in steeper slopes, it can be between 3 to 5 meters.

The gully checks may be constructed with easily accessible materials. Such materials include vegetative strips, brushwood, or rocks. Rocks can be wrapped in wire baskets or gabions.

1.2.5 **Soil trenches**
Soil trenches are small holes (1 x 1 x 0.5 meters) dug one to two meters above a gully check dam. These help to further trap sediments carried by water runoff. Part of the sediments carried by water runoff is deposited here. After the rain, that sediment is collected and returned to the farm.
1.2.6 Other soil and water conservation approaches
In addition to the NVS, other approaches to soil and water conservation structures may be considered. These include:

- Contour grass strips – sturdy grass like vetiver grass or napier grass on the hedgerow and pruned regularly;
- Contour hedgerows - woody leguminous species planted along the contour and coppiced regularly to avoid shading;
- Contour bunds with contour canals – bunds along the contour line with various grass or tress planted on the bunds;
- Rock walls - in rocky areas, rocks can be placed along the contour line to serve erosion control;
- Trees on the steeper slopes – soil conservation structures are not encouraged on very steep slopes (above 45 degrees). Instead, deep rooted fruit trees and other types of trees useful for the farmer may be established.

Many farmers farm the land even if these are in very steep slopes. In these steep slopes, soil conservation structures would not be very effective especially if the soil is intensively cultivated. Rather natural vegetation either in the form of undisturbed natural grasslands or natural tree growth would be the best protection against surface runoff or soil erosion.

The publication entitled “Soil and Water Conservation Technologies and Agroforestry Systems” by ATIK and “Soil and Water Conservation: A Study Guide for Farmer Field Schools and Community-based Study Groups” by FAO, are good sources of basic information on establishing runoff management structures. The ATIK book first discusses how to determine contour lines, which is the basis in establishing any kind of structure.

1.3 BENEFITS AND COSTS

The water management structures protect the farm from the destructive effects of runoff due to heavy storm events. It can save up to 100 tons of soil per year. If this soil is not saved, the farmer would have to buy expensive inorganic fertilizers to compensate for the loss of soil nutrients. Without these structures, there is also foregone income from crop damage and animal mortality.

The main costs are labor costs in terms of constructing the water and soil conservation structures. The NVS do not require planting materials and the initial effort needed is to determine the contour lines and avoid plowing a half-meter wide strip of land along the contour. Other soil conservation structures may require the procurement of certain types of grasses and legumes. In rocky areas, hauling the rocks will add to the cost of labor. Maintenance costs would involve labor to cut the grasses every 3 months or check on the stability of the rock wall every year.

Overall, the cost of labor will be smaller compared to the avoided cost of purchase of inorganic fertilizers, having unhealthy plants due to poor fertility and avoided cost of crop damage due to landslides.
1.4 APPLICABILITY IN IRAS PROJECT SITES

All the above recommendation is applicable in all Project sites that are exposed to surface runoff. The rule of thumb in applying soil conservation structures in gentle to rolling areas and natural vegetative cover in steeper areas would apply to all sites.

1.5 COMPANION EXTENSION MATERIALS THAT COMES WITH THIS CCTAM

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Figure 1. Minimizing surface runoff

Figure 1.1. When rain falls on the ground, what happens? In lands with little vegetative cover (forests, undisturbed grasslands etc), most of the rainfall become surface run off (a) because the soil has little absorptive capacity for water. For the little water that is absorbed by the soil, some are evaporated (b); some are retained in the root zone (c); while some become part of groundwater (d); The objective of water management is have more water infiltrating the soil (e); so that more would be available to the root zone (f); and the groundwater aquifers (g). (Adapted from UNEP, 2007)
Figure 1.2. Managing surface run off. Surface run off can be very destructive especially in hilly areas. The first simple but vital step is to avoid plowing up and down the slope. Rather do it across the slope (right). Pictures adapted from MSEC (left) and ICRAF (right).

Figure 1.3. Erosion control. Soil conservation structures should be established along contour lines or imaginary horizontal level lines following the face of the relief of the land. Simple methods for determining contour lines include the combination of plastic hose and calibrated meter stick called the U TUBE (right). Source: Soil and water Conservation (SWC) Technologies and Agro forestry Systems
Figure 1.4. Erosion control. Simple method for erosion control is the Natural Vegetative Strips (NVS). This involves NOT plowing half meter strips of land during land preparation (left). The strip of land with its natural grass and herb vegetation becomes the initial base for erosion control (b). No planting materials are needed. Little labor is required. When the farmer has the time, he can improve the strip and plant deep rooted crops to make it stable and profitable. (Source: ATIK and ICRAF)

Figure 1.5. Diversion canal. In areas where the land above the farm is prone to high surface run off, the farmer can intercept and divert the surface run off by establishing a diversion canal (center and right). Soil trenches on the other hand catch the soil carried by the run off.
Figure 1.6. Other soil erosion control structures. These include strips of sturdy grass like Vetiver grass (left), or contour hedgerows (center and right) (Source ATIK)
2.0 CONSTRUCTION OR REHABILITATION OF FARM PONDS AND RAINWATER HARVESTING TANKS

2.1 RATIONALE FOR THE ACTION

Among the projected changes with climate change include increasing frequency of droughts and dry spell periods. Irrigation demand in some regions of Asia is estimated to increase by 10% for each 1°C increase in temperature. Higher temperatures will increase evapo-transpiration, increasing the water demand of crops and pastures in both rainfed and irrigated systems.

Limited quantity and ineffective distribution of irrigation water are often stated as one of the reasons for limited production. A more feasible option is to utilize the limited amount of rainfall with higher efficiency. In areas without or have limited sources of water for irrigation and where rainfall is insufficient to cover the water demands of crops, water can be harvested in order to increase available water resources.

The methods in establishing these ponds are generally well known by the local villagers. Presently, farm ponds and village ponds are most useful during the short dry spells of a rainy season. They are also used to support the livestock and water backyard grown vegetables during the dry season. However, the water cannot last long enough for the long periods of dry season.

The key challenge with both village and farm ponds are excessive evaporation and seepage. In some areas, the ponds are full of sediments. The wide surface area contributes to the evaporation while porous soil properties in some areas promote seepage.

In addition to farm and village ponds, we need to encourage our farmers to collect the water that lands on the roof and store the same for rainwater harvesting tanks. This is useful not only for domestic use but also for livestock and small garden.

2.2 RECOMMENDED PRACTICES

There are at least three types of farm ponds/village ponds. The runoff ponds rely on runoff especially from sloping areas. The groundwater farm ponds occur in natural depressions and where the water table is near the ground surface. The borrow pit or dug out ponds are holes deliberately made by man and/or machine. The FAO publication entitled “Farm Ponds for Water, Fish and Livelihoods” describes the characteristics of these ponds in terms of fishery production.

2.2.1 For farm ponds, consider the following:

- Determine the farmers’ objectives. In most cases, ponds are built for multiple purposes such as water for the home, water for crops and livestock and fish production. If it is for semi-commercial fish production then the criteria for fish ponds would be considered.
Many farmers are increasingly relying on private contractors with back hoes to construct farm ponds. These operators generally know what dimensions to follow.

Plan to construct the pond towards the end of the wet season when the soil is more manageable.

Choose the site correctly. Small valley bottoms would be ideal candidates in upland areas. Natural depressions can also be good candidates. In both cases, take note of the catchment that would provide the water runoff for the pond.

Areas with clay type of soils would be ideal sites. Soils that are porous would require special lining. Areas near natural springs would also be good sites. To minimize seepage, line the pond with lime and manure. The general rule of thumb is to have a pond that would have the size equivalent to 20% of the farm area.

Take note of the catchment area needed for farm pond. For instance, to irrigate two hectares for a year, a farm pond of 1000 m$^2$ to 1500 m$^2$ may be constructed. To provide the water for this size of pond, a 10 hectare neighboring catchment area may be needed. To irrigate smaller areas during the wet season only (e.g. during dry spells) much smaller catchment area would be needed.

Aim to have ponds that are smaller in size but deeper in depth. Smaller surface area means lesser area for evaporation. Ponds with smaller surface areas allow for the installation of natural structures such as vegetable trellises that can help reduce evaporation. To compensate for the smaller size of pond, increase the number of smaller sized ponds.

If the farmer plans to raise fish for markets, the depth, however, should ideally not exceed 2 meters during the rainy season. Deeper than that would not be good for the fish that also needs sunlight.

Plant grass or shrubs around the pond to prevent erosion and sedimentation of the pond. Plant medium sized trees on the side of the pond.

Avoid planting fast growing trees near the banks because they transpire a lot and might use up the moisture in the soil.

Line the side of the pond with clay and bentonite or a plastic lining.

2.2.2 For the village pond, apply the same guidance for farm ponds. In addition, agree on rules to make these structures sustainable. Such rules may include:

- Agreement on equitable use;
- Preventing water pollution (e.g. not to throw of waste or washing of containers of chemicals);
- Protecting the catchment that generates the water to the pond;
- Regular de-silting; and
- Planting and maintaining vegetation on the perimeter of the pond to help reduce evaporation and siltation.
2.2.3 Ferro cement rainwater harvesting tank
For farm households that use GI sheet or tiles, water from the gutter can be stored in ferro cement rainwater harvesting tank. In this case, the roof is the catchment. These tanks utilize concrete construction technology that favors the use of closely-spaced mortar and small diameter reinforcement such as wires and meshes. This is opposed to graveled concrete and rebars mainly used by conventional reinforced concrete. Ferro cement structures usually cost 65-85% less than the conventional reinforced concrete.

Factors to consider in constructing a ferro cement tanks include the following:

- Determine the needs of the farm household (domestic, garden, livestock, etc.);
- Determine how much water can be stored by knowing the rainfall pattern (volume and rainy days) and catchment area of roof; and
- Determine site characteristics (soil that will carry the weight of tank, space available, location of tank).

The publication of the UNICEF (Harvesting the Rain) and WASH (How to construct a ferrocement rainwater harvesting tank) provide a step by step description for the construction and maintenance of rainwater harvesting tanks.

2.3 BENEFITS AND COSTS

One thousand meter square to 1500 m² farm pond can serve the needs of up to 2 hectares throughout most of the year depending on the rainfall situation. New farm pond construction will usually require the services of a medium sized back hoe for at least one day. In Thailand, the cost would be about USD 500 to 700.

A 4,000 litter Ferro cement tank can cost approximately USD 50 thousand.

2.4 APPLICABILITY IN IRAS PROJECT SITES

Farm ponds that depend on surface run off would be ideal for the northern upland communities. Ponds that rely on runoff groundwater as well as borrow pit or dug out ponds would be suitable for lowland communities. The measures for minimizing evaporation and seepage as well as maintaining the sanitation of these ponds are applicable to all areas.

2.5 COMPANION EXTENSION MATERIALS THAT COMES WITH THIS CCTAM

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Figure 2. Construction and rehabilitation of farm ponds and rainwater harvesting tanks

Figure 2.1. Farm ponds are important adaptation measures. But the challenge in these funds is high evaporation and seepage. They can hardly service the water needs of farmers during the dry season.
Figure 2.2. Trees and grasses can be planted on the edge of help reduce evaporation. Village ponds on the other hand would require better community agreements on how to prevent pollution, sedimentation and equitable use.

Figure 2.3. Rainwater harvesting tanks. They can support domestic needs as well as the needs of livestock and small gardens during dry spells. The jars are made of ferro cement which can be built 60% less cost than the current cement structures (Pictures adopted from WASH)
3.0 IMPROVING EFFICIENCY OF WATER USE

3.1 RATIONALE FOR THE ACTION

Water is the most limiting factor for agricultural production. Irrigation can provide water for crop production. However, due to lack of available water management resources, expanding the irrigation service area is often not an option. This is not only because of the lack of financial resources but also because in many parts of Asia, many watersheds under climate change conditions are going through change in hydrology. This sometimes means that there is not enough water when it is needed most. A good adaptive measure is to utilize the limited amount of water with higher efficiency. This involves actions that make the most out of available water either from irrigation systems and pumped underground water sources.

An example would include the Alternative Wetting and Drying (AWD) system being demonstrated under irrigated rice conditions. This can save up to 30% of the water. Another example would be the use of bucket micro-irrigation system, an inexpensive drip irrigation method for smallholder vegetable production.

3.2 RECOMMENDED PRACTICES

3.2.1 Controlled irrigation through Alternative Wetting and Drying (AWD)

Farmers are utilizing water from both community irrigation facilities set up by government or by utilizing underground water drawn out by pumps.

To reduce water consumption in both cases, the technology of “Alternative Wetting and Drying” or AWD may be practiced. This is a water-saving technology to reduce the water use in irrigated fields. Instead of permanently flooding the rice field, water levels can drop down to 15 cm below ground level before they require being flooded again.

By doing so the requirement for irrigation water is reduced by up to 30% and the cost of irrigation. Other key benefits include increased efficiency of plants to use soil nutrients. Those who will benefit mostly are the farms at the tail end of irrigation systems and farms supported by small water impounding systems and pump irrigation system.

The steps involved are:

- After irrigation, the depth of the ponded water will gradually decrease. Monitor the depth of ponded water on the field using the field water tube which is inserted into the soil;
- When the ponded water has dropped to 15 cm below the surface of the soil, irrigation should be reapplied to re-flood the field with 5 cm of ponded water;
- From one week before to one week after flowering, ponded water should be kept at 5 cm depth; and
• After the flowering, during the grain filling and ripening, the water level can drop again to 15 cm below the surface as in before irrigation.

The IRRI publication entitled “Alternative Wetting and Drying Technology” and the PhilRice publication entitled “Practical and Doable Water saving techniques in controlled irrigation” provides a good discussion of the AWD method.

### 3.2.2 Other physical methods to save water in rice production

- Plow the field immediately after initial irrigation. This reduces percolation during land preparation by sealing big cracks as soon as possible.
- Puddle the soil very well. This is done by harrowing or rotating the field 2 to 3 times followed by leveling. This practice increases the water holding capacity.
- Maintain rice paddy dikes to minimize seepage and clean irrigation ditches regularly.
- Plant windbreaks to reduce evapo-transpiration of the rice crop.
- If possible and through consensus among members of an irrigation system, practice synchronous farm operations. From land preparation, all farm operations should not vary by 4 weeks within at least 20 hectare contiguous areas.

### 3.2.3 Micro Drip Irrigation System

Drip irrigation involves the slow application of water, drop by drop, to the root-zone of a crop. Water is used very economically, since losses due to deep percolation and surface evaporation are reduced to the minimum. The simplest micro-scale technology is the “bucket drip method.” This involves a small 20 liter bucket with drip lines that can serve up to 20 m² of vegetable garden. This method would be helpful for market-oriented vegetable farmers in peri-urban areas.

The publication of USDA entitled “Bucket Drip Irrigation” (and applied in South Asia) as well as the publication of AVRDC entitled “More Crop Per Drop” provide good discussion of the principles and specific methods for setting up the simple method.

### 3.2.4. The Sorjan Method

Reduce the area planted by rice to increase the amount of irrigation or residual rainfall water available. The sorjan system developed by farmers in Indonesia is one such method of water management. Tests done in Indonesia showed that this system nearly doubled the amount of available water for rice production. Devote low-lying areas of the farm to rice and plant the upper areas with dryland crops. The rice crop can take advantage of the higher water table in the lower areas and can utilize runoff from the upper areas. For more information, please see the technology sheet on Sorjan: Towards Rice-based Integrated Cropping System

### 3.3 BENEFITS AND COSTS

Alternative wetting and drying methods save up to 30% of water and would be valuable particularly for those relying on groundwater extracted by pumps run by fuel costs. The costs are minimal – essentially the time and attention to monitor the water level.
Drip irrigation systems also save between 60 to 70% of its water needs. The cost would be between USD 20 to USD 200.

### 3.4 APPLICABILITY IN IRAS PROJECT SITES

The methods above are technically applicable in all project sites. AWD methods are applicable to farms irrigated by irrigation systems or by pumped groundwater.

Drip irrigation methods are suitable for small scale but market oriented vegetable farmers.

### 3.5 COMPANION EXTENSION MATERIALS THAT COMES WITH THIS CCTAM

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ADDITIONAL REFERENCES:

- Revitalizing Irrigation: [IWRMI](http://www.iwmi.cgiar.org/Publications/Water_Issue_Briefs/PDF/Water_Issue_Brief_9.pdf)
Figure 3. Improving water use efficiency

Figure 3.1. Alternative wetting and drying (AWD). The AWD technology enables the farmer to save up to 30% of water because the water volume is adjusted according to the actual needs of the plant. This is particularly helpful for farmers who rely on pumped irrigation because of the reduction in costs for fuel (Source: Phil Rice and IRRI)
Figure 3.2. Micro Drip irrigation. This is the small farmers version of the drip irrigation. The simple method includes a bucket that can carry 20 liters; and a set of drip lines (center). This can irrigate at least 20 m² of small garden. To cover more area, a larger bucket would be needed. This is helpful for small scale vegetable gardeners. (Source USDA FS of center and right pictures)

Figure 3.3. Other simple measures to make efficient use of water is land leveling to level high and low spots in the field. Also regularly repair dikes, remove weeds which compete in water consumption and establish windbreaks to reduce evaporation and evapo transpiration.
Figure 3.4. The Sorjan method which is practiced in parts of Indonesia and India involves the construction of raised bed and low areas. The low areas are devoted permanently to rice while the raised bed would for upland crops.
4.0 ENHANCING THE WATER HOLDING CAPACITY OF THE SOIL

4.1 RATIONALE FOR THE ACTION

Higher temperatures under climate change will increase evapo-transpiration of plants and evaporation from the soil. Limited and delayed rainfall in some areas including the occurrence of dry spells during the wet season is expected to affect crop performance.

Limiting evaporation through soil moisture retention will help improve crop yields, and therefore, successful crop production can be made possible. By ensuring soils can hold moisture for a longer period, the farmer can plant more crops in the same piece of land within a year.

Simple and inexpensive options for increasing soil moisture through soil moisture retention and enhanced infiltration may include techniques such as mulching, green manuring, intercropping, relay cropping and sequential cropping, and minimum or zero tillage.

4.2 RECOMMENDED PRACTICES

4.2.1 Increasing organic matter and keeping the soil covered

One strategy to improve the water holding capacity of the soil is to increase the organic matter content. Organic matter enables the soil to hold the water as well as soil nutrients near the root zone so that it can be utilized by the plant. To increase organic matter, one needs to incorporate organic material in the soil. This is done by applying compost and other natural fertilizers, intercropping and practicing mulching.

It is also important to keep the soil “covered” most of the time and protected from the direct head of the sun which induces high evaporation. The scorching sun also tends to kill beneficial soil micro organisms that help breakdown crop residues into organic matter. Mulching is the best way to keep the soil covered. Cover cropping with crawling leguminous crops would be another way.

The CCTAM # 1 on crops discusses the various steps involved to increase the organic matter of the soil as well the techniques of applying mulch.

4.2.2 Direct Seeded Mulch based cropping system

Another proven method is to avoid plowing the soil. Plowing exposes the soil to high evaporation. One way this is done is through the Direct Seeded Mulch Based cropping system, which is now being promoted by GoL and adopted by many farmers particularly in the northern upland provinces. The CTTAM # 1 on crops further discusses the steps involved.
4.2.3 Crops that can withstand low soil moisture

To complement the strategy of making the soil retain more moisture, it will also help if the farmer would raise crops that are short duration and do not require too much water especially if planned of the rice crop, CCTAM # 1 on crop production describes the various crop species that have the ability to do this.

The above measures are discussed in detail in CCTAM # 1 on crop production.

4.3 BENEFITS AND COSTS

The farmer would benefit from this practice by having a higher chance to successfully raise a second or even the third crop after wet season rice. The key costs involved are the increase in labor for incorporating and maintaining organic matter into the soil.

Practicing the direct seeded mulch based cropping system would involve the procurement of a hand-held mechanical seeder, the use of herbicide for the first few years of implementation and leguminous seeds for crop rotation.

4.4 APPLICABILITY IN IRAS PROJECT SITES

Practices that increase organic matter and cover the soil from the sun are all relevant to project sites. The DMC technology is generally recommended for upland conditions only.

4.5 COMPANION EXTENSION MATERIALS THAT COMES WITH THIS CCTAM

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| Systems                            |        | 13b24e0.10.3&g=1                                                     |
| Soil and Water Management Techniques| FAO    | http://www.fao.org/docrep/X5672E/x5672e03.htm                      |
| How to Save Water                  | PhilRice| http://www.pinoyrkb.com/main/resources/phlirice-machines/doc_details/375-how-to-save-water |
| Irrigation                         |        |                                                                      |
Figure 4. Enhancing soil water holding capacity

Figure 4.1. Water holding capacity of the soil. If soil has sufficient moisture after the wet season it can support a second crop, usually a short duration legume which can tolerate some possible moisture stress during the early part of the dry season (Source: Low-external Input Rice Production).
Figure 4.2. Organic matter in the soil. This is the key to increasing moisture content of the soil and make soil nutrients more readily available to the plant. Some simple ways to increase the organic matter content would be: Mulching with crop residues (left and center) and applying compost (right).

Figure 4.3. The Direct Seeded Mulch based cropping system involves zero tillage. The land is always covered either by rice/cereals or legumes which are rotated. Herbicides are needed for the first year though. To plant the seed a simple manual seeder may be used.
5.0 DEALING WITH FLOODED CONDITIONS – FYI ONLY

5.1 RATIONALE FOR THE ACTION
The reverse to drought is the flooded condition in some areas brought by intense rainfall. In some areas, the field can be flooded for 3 to 5 months. Both earthworks and agronomic solutions may be considered. The following are just examples of how other countries are doing it. They have not yet been tested in Lao PDR but are shared here for information purposes as input to possible action research.

5.2 RECOMMENDED PRACTICES

5.2.1 Mounds and Dikes system (example from Bangladesh Triple F model- for information only)
In Bangladesh communities in coastal areas apply what they refer to as the Triple F Model (Forest, Fruit, Fish). The area is protected by mangroves for protection against tide surges. The concept can also be applied in riverine systems.

This involves building 8 ditches and mounds in one hectare of land. The dike is 2 meters high; the ditch width at top is 6 m while the ditch depth at the bottom is 3 meters. Forest and fruit trees are planted on the mounds, while fish is raised in the ditch. The ditch is strengthened by planting grass on the dyke.

5.2.3 Floating Gardens

In areas where flooding is for very long periods, one possibility is to construct simple floating gardens such as those done in Bangladesh. The Bangladeshi case involves constructing a platform (10m x 5m or smaller) composed of water hyacinth, water creepers. Compost and dung is placed on top of the platform and vegetables are planted on them. This system allows the planting of vegetables all year round.

5.2.4 Agronomic practices

Agronomic practices deal with adjusting the timing of planting as well as land preparation and planting operations. Briefly these agronomic practices would include:

- Timing of planting; and
- Use of flood tolerant varieties (If the flooding regime is less than 15 days).
These are described under the CCTAM # 1 on crop production.

5.3 BENEFITS AND COSTS

Insufficient information that can help make a determination of the potential costs and benefits in Lao PDR.

5.4 APPLICABILITY IN IRAS PROJECT SITES

These need to be tested yet at site level.

5.5 COMPANION EXTENSION MATERIALS THAT COMES WITH THIS CCTAM

<table>
<thead>
<tr>
<th>Topic</th>
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<tr>
<td>SUPPLEMENTAL GLOBAL REFERENCES</td>
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<td>Sorjan: towards rice-based integrated cropping systems (Low-external Input Rice Production (LIRP): Technology Information Kit)</td>
<td>IIRR</td>
<td><a href="http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0fnl2.2--00-0---0-10-0---0-0direct-10---4-------0-11-1-11-en-50---20-about---00-0-1-00-0-4--------0-0-11-10-0utfZz-8-00&amp;a=d&amp;cl=CL3.33&amp;d=HASHd3b46cd4916b56b3547bcc.4.5">http://www.nzdl.org/gsdlmod?e=d-00000-00---off-0fnl2.2--00-0---0-10-0---0-0direct-10---4-------0-11-1-11-en-50---20-about---00-0-1-00-0-4--------0-0-11-10-0utfZz-8-00&amp;a=d&amp;cl=CL3.33&amp;d=HASHd3b46cd4916b56b3547bcc.4.5</a></td>
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</table>
Dealing with flooded conditions

Figure 5.1. In Bangladesh vegetables are grown in floating mounds of water lilies topped up with soil. A modification is being made in the Philippines where the soil is placed on platforms supported by bamboos.
6.0 SUSTAINING THE NATURAL WATER SUPPLY FOR THE COMMUNITY

6.1 RATIONALE FOR THE ACTION
Watersheds and the ecosystems in them are under great threat from climate change. These changes include changes in rainfall pattern, the frequency of extreme weather events, and increase incidence of fires among others. The ecosystem and the services they provide such as water and water management are usually affected. This is usually manifested in terms of landslides, flash floods and extensive drought. Water, especially the lack of it or the overabundance of it is the central issue.

As discussed earlier, there are three ways to conserve water – surface level (e.g. ponds), ground water, and soil moisture. For water to be available under situations of climate change, all three sources must be tapped.

Consider that the farm is just part of the bigger landscape, which may be the community watershed. A community watershed is the total area of land that drains eventually into a creek or a river. It is the scale of watershed that is important to the community. The community watershed is just a small part of a bigger basin.

Look at the distribution of water both on the farm and the landscape.

- **Surface water**: Part of the water infiltrates the soil. But most part is shed as water runoff which may start from the uppermost reaches. Surface runoff is also used for water impoundments in the form or rice paddies.

- **Ground water**: At the same time, consider also the increasing use of groundwater through wells supported by pumps. It is anticipated that there will be an increasing use of water pumped up from the ground. Without some form of regulation as in the earlier experience in other countries, the ground water could be used up. In other countries such as Bangladesh and India, the rapid depletion of groundwater resources has led to the occurrence of arsenic in the water.

- **Water in the soil**: From the above scenario, it is important to help the soil absorb more of the water, which can be done by forests or equivalent vegetation in the farm. The more water retained in the landscape, the higher amount of soil moisture in the water during the dry spell of the wet season and during the long dry season itself.

6.2 RECOMMENDED PRACTICES

Two sets of practice (mostly community level) are recommended – protecting the uppermost portions of the watershed (which supplies surface water) and enhancing the water supply from groundwater. The measures to improve water retention in the soil are the produce of farm level interventions. And these are mostly discussed in the earlier chapters as well as CCTAM # 1 on crop production.
6.2.1 Protecting the headwaters of the community watershed

First, manage water runoff in the steeper, headwaters portion of the community watershed is best protected by maintaining forest vegetation.

- **Fire Protection**: Forest cover in this area must be protected from destruction especially by community-based fire protection measures may be instituted. The publication entitled “Community-based fire management” provides guidance in facilitating a community process for fire protection.

- **Assisted Natural Regeneration**: If the area is already deforested and there are still remnants of some trees, the community may practice assisted natural regeneration or ANR. ANR involves in helping Mother Nature to regenerate the forest itself. This is accomplished by giving young seedlings of naturally occurring pioneer species the chance to grow and become big trees. Protect these young seedlings from fire, stray animals, and reduce competition from grass and weeds so that they can become big trees. This method involves less than 50% of the regular cost of conventional reforestation methods. The method for ANR is described in the publication of the US Forest Service entitled “Assisted natural regeneration.” It is also discussed in a power point presentation by FAO.

- **Regulating livestock**: Aside from fire, young tree seedlings for forest protection programs or on-farm tree production are vulnerable to destruction or consumption by grazing livestock. Seedlings need the livestock but we must keep the livestock away from the seedlings, what this means is that the young plants need the manure from the livestock as fertilizer but it must be protected from the grazing livestock. This is one important value of raising the fodder in the farm and keeping the animals within the premises of the farm. The ways to integrate livestock raising in the farm is described in CCTAM # 4 on livestock.

- **Protecting the waterways from pollution**: Protecting the community watershed is not only about ensuring adequate yields of water. It is also equally important to protect water quality. For example, the community must agree on ways to prevent indiscriminate disposal of polluting materials (insecticide bottles) into waterways. Land concessions that may contribute to the agricultural chemical pollution also need to involve in local dialogue.

6.2.2 Groundwater recharge to ensure sufficient and safe groundwater

The second action is encouraging groundwater recharges in areas where the use of groundwater pumping is prevalent and increasing. This involves the establishment of a network of gully checks, village ponds, and farm ponds which recharges water to aquifers. These structures lessen the velocity of water runoff and promote the infiltration of water into the soil. This action ensures that there is sufficient groundwater to provide for the needs of an increasing number of farmers who use water pumps.

Recharging of groundwater is important also to ensure safe water quality. In the central and southern flood plains of Lao PDR where there is a rapid increase of use of shallow tube wells, arsenic contamination is being reported. Drinking water containing or eating food with arsenic causes life threatening sickness.
The accepted theory is that overdrawing water from shallow water tables creates zones of aeration in clayey soil systems that contain naturally occurring soil chemicals that carry arsenic. Oxidation of these chemical compounds releases arsenic into the shallow aquifer. To prevent or minimize this from happening it has been recommended that shallow aquifers are sufficiently recharged (replenished with surface water).

What can be done to recharge aquifers and ensure continuing supply of groundwater for future generations?

- The most practical method, that have been tried successfully in several countries such as in India is to construct and maintain percolation ponds that recharge stored surface water back into the groundwater. Percolation refers to the infiltration of water into the subsurface and lower depths of the soil. All earthworks that store water are potential percolation ponds. Check dams, which are usually located in higher elevation, are ideal examples of percolation dams. Natural wetlands, natural depressions also serve as good recharge areas. Village ponds, farm ponds even rice paddies indirectly contribute to recharging watersheds. It may be noted at this point that these structures serve multiple objectives - to store surface water for future use, to minimize flash floods and to store water for the soil moisture and ground water.

- In communities where groundwater supply is becoming pronounced (as in India) they make community decisions to designate certain reservoirs for recharging purposes (not to be used for irrigation). Some regulation is also being tried out in the number of ground water wells. Their decisions have resulted in farms being able to maintain their crop yields with some slight increases in some.

6.3 BENEFITS AND COSTS
The benefits are increased resilience of the ecosystem and the farms within them, to the destructive effects of climate change. This would reflect in terms of:

- Reduced incidence of fires;
- Natural regeneration of forests;
- Observable increase in water infiltration;
- Reduced incidence of local landslides;
- More farmers able to plant a 2nd upland crop under rainfed conditions;
- Better managed village and farm ponds; and
- Sustained supply of safe, arsenic free, groundwater.

The costs are the related to the effort of leaders to bring people together (between farmers, between villages and between village and local authorities) to agree on common sets of actions and implement them. There are no huge costs involved in traditional reforestation programs.

6.4 APPLICABILITY IN IRAS PROJECT SITES
The above practices are all generally applicable in IRAS project sites. Headwater protection is particularly important in hilly upland communities while groundwater protection is needed in the low lying areas.
### 6.5 Companion Extension Materials That Comes with This CCTAM

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<thead>
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<tr>
<td>Community-Based Fire Management in Lao People’s Democratic Republic: Past, Present And Future</td>
<td>UCN</td>
<td><a href="http://www.fire.uni-freiburg.de/Manag/6-Lao.pdf">http://www.fire.uni-freiburg.de/Manag/6-Lao.pdf</a></td>
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<td>Community Based Fire Management (CBFIM)</td>
<td>FAO</td>
<td><a href="http://www.fao.org/docrep/015/i2495e/i2495e02.pdf">http://www.fao.org/docrep/015/i2495e/i2495e02.pdf</a></td>
</tr>
<tr>
<td>Improving water use in rainfed agriculture in the Greater Mekong Subregion</td>
<td>IWMI</td>
<td><a href="http://www.iwmi.cgiar.org/Publications/Other/pdf/Summary-Improving_water_use_in_rainfed_agriculture_in_the_greater_mekong_subregion.pdf">http://www.iwmi.cgiar.org/Publications/Other/pdf/Summary-Improving_water_use_in_rainfed_agriculture_in_the_greater_mekong_subregion.pdf</a></td>
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Figure 6. Protecting the community water supply

Figure 6.1. The farm is part of a bigger landscape such as the community watershed. It is important to plan interventions considering the situation of the bigger landscape (left). Stakeholders must be involved (center). The state of the headwaters or the upper most reaches of the watershed (left) would greatly influence the hydrology of the community watershed (right). Thus, to protect the community watershed, one needs to start with the protection of the headwaters and other sensitive features of the watershed such as gully formations.
Figure 6.2 Headwater protection may involve community based fire protection (a) and assisted natural regeneration or ANR (center and right). ANR involves giving a chance for young pioneer seedlings to grow into full size trees. ANR reduces the cost of reforestation by at least 50% because it does not need external planting materials.

Figure 6.3. To protect the community’s water supply we need to protect both the upper portions of the watershed and the water under the surface or groundwater (right and center). Unregulated use of groundwater because of high demand, could deplete water resources, cause salt intrusion or the release of poisonous arsenic. Thus, there is a need to understand the character of the local water table and on this basis undertake a plan of taking care of this resource. In some parts of Asia, communities recharge their depleted aquifers though percolation ponds and open ditches (right).
7.0 PHASING THE IMPLEMENTATION OF TECHNOLOGIES

The practices and technologies for climate change adaptation cited above are applicable in varying degrees in the IRAS project sites. However, location specific conditions at the district level may require that some technologies be immediately implemented, while others may be implemented at a later time. Such conditions would include the following:

- Relative exposure of communities to certain technologies;
- Level of skills, level of risk taking;
- Availability of planting materials and markets; and
- Some financial resources for procurement of materials or hiring supplemental labour.

The following criteria may be used to identify those technologies that can be done immediately (Year 1).

- Local communities already have some exposure to the technology;
- Do not require major changes in growing practices requiring new and relatively complex skills;
- Do not require a lot of time and money to acquire planting materials or equipment;
- Can provide immediate protection or adaptation to physical hazards e.g. surface runoff.

Based on these criteria, the following technologies can be implemented immediately while others can be done in succeeding years. However, for technologies falling under the second category, certain preparatory work needs to be done immediately.

Table 11. Proposed phasing of application of technologies.

<table>
<thead>
<tr>
<th>ACTIONS IN YEAR 1</th>
<th>ACTIONS IN SUCCEEDING YEARS</th>
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<tbody>
<tr>
<td><strong>Managing Surface runoff</strong></td>
<td>• Diversion canals in the upper portion of the farm</td>
</tr>
<tr>
<td>• Contour plowing</td>
<td>• Gully checks and soil traps</td>
</tr>
<tr>
<td>• Natural vegetative strips (NVS)</td>
<td>• Community level watershed and aquifer protection</td>
</tr>
<tr>
<td><strong>Farm Ponds and rainwater harvesting tanks</strong></td>
<td>• Introduce better community management of village ponds</td>
</tr>
<tr>
<td>• Improve design of farm ponds</td>
<td>• Alternative wetting and drying</td>
</tr>
<tr>
<td>• rainwater harvesting tanks</td>
<td>• The Sorjan method requires on site testing first</td>
</tr>
<tr>
<td><strong>Water use efficiency</strong></td>
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</tbody>
</table>
### Increase Water holding capacity of the soil (see also CCTAM #4 Crops)

- Application or compost and other organic matter
- Mulching

- Direct seeded, mulch based cropping system

### Dealing with flooded conditions

- Try out Submergence tolerant varieties

- The Mounds and Dikes system and the Floating garden need to be tested on site yet if applicable.

### Sustaining the natural supply for the community

- Identify and delineate the community watershed on the map and facilitate community discussion on issues and plans

- In pilot areas, conduct Assisted Natural Regeneration (ANR) including fire protection and weeding around pioneer seedlings

- Construction and maintenance of bodies of water that will help recharge aquifers (open ditch etc)

## KEY REFERENCES

- Consultations with PAFO, DAFO and selected farming communities in Savanakhet and Sayaboury

- Consultations with Department of Irrigation, Department of Water Management, NAFRI Centers

- Relevant literature from NAFRI and NAFES information base

- Asia Pacific Adaptation Network – literature


- Key IWMI Publications on Water storage


Key IRRI Publications on water use efficiency


Bureau of Soils and Water Management. PRIMER on Water Resources Management Technologies. Training and Information Dissemination Services
Glossary of Terms

Agronomic practices
Deals with adjusting the timing of planting as well as land preparation and planting operations.

Aquifer
A geological formation where all the void spaces are filled with water (saturated). The formation must be permeable enough to yield economic quantities of water.

Assisted Natural Regeneration (ANR)

Alternative Wetting and Drying (AWD)
A water-saving technology that lowland (paddy) rice farmers can apply to reduce their water use in irrigated fields. In AWD, irrigation water is applied to flood the field a certain number of days after the disappearance of ponded water. Hence, the field is alternately flooded and non-flooded. The number of days of non-flooded soil in AWD between irrigations can vary from 1 day to more than 10 days.

Bund
A low embankment, wider than a ridge, normally greater than 20 cm but less than 1 m, used to control runoff in irrigated lands.

Check Dam
A structure that is used to retard runoff velocity and some5mes trap sediments

Community watershed
Is the total area of land that drains eventually into a creek or a river

Contour Bunds
Bunds along the contour line with various grass or tress planted on the bunds

Contour Grass Strips
A sturdy grass like vetiver grass or napier grass on the hedgerow and pruned regularly

Dike
An embankment of earth and rock built to prevent floods or to hold irrigation water in for agricultural purposes.

Ditch
A system of earth canal established across flatlands with no shallow groundwater. It collects or harvests rainwater during rainy season for storage in the subsoils which is consequently used for dry season crops

Diversion Dam
A concrete or rockfill structure constructed across a channel of streams, creeks and small rivers of continuous and dependable flow to raise the water level. It allows diversion of water by gravity from the source to the adjoining farmlands.

Green Manure
A type of cover crop grown primarily to add nutrients and organic matter to the soil.
Groundwater Recharge
Inflow to a groundwater reservoir.

Groundwater
A subsurface water that occurs beneath a water table in soils and rocks, or in geological formations.

Gully
A deep ditch or channel cut in the earth by running water after a prolonged rainfall. Gullies increase the velocity of runoff water.

Hedgerows
A line of closely spaced shrubs and tree species, planted and trained to form a barrier or to mark the boundary of an area.

Irrigation
The artificial application of water to the land or soil.

Intercropping
The practice of growing two or more crops in proximity.

Minimum tillage
A tillage method that does not turn the soil over.

Mound
An artificial heap or pile, especially of earth, rocks, or sand.

Mulching
The application of organic residues to soil surface.

Natural Vegetative Strips (NVS)
Are narrow live barriers vegetated with naturally occurring grasses and herbs.

On-farm water management

Relay cropping
The planting of two or more annual crops with the second crop planted after the first crop has flowered or nearing its harvest.

Runoff
Surface water entering rivers, freshwater lakes, or reservoirs.

Soil water holding capacity

Soil erosion
The detachment and movement of soil or rock by water, wind, ice, or gravity.

Soil trenches
Are small holes (1 x 1 x 0.5 meters) dug one to two meters above a gully check dam.
Surface water
All water naturally open to the atmosphere, concerning rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries and wetlands.

Water runoff
Portion of total precipitation from a given area that appears in natural or artificial surface streams.

Watershed
The area that contributes water for impoundment, serves as a water collecting and natural storage facility.

Zero-tillage (No-tillage)
A way of growing crops from year to year without disturbing the soil through tillage.