Improved Water Management for Sustainable Mountain Agriculture: Jordan, Lebanon and Morocco
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Annual report for 2011 and plan of work for 2012

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Background

More than half the world’s population depends directly on mountain watersheds for water to grow food. Over the last three decades, these upland watersheds have come under increasing pressure. Degraded watersheds are a threat to the environment and to the livelihoods of rural communities, both upstream and downstream. Watershed degradation is a clear symptom of unsustainable development. Nowhere is the link between poverty and the environment more pronounced than in the fragile mountain ecosystems, where people and communities frequently overuse natural resources in their struggle for survival.

Most countries in West Asia and North Africa (WANA) have a semi-arid climate with unpredictable rainfall and recurrent droughts. These marginal environments have large rural populations that depend on rainfed farming. Most small-scale farmers, therefore, operate at subsistence level, minimizing the use of inputs in order to reduce the risk of loss in the event of drought. In recent years, rural areas throughout Lebanon, Morocco, and Jordan have seen changes in hydrology. Villagers complain that groundwater levels have fallen, springs and wetlands have dried up, and rivers no longer flow in the dry season. Moreover, reduced vegetation cover due to deforestation and overgrazing, and poor surface management of cultivated lands has led to reduced infiltration, increased runoff, evaporation and soil erosion, and a decline in groundwater recharge.

Water conservation and collection measures can significantly improve local farming systems. However, water harvesting in large lakes is hampered by various obstacles: high investments, private land ownership and high evaporation losses. A more effective alternative suggested by local communities and governments is water harvesting through small water reservoirs (< 10,000 m³) which can be filled by diverting rainfall runoff and snowmelt. Construction of small lakes, combined with introduction of (and farmer training on) water-efficient irrigation methods could help communities use scarce water more efficiently. These structures not only collect runoff water but also reduce water erosion – a severe problem in steep Mediterranean landscapes. They also reduce flood intensity, and improve soil-water storage and aquifer recharge.

Small farm reservoirs enable farmers in mountain areas to irrigate small plots downstream. In Lebanon, a number of hill lakes and farm reservoirs for agricultural use were constructed during the post-war period (1994-2000) in the Bek’a’ Valley. In Jordan, various small and medium water storage structures, such as stone walls and terraces, contour furrowing and the development of cisterns for on-farm irrigation, are being built in the highlands of Karak and Tafilah Governorates. In Morocco, in the Tafilalet and Haouz regions, the *khettaras*, which are traditional water delivery systems, were constructed near a water source often at the point where the alluvial soils meet the foothills of mountains to increase water availability for agricultural uses. In these countries, the construction of hill lakes and small farm reservoirs has stimulated increased investments in local small irrigation perimeters. However, it is important to quantify these benefits more accurately by studying the efficiency of different structures and their impacts on farming systems and rural livelihoods.

Rainfall in these areas is highly erratic both in space and time. Agricultural development is also constrained by numerous other factors (small landholdings, obsolete farming methods, lack of
infrastructure and institutional support), but the key limiting factor is water: erratic supplies during the cropping season, and shortage of irrigation water during the dry season. Improved water conservation practices will help sustain these fragile systems and enable communities to achieve self-resilience.

**Objectives of the project**

The overall goal of the project is to promote sustainable agricultural production, higher incomes and improved livelihoods of rural communities in mountain agro-ecosystems through better management of the scarce water resources. The project’s objectives are to introduce and promote adoption of optimal and integrated water, land, crop and livestock management techniques for sustainable increases in agricultural productivity and profitability as well as for ceasing land degradation in mountainous areas of Lebanon, Morocco, and Jordan.

**Target groups and countries**

The main target groups are: (i) smallholder farmers in the mountainous areas whose livelihoods depend on rainfed agriculture, (ii) individual and collective irrigators, (iii) rural communities in areas with scarce water resources, and (iv) national agricultural research and extension agencies in Jordan, Lebanon and Morocco.

**Expected Outputs**

1. Increased water availability (by at least 50% to farmers) for agriculture and promotion of indigenous as well as improved techniques for soil-water storage and micro-catchment water harvesting
2. Best-bet technological packages that improve agricultural productivity (increase of 35%), generate higher incomes (30% increase in farmer incomes) and better economic returns and livelihoods for small-scale farmers in mountain watersheds - improved irrigation technologies are expected to save large amounts of scarce water resources
3. Institutional and policy options (TIPOs) developed
4. Capacity building and knowledge management products - farmers in target communities, as well as national research and extension staff will be trained and will use generated knowledge to plan, implement, and manage integrated water and land conservation systems
2011 PROGRESS REPORTS
I. Mountain benchmark site of Jordan

Output 1: Increased water availability for agriculture and promotion of indigenous as well as improved techniques for soil-water storage and micro-catchment water harvesting

Activity 1: Selection of benchmark site (Completed)

Objective:

- To select a benchmark site that represents the mountainous area in Jordan

Methodology:

- Design selection criteria: the following criteria and actions were used to select a benchmark site:
  - Representative of the mountainous area
  - Associated with cooperative community with obvious poverty
  - Encompasses enough and diverse water resources,
  - Accessible
  - Located within the target area of the agricultural resources management project stage two (ARMPII)
- Revision and approval of the criteria after discussion among multidisciplinary team of researchers/engineers from NCARE, ARMPII, Universities and ICARDA.
- Field visit by the multi-disciplinary and multi-institutions group
- Discussion and selection of the benchmark site

Progress:

A multi-disciplinary team visited three sites one in the north in Ajloun governorate and two others in the south in Al-Karak governorate. After discussion and revision of the characteristics of visited sites, the team selected the watershed that includes Irak village (30 km south west of Karak city and 10 km west of Mutah town). The selected part of the watershed (sub-watershed) was in agreement with administrative boundaries (land tenure) of the Iraq village. This will facilitate the integration of socio-economic and biophysical aspects and enhance better land use planning.
The total area of the selected watershed is 29 km$^2$. The population of Irak village is about 4000 inhabitants. Fourteen percent of it depends solely on agricultural resources to provide their income; while most of the inhabitants practice one or more kinds of farming activities. The length of road network in the village is 18 km, 5.5 km is paved. The village has 25 springs, from which only 12 springs are active. There are 6.13 km cement canals and 2.15 km pipes that were constructed to convey water for agricultural use. A large area of the watershed is considered as pasture and forms about 32% of the total area. Urban area represents less than 1% (Table 1). Areas with high potential for agricultural productivity that are planted with field crops, vegetable and tree orchards occupy 38.2% of the watershed. There are more than 50 ha planted with old olive trees. An area of 236.1 ha has benefited from ARMPII project through activities related to soil conservation, water wells (135.2 ha) digging/rehabilitation and agricultural development (62.8 ha). The number of livestock in the village is about 7000 sheep and goats. There are two associations; one is a cooperative and another is for charity purpose.

Table (1): Area of land use classes according to scale of 1/250000 in the watershed of Irak village.

<table>
<thead>
<tr>
<th>Land use class</th>
<th>Area-km$^2$</th>
<th>Area%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pastures</td>
<td>9.2</td>
<td>32.0</td>
</tr>
<tr>
<td>Bare Rocks</td>
<td>7.3</td>
<td>25.4</td>
</tr>
<tr>
<td>Field Crops</td>
<td>6.8</td>
<td>23.7</td>
</tr>
<tr>
<td>Vegetables</td>
<td>2.4</td>
<td>8.3</td>
</tr>
<tr>
<td>Tree orchards</td>
<td>1.8</td>
<td>6.2</td>
</tr>
<tr>
<td>Bare Soil</td>
<td>1.1</td>
<td>4.0</td>
</tr>
<tr>
<td>Urban Fabric</td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Total Area</strong></td>
<td><strong>28.7</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

**Physiography:**

The topography of the project area is dominated by an undulating to rolling dissected plateau with slopes varying from 0 to more than 5%. Parent material is primarily colluviums derived from limestone and moderately deep stony to shallow with very common stones and boulders with >20% rock outcrop. Rainfall is between 280 to 350 mm. The altitude varies from 100 to 1240 m above sea level with high thermic temperature regime and xeric moisture regime.
Land capability:

There is a mixture of rangeland and rainfed annual crops and fruit trees. A small area receives irrigation water. The hill slopes are suitable for tree crops and the gently sloping colluvial foot slope for cereals with appropriate conservation measures. The broad valley bottoms are suitable for cereals and summer crops. Tree and horticultural crops are also successfully growing in the valley with ground water irrigation.

Soil type (USDA classification):

There are three subgroups of soil in the project area; a typic xerochrept (moderately deep to deep, described according to the Soil Survey Manual, Soil Survey Staff, 1992) in the valley, lithic xerochrept (shallow soil, less than 50cm ) in the areas with medium to steep slope and lithic xeronthent (very shallow soil, less than 25cm) in the steep slopes and upper area more than 70cm average depth with very high presence of gravels in the soil horizons at the broad valley bottom.

Activity 2: Watershed characterization and land suitability

Objective:

- Biophysical characterization of the watershed to identify proper land use

Methodology:

The actions taken can be summarized as follows:

- Collection of the required data: digital maps, soil, land use, topography, slope, rainfall, in addition to relevant surveyed sites with descriptive information.
- Conduction of an overlay analysis using GIS to identify the land mapping units.
- Matching of land use requirement with attributes of land mapping units
- Mapping of different potential land uses with the limitations of possible types of land use (suitability map using survey data, map A).
- Development of a map of potential land use using overlay of available layers (Moderate Resolution Imaging Spectroradiometer (MODIS)-Normalized Difference Vegetation Index (NDVI) using time series of 2000-2011, 250 m resolution, with slope, current land use, soil…. etc.) (map B).
- Overlaying of the two maps (A & B)
- Comparison of the existing land use to the potential suitability for different land uses
- Proposal of different alternatives and scenario for proper land use planning.
Progress:

A template for biophysical and socio-economic data collection was designed and data were collected and analyzed. Based on the information collected, constraints and problems of the watershed and community were identified, in collaboration with ARMPII as follows:

- No roads to reach some agricultural lands and horticultural fields
- Water shortage for irrigation of horticultural crops due to lack of maintenance of water canals, reservoirs and to a limited number of springs
- Problems of marketing agricultural products
- Low fruit tree productivity due to lack of extension supervision and advise
- Lack of associations in the agricultural sector.

Accordingly, the following potential land utilization types were identified:

- Rangelands with the implementation of water harvesting interventions
- Water harvesting on trees
- Runoff areas
- Areas suitable for surface irrigation
- Areas suitable for drip irrigation on trees
- Areas suitable for drip irrigation on vegetables
- Areas suitable for rainfed perennials crops.
- Areas suitable for rainfed annual crops.
- Areas that need re-forestation

Two approaches of land suitability were followed: a) the first one is based on the overlaying of secondary data from soil map, topography and precipitation. Then, suitability maps were generated as outputs, b) the second approach is based on field data collection and analysis. In this report, the first approach will be explained as a progress of this activity during the last six months.

The watershed at Irak village was divided into sub-watersheds. This was overlaid with administrative village boundaries (land tenure). The first approach (MAP A) was produced with overlay of available layers, soil map (scale 1:100,000), topography map derived from DEM of 30m resolution and rainfall isohyets), in addition to data available from ARMPII project. This approach responds to the need of IFAD development project (ARMPII). This approach will be compared with suitability maps derived using detailed field survey to make relevant recommendations.
First approach:

A qualitative approach to land evaluation was adopted in this study following principles and guidelines of FAO (1983). In the FAO framework, combinations of land characteristics relevant to specified uses are used as assessment factors reflecting limitations to land suitability and are called land qualities. The first step for land suitability is the definition of the land use types to be evaluated in the study area. These were defined taking into consideration the biophysical characteristics of the area and the problems and constraints raised by the local community. Maps and data required for suitability analysis were collected. These data include digital maps: soil, land use, topography, slope, rainfall, in addition to relevant surveyed sites with descriptive information. Overlay analysis using GIS has been carried out to identify the land mapping units. The output map contained 4004 polygons. Three soil mapping units exist in Iraq watershed. These mapping units were characterized using three representative profiles. Each profile has different physical and chemical data. Other missing data were derived using pedo-transfer functions and tables. For example available water holding capacity and infiltration rate (IR) were derived according to soil texture. Other chemical data were estimated from soil sampling survey and laboratory analysis.

Two sets of information required for the suitability analysis were used: biophysical data for land mapping units and the requirements and limitations of possible kinds of land use. These two sets of data were compared together (matching process). The requirements of each land utilization type are compared with land attributes derived from each land mapping, resulting in the land suitability classifications for each use.

According to the FAO framework, four suitability categories are distinguished:

- **S1**: Highly suitable: Land having no significant limitations to the sustained application of the defined use.
- **S2**: Moderately suitable: Land having limitations which will reduce production levels and / or increase costs, but which is physically and economically suitable for the defined use.
- **S3**: Marginally suitable: Land having limitations which will reduce production levels and / or costs that it is economically marginal for the defined use.
- **Ns**: Not suitable

The assessment of land suitability classification was based on the “simple limitation method.” Final suitability ratings are referred to in terms of severity (worst) of climatic constraints as well as soil, erosion hazard, rockiness/stoniness, and salinity/alkalinity constraints.

As a result of applying the land suitability analyses, nine land suitability maps for potential land uses with their limitations were developed as shown in figures (1-9).
The second approach (Map B), based on collected laboratory analysis and field observations, has already started. 240 field sites were surveyed in the watershed and surface soil samples from about 180 sites were collected and sent to NCARE laboratory for analyses for biophysical soil properties such as salinity (EC), texture, CaCO$_3$, potassium, nitrogen, phosphorus Mg, Na and organic matter contents, and acidity (PH). In addition to soil analysis, information in each point, such as; altitude, longitude, altitude, soil depth, soil structure, stones coverage percentage, land use, vegetation, erosion type, erosion severity, and drainage was collected.

Moreover, water samples were collected from 10 active springs in the watershed and analyzed in NCARE laboratory as shown in table 2.
Table 2: Water analysis of samples taken from active springs in Irak watershed (sampling date 1 September 2011).

<table>
<thead>
<tr>
<th>Spring name</th>
<th>pH</th>
<th>EC (do/m)</th>
<th>SAR</th>
<th>Total Cation meq/l</th>
<th>Water Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al-Maqbasyah</td>
<td>7.2</td>
<td>0.62</td>
<td>0.73</td>
<td>6.6</td>
<td>C2-S1</td>
</tr>
<tr>
<td>Al_Muqysel</td>
<td>7.2</td>
<td>0.56</td>
<td>0.53</td>
<td>6.32</td>
<td>C2-S1</td>
</tr>
<tr>
<td>A’ssi</td>
<td>7.0</td>
<td>0.60</td>
<td>0.56</td>
<td>6.42</td>
<td>C2-S1</td>
</tr>
<tr>
<td>Wadi Byda</td>
<td>7.1</td>
<td>0.55</td>
<td>0.59</td>
<td>6.15</td>
<td>C2-S1</td>
</tr>
<tr>
<td>A’wassi</td>
<td>7.3</td>
<td>0.82</td>
<td>1.17</td>
<td>9.48</td>
<td>C3-S1</td>
</tr>
<tr>
<td>AlQalah</td>
<td>7.1</td>
<td>0.68</td>
<td>0.69</td>
<td>6.96</td>
<td>C2-S1</td>
</tr>
<tr>
<td>Amood</td>
<td>7.1</td>
<td>0.88</td>
<td>0.99</td>
<td>9.71</td>
<td>C3-S1</td>
</tr>
<tr>
<td>Fawarah</td>
<td>6.9</td>
<td>1.90</td>
<td>1.99</td>
<td>22.04</td>
<td>C3-S1</td>
</tr>
<tr>
<td>Tireen</td>
<td>6.8</td>
<td>1.00</td>
<td>1.57</td>
<td>11.51</td>
<td>C3-S1</td>
</tr>
</tbody>
</table>

Satellite image with high resolution will be requested to use as a base map to detect actual land cover of watershed.

**Activity 3: Identification of a proper land use**

**Objective:**

- Integrate biophysical characterization with the socio-economic aspects to identify proper land use.

**Methodology:**

- Prepare a cadastral map and integrate it with the community development plan
- Integrate the cadastral map with land suitability maps within the sub watershed that is located within the village boundaries.
- Organize a meeting of the whole team to discuss and finalize land use plan for the whole village.

**Progress:**

Modern cadastral map was bought and will be used as a layer in the GIS study to identify land tenure and link it to land suitability.
Activity 4: Identification, selection and assessment of the performance of WH structures/soil and water conservation

Objective:

- Evaluate the performance of water harvesting structures / soil conservation interventions

Methodology:

- Identify the type and location of existing water harvesting / soil conservation interventions
- Design procedure for evaluation for each type of intervention
- Collect secondary and field data
- Assess the performance of water harvesting / soil conservation interventions

Progress:

Field visits to the site to identify the existing structure were conducted.

Activity 5: Evaluation of environmental and socio-economic impact of interventions

Objectives:

- Conduct a baseline study on land use and farming systems
- Assess the impacts of the project interventions on land cover, farming systems, rural livelihoods, and the environment (land and water resources)

Methodology:

- Define indicators of impact monitoring based on biophysical characterization and socio-economic interventions (economic values, yield, moisture content, erosion, organic matter, NDVI high resolution, biodiversity, sedimentation) at field and watershed levels.
- Collect baseline information for selected indicators, and selected representative sites.
- Design monitoring plan for four years
Progress:

Field survey was completed and necessary data, such as analyses of chemical and physical soil properties of 200 soil samples, have been processed. Also, soil depth and soil surface description was conducted. The socioeconomic survey was completed and the analysis of the data of the questionnaire, other indicators may be identified.

Description of land uses using NDVI:

In addition to surveys and soil characterization, the land uses are described using NDVI as summarized below and this will be used as baseline for the impact study of the interventions that will be introduced by the project.

1. A map MODIS NDVI mean value for time series 2000-2010, 250 m resolution is compared with the available land use map. The two maps are shown below.
2. Mean seasonal NDVI profiles of different land use classes are extracted and developed as shown below.
3. NDVI values, according to unsupervised ISODATA classification are classified (10 classes) as follows:

4. Mean seasonal NDVI profiles of the resulting vegetation classes (Unsupervised classification) are developed.
5. Supervised maps were produced by joining different classes from the unsupervised map.

A quick comparison between the 10 classes of the unsupervised and supervised NDVI maps and the Google land use, shows the 10 classes below:

- Class 1: bare rock
- Class 2: Shallow bare soil with minimum field crops area.
- Classes 3, 4, 5 (3 supervised) are mainly field crops
- Classes 6, 7, 8 (4 supervised) represent mixed land use (bare rocks and soil, Field crops, and trees)
- Classes 9, 10 (5, 6 supervised) have high concentration areas of trees.

From the comparison of profiles developed for land use classes (2), and for the vegetation classes (4), it is obvious that the profiles are different. This could be attributed to the following reasons:

- The low resolution of the NDVI images (250 m)
- The land use maps can be out of date and need to be updated

Nevertheless, the NDVI maps were able to provide the following information about area:
A. The density of vegetation covers (taking in consideration the mean NDVI value for 10 years).
B. The growth pattern of different vegetation classes

![Mean NDVI values (250 m) for time series 2000-2010](image_url)
C. The variation of land cover between different years, which can give an indication that the area is affected by drought and rainfall shortages.

- **Suggestion and future plans**: It is suggested to develop an up to date land use map from recent satellite (high resolution) image, validated with field investigation, with the assistance of the GIS team and field researchers.
- Develop NDVI maps from the high resolution image and correlate them to the currently available images to determine advantages and disadvantages of low resolution NDVI images.
- Develop correlation between new land use map and the low & high resolution NDVI images.

A series of ASTER images of resolution 15 meters will be sold to complete the evaluation.
Socio-economic indicators

Indicators of impact monitoring based on socio-economic interventions at field and watershed levels were identified. Baseline information for selected indicators and selected representative sites were collected. Furthermore, the socio-economic team collected the baseline information on the following major indicators:

- Number of active family members working in agriculture
- Percent of the contribution of family in agricultural activities
- Access to land: average cultivated area; harvested area of field crops
- Farming systems
- Average value of land (JD/dunum)
- Percent change/increase in cultivated area per crop
- Percent change/increase in production per crop
- Percent change in selling price per crop
- Herd size and composition
- Access to pastures (percent use), general village land, governmental land, rented fields
- Access to water: fresh water, supplemental irrigation for fruit trees and crops; water for livestock
- Percent change/increase in agricultural income and total income per household

Baseline survey:

Sample Design: The sample was drawn from Iraq village. A simple random sample of 100 farmers was collected from targeted area.

Scope of the Survey: The scope of the survey was determined in consultation with the project teams, and the ARMP II. The topics investigated were basic demographic characteristics; education, family, employment, wages and earnings; household economic activities; access to land; farming systems, land endowment, water harvesting techniques; soil and water conservation; household income; infrastructure and access to basic services.

Staff Training: Four enumerators conducted the survey. The enumerators were teamed and supervised for fieldwork. The survey was conducted during the period extended from September to October 2011. The enumerators were trained before conducting the survey by the project staff supported by a senior socio-economist.

Data collection: The data collection process was carried out through visits to the sampled household where several members of the household were interviewed by enumerators. The fieldwork was coordinated with ARMP II. The completed questionnaires were retrieved, edited, coded and computerized. The secondary data on programs and policies related to agriculture and mountain areas were collected from different sources, including: Ministry of Agriculture (MOA), department of Statistics (DOS), available literatures.
Data Coding and entry: A database using the Statistical Packages for Social Sciences (SPSS®) statistical software was built to facilitate data entry.

Data Processing and Analysis: After computerizing the collected data, the data processing and analysis will be carried out using Microsoft Excel® and the Statistical Packages for Social Sciences (SPSS®) statistical software. Completed questionnaires will be checked, edited and coded before the data was keyed in. The tabulations will be extracted after cleaning the data files. Measures of descriptive statistics will be calculated for the main variables studied in this study. Averages (arithmetic means), frequencies, percentages and histograms are used to explain and interpret the results of the survey.

Output 2: Best-bet technological packages that improve agricultural productivity, generate higher incomes and better economic returns and livelihoods for small-scale farmers in mountain watersheds

Activity 2: Study of crop water requirements using modeling and remote sensing techniques to conduct suitability analysis at watershed scale

Objective:
- Model water demand and supply using crop water and remote sensing techniques.

Methodology:

Data to be collected:
- Monthly or daily climatic data for study area (temperature, relative humidity, solar radiation, and wind speed)
- Temporal satellite images of study area (one each month, starting in October 2011) with a resolution of (10-30 m)
- Field spatial data about irrigated areas
- Land cover maps provided by the GIS unit

Calculations
- Computation of CWR of different crops using available data according to FAO-56 paper.
● Calculation of monthly NDVI values, using high resolution satellite images.
● Comparison between high resolution NDVI values, and those available at the Drought Monitoring Unit/ NCARE (MODIS 16 day – 250 m).
● Correlation between CWR and NDVI, to develop a model to predict CWR using Satellite images for the watershed.
● Study changes in the irrigated area by comparing long term record of NDVI 250 m data with recent images.

Progress:

● NDVI values were derived from MODIS 16 day – 250 m for the watershed.
● Daily climatic data for study area (temperature, relative humidity, solar radiation, and wind speed) were collected

Output 3: Institutional and policy options (TIPOs)

Activity 1: Existing policies of land and water management and use in the mountainous areas

Objective:

● To identify and describe the existing policies in the mountain areas.

Methodology:

● Review the literature to inventory existing policies and recent policy changes in the mountainous areas
● Collect secondary data about policies from the Ministry of Agriculture, Ministry of Water and Irrigation, Department of Statistics, Agricultural Resource Management Project-Phase II, the relevant projects and studies and any other available references.
● Determine technical, institutional and policy constraints affecting the adoption of improved technologies.
● Analyze local institutional arrangement for common resources use and management (water, land, forest,…etc)
Progress:

The literature review on the existing policies has been conducted (see summary in the annex).

Activity 2: Institutional set-ups and farmers associations of land and water management and use in the mountainous areas

Objectives:

- To assess the role of community organization and NGO in mediating common resources use.

Methodology:

- Participatory Rapid Rural Appraisal (PRRA) to assess the existing associations and evaluate their characteristics, capacities, organization, memberships, potential roles and abilities to handle collective water storage structures, interventions and activities of the Program.
- Develop recommendations for enhancing collective action for common resources use

Progress:

- A Participatory Rapid Rural Appraisal (PRRA) was prepared to assess the existing associations
- Data collected on existing association's characteristics, capacities, organization, memberships, potential roles and abilities to handle collective water storage structures, interventions and activities of the Program.

Output 4: Capacity building and knowledge management products

Progress:

Soil and Water Assessment Tool SWAT model training was conducted in Amman from 09 to 14 July, 2011 for one week. Trainees were 1 from ICARDA, 1 from Lebanon, 1 from Morocco and 6 from Jordan.
Annex: Summary of the review on policies

1.1 The Agricultural Policy Charter

The Agricultural Policy Charter prepared in August 1995 and constituted an integral part of overall policy for the development of the Jordanian society and economy, recognizing the interdependence and yet polarity of rural and urban development. The Policy Charter aims to achieve efficiency, sustainability and equity.

The agricultural policy aimed at achieving balanced rural development, a prerequisite to achieve that is a diversified agrarian structure with a variety of viable land and flock ownership modes, farm types and farm sizes, taking the interrelationships into consideration, which acknowledge that agricultural and rural development, as well as economic stability and growth are inseparable. In respect to property rights, the Government of Jordan seeks to achieve an agricultural sector with a varied structure of ownership of land and water resources as well as plant and animal stocks, and an agricultural sector that constitutes the basis for integrated socio-economic development of the rural areas.

1.1.1 Agricultural Land Tenure and Urban Expansion

Although acknowledging the principles of private ownership and private management of resources, private ownership cannot ignore the most important obligations in meeting actual interests of the entire society.

- Thus, land use for agricultural purposes should be environmentally sound and sustainable.
- Land fragmentation in rainfed agriculture zones must be halted and reversed by land consolidation.
- Land leasing and tenancy systems in the irrigated zones will have to be adjusted to better respond to actual social and technological requirements.
- Land tenure legislation for the Badia will have to address the problems of laying claim on ostensibly unoccupied land to stop overgrazing.
- As similar problems apply to forestry areas, a well-defined legislation will be needed to ensure that forestry policies are adequately implemented in future.
- Address the problems associated with the conversion of agricultural land for housing, industry and road development optimize benefits to the society and minimize the loss of productive agricultural land.
1.1.2 Regulatory Framework, Services and Information

The Government is committed to support the development of the agricultural sector through its institutions and activities by providing the policy framework and regulations as well as the needed information and services. The importance of these institutions and activities lies in their direct impact on the environment within which the farmers enterprises and agribusinesses operate, e.g. information and advisory services, production technology, regulatory marketing environment, availability of capital resources and inputs.

1.1.3 Optimal Utilization of the Water Resources

In order to achieve the objective of efficient and sustainable utilization of the available production resources, the Government will adopt the following policies and strategies.

- Policies aiming at maximizing the efficiency of water storage, conveyance, distribution and on-farm application
  - Developing suitable water storage structures both on- and off-farm in order to minimize evaporation and seepage losses; and
  - Converting from the open canal conveyance and distribution systems to closed pipe systems in the Jordan Valley and the Highlands;
  - Replacing existing surface basin or furrow irrigation by drip systems;
  - designing and implementing approved irrigation schemes, jointly between public and private sector;
  - The price of the publicly developed and managed water to reflect its importance and scarcity.

1.1.4 Land Consolidation

Land fragmentation is a serious obstacle for both, increasing agricultural productivity and natural resource management. It is a very difficult problem to be dealt with, politically and socially. However, consolidation of fragmented holdings will be encouraged and further land fragmentation must be averted. This will require comprehensive and prudent legislation in this respect. Such legislation will also stipulate minimum plot sizes, which would vary according to the production potential of the land. Also, land envisaged for development, with more than 75% of its surface covered with bedrock, could be subdivided for urban or industrial use.

1.1.5 Encouraging Soil and Water Conservation

Soil and water conservation will be targeted on land with slopes which are greater than eight percent. Although a great deal has been achieved through government supported program in certain areas, the remaining task is urgent and large in scope. Public sector involvement will be expanded, and increasing the pivotal role of the private sector will be encouraged, especially
through investing in the establishment and maintenance of fruit farming - with the aim of increasing the productivity of the land and at the same time protecting water and soil resources.

1.1.7 Rainfed Agriculture

The following policy objectives for rainfed agriculture will be pursued by the Jordanian Government:

- Increasing productivity of land, water and labor, in rainfed agricultural zones, through an efficient allocation of these resources, setting rational priorities in investment, technology transfer and research and ensuing sustainability and environmental compatibility of investments and production technologies.
- Encouraging public and private sector investment in rainfed agricultural areas.
- Promoting activities which result in equitable incomes to farm households in rainfed agricultural zones.
- Curbing the urbanization encroachment on the agricultural lands in the Highlands.
- Attaining continuity in the engagement of the public and private sectors in soil and water conservation.
- Setting rational priorities and guiding investments to improve rainfed agricultural productivity, taking into consideration the potential economic capabilities. This will result in improving resource use efficiency and distribution.
- Giving high priority for fruit production in the areas with annual rainfall of more than 400 mm and with slopes greater than 8 percent.
- Making available incentives to attract more private sector investments, in the light of future absence of government subsidies.
- Increasing public sector investment and services in research, extension and infrastructure.

The expansion of upland resources in olive and deciduous fruit and grape production will be encouraged, especially on land with a slope greater than eight percent, because the economic return for fruit production is higher than that for traditional annual rainfed crops and because the establishment of orchards and vineyards, with their walls and terraces is an effective means for soil and water conservation, in addition to the fact that increasing production of stone fruit will enhance the export of vegetables in certain markets requiring mixed shipments of fruit and vegetables.

To encourage the expansion in fruit production, research and technology transfer will focus on diversification and adaptability, marketing potentials, production practices, and reuse of properly treated waste water in supplementary irrigation.

As barley is more hardy and drought resistant than wheat, its production is out yielding wheat is many medium rainfall locations with annual averages of 200 to 300 mm.
Therefore, the Government will reconsider the cereals pricing system to achieve a rational balance between prices of wheat and barley. Through such policy, farmers will be encouraged to shift to mixed barley - livestock farming system. Cereal research and technology transfer will focus on specifically designated regions and production technologies or innovations which are in harmony, realizing that such areas enjoy high potentials and acceptance by target groups, and because of potential increases of up to 50 percent in yield, and of up to 25 percent in net incomes, however, also linked with a significant increase in production risks.

1.1.8 Forestry

From a merely economic point of view, forestry in Jordan is an entity which is mainly funded from the government budget. Nevertheless, it is recognized that this sector is an important part of the national patrimony, which is essential for the socio-economic and environmental stabilization of the country and for the well-being of its people. This sector is suffering from steady loss of public and private forest lands and other kinds of transgression, such as unorganized grazing, fire and others; also there is a shortage of adequate professional manpower and a shortage in financial resources to meet the actual requirements and a lack of forestry research. Realizing the importance of the role of forests and to overcome the problems, the forestry development policy will seek:

- Diversifying forestry activities to meet peoples' needs,
- Promoting sustainable land-use and consolidation of forest land.
- Discouraging practices that are environmentally unsound. A more careful and creative approach is needed, both in selecting land for conversion to agriculture, and in encouraging more sustainable use of the land, e.g. through agro forestry systems and other combinations of trees and crops on farm lands.

Thus, the major and immediate objectives of the forestry policy will be:

- Increasing the Area under Forest Cover:
- Improving the National Capability for Forestry Development
- Extending the Knowledge Base on Forest Resources and Environment:
- Improving the Management of Existing Forest Areas

1.2 Agricultural development strategies

Agricultural development strategies were included in the economic and social planning since the 1950s, where the 10-year program was drafted. The Council of Construction by cooperation with relevant ministries and governmental offices prepared the first development plan for the period (1963-1967), adjusted and reorganized in a new seven-year plan for (1964-1970). In 1971, the
National Council for Planning created and implemented three development plans for the periods (1972-1975), (1975-1980), and (1981-1985). These plans drew up a set of overall strategies for maintaining high economic growth rates, for increasing the GDP contribution of commodity-producing sectors and for balanced social and economic policies at both national and regional levels. Agricultural development strategies are a key element of the Plans. These strategies aim to increase agricultural production in both irrigated and rainfed areas, and to stem population migration from rural to urban areas by providing opportunities for small farmers and farm workers to raise their incomes to local levels.

Four consequent economic and social development plans prepared and implemented by the Ministry of Planning by cooperation with relevant ministries and covering the periods (1986-1990), (1993-1997), (1999-2003), and (2004-2006). These plans were drafted as a tool for a new developmental strategy, and designated a major role for the private sector, and confined the role of the government mostly to infrastructure-related projects that are essential for stimulating private investment (Ministry of Planning and International Cooperation, 1986-2004).

Furthermore, agricultural policies and strategies were developed for desertification control, rangeland rehabilitation, agricultural sector development and bio-diversity conservation. A special law for the protection of the environment was enacted (Law No.12 for 1995).

1.3 Social and Economic Development Plan

The Social and Economic Development Plan for agricultural sector was prepared in 1998. Major objectives of the Development Plan in the Agricultural Sector can be summarized as follows:

- Increase agricultural production to enhance self-dependency at a growth rate of 6% per year.
- Adopt a market-oriented production policy and expand production of commodities that Jordan enjoys competitive advantage and competent prices in their production at the regional and international levels.
- Improve national capacity in forest management and livestock development, afforest 150 thousand dumdums of lands registered as forests in the various governorates, and conserve the major water catchments.
- Expand plantation of barley in lieu of wheat in suitable areas, and transfer from the existing production system thereat to a system that combines barley plantation and livestock breeding.
- Control natural rangeland degradation, define their uses and reinstate their productivity; and consequently increase their contribution in fodder production.
1.3.1 Agricultural Development Constraints and Obstacles
Agricultural Development Constraints pertaining to scarce natural resources (arable lands and water); institutional, financial and technical constraints; and economical and social factors that have directly and indirectly affected - and are still affecting- the agricultural development. Most important constraints and obstacles relevant to property rights are:

- In-efficient legislation as regards the agricultural sector and their inability to be in harmony with the economic and social changes and with the agricultural development needs and requirements. In addition, some of these legislations are not being enforced.
- Weak farmer organizations and lack of suitable conditions for participation by the farmers and workers of the agricultural economical activities in decision and policy making.
- Limited arable lands, fragmented and small-sized holdings, and high dependency of production on rainfall
- Limited water resources that are available for agricultural purposes and their low quality

1.3.2 Means and Procedures in the Field of Policies, Legislations and Structural Reform

- Re-consider the duties of the various ministries and government institutions and define their responsibilities to ensure avoidance of overlapping and interaction and guarantee complementarily among them.
- Review the laws, regulations and instructions, and re-consider them to be in harmony with the local, regional and international social and economic changes and developments and with the adopted agricultural policy requirements. These include Agricultural Law No. 20 for 1973, Agricultural Council’s Law No. 24 for 1989, Agricultural Marketing Organization Law No. 15 for 1987, and National Center for Agricultural Research and Technology Transfer Law No. 42 for 1993 … etc.
- Attain optimum use of lands by issuing the necessary legislations to control urbanization encroachment onto arable lands, and representation of the Ministry of Agriculture in the Planning Council.
- Abstain from expanding the municipal and village council borders except after a thorough study approved by all concerned parties, including the Ministry of Agriculture, to serve optimum land uses.
- Set up suitable legislations and incentives to encourage integration of holdings and small plots.
- Establish the Plant and Animal Production Support and Enhancement Fund, pursuant to Article 197 of Agricultural Law No. 20 for 1973. Resources of the fund to consist of fines, confiscation and fees as stipulated in the law, in addition to prices of selling forest lands located within the municipal and village council planned borders and the percentage of fees collected by municipalities for marketing agricultural products within their boundaries.
Previous government agricultural development plans characterized by:

- Not comprehensive, lacked integration and the continuity needed to ensure stability and sustainability.
- Lack of a strategic approach for natural resource use to formulate a plan for resource management, including protection from misuse, and deterioration.
- Previous agricultural policies did not cover all aspects of development.
- Weak participation of the private sector in agricultural development planning, which is attributed to Government reluctance concerning private sector participation, and shortage of professional and agribusiness organizations in the private sector.
- Inadequate cooperation and coordination among government organizations involved in agricultural development, due to weak administrative and technical capacity and the absence of joint programs.
- Shortage in financial resources that prevent implementing some of the adopted policies and giving them the required strength.
- Inadequate organization and structure of the national agricultural information system, data provided by the Department of Statistics (DOS) differ from that of the Ministry of Agriculture, in addition to inaccuracy of data provided in different areas. This affects the ability of planners and decision makers to plan and make sound decisions.
- Ineffective agricultural research programs, methods of technology transfer, and agricultural extension and their impact on increasing production, improving produce quality and lowering costs of production.

1.4 National Strategy for Agricultural Development (NSAD)

In 2003 The National Strategy for Agricultural Development (NSAD) was drafted, including five sub-sector strategies. The NSAD aims to attain economic, social, and environmental objectives. The economic objectives emphasized the importance of providing a suitable environment for the private sector to effectively participate in agricultural development, increase investment in the agricultural sector, increase incomes of farmers and workers in the supporting agricultural activities, and improve the competitiveness of produce in quality and price in local and export markets. Social objectives include: limit migration from rural areas into urban areas, increase women participation in agricultural development, enhance the capabilities of farmers and agricultural workers, and develop living standards for rural people. Environmental objectives include: conserve land, water and natural vegetation and utilize them within their production capacity to ensure sustainable and long-term agricultural production, conserve Jordan’s biodiversity and utilize it in supporting agricultural development.
Historically, agricultural policies in Jordan have emphasized import substitution for key food commodities, and have adopted a range of input and output subsidy, tariff protection, price control, credit, and other incentive measures to stimulate domestic food production. The government also intervened massively to control purchase, marketing, and processing of strategic commodities and farm inputs, as well as supporting consumers through pricing policies.

Consequently, the agricultural sector started to witness declining growth rates during the late 1990s. This decline was attributed to the policy of trade liberalization adopted by the Government in 1994, and to the structural adjustment program of the agricultural sector (ASAL) in 2000. This trend increased with the implementation of measures related to Jordan’s accession to the WTO, where measures undertaken for the protection of local production from external competition where abolished, except for a small percentage of custom duties on the import of certain commodities.

1.5 Other Program and Policies

1.5.1 Economic Adjustment Programs

During 1988-1989 Jordan has experienced rigorous economic crisis, where deterioration of real GDP growth (-13.4%), double-digit inflation rate (25.7%), mounting budget deficit 20.8%, and sharp devaluation of the Jordanian Dinar. Both external shocks (sharp fall in grants and remarkable reduction in workers' remittances) and internal factors (expansion of public sector, intensive government subsidies, and inefficient tax system and trade regime) were caused such crisis.

The government adopted six International Monetary Fund (IMF)-supported programs during the period 1989-2004. The comprehensive economic adjustment programs emphasized both public and private sector involvement and partnership, and the growth of international and inter-regional trade, strategically managed within a framework of sustainable development. The first phase of the economic reform program resulted in an improvements achieved in a number of important areas have been satisfying. Real gross domestic product (GDP) grew from – 13.4 in 1989 to 7% in 2004. Foreign exchange reserves increased from $ million 130 in 1989 to about $ million 4824 in 2004. Moreover, inflation was reduced from 25.6 percent in 1989 to an average of 3.4 percent in 2004 (Jordan’s Economic Reforms, 2005). In the second phase, a five-year economic and social development plan for (1993-1997) was drafted as a tool for a new developmental strategy.

The plan designated a major role for the private sector, and confined the role of the government mostly to infrastructure-related projects that are essential for stimulating private investment. The third phase builds upon past accomplishments to further consolidate and expand the reform programs. These programs, underscored in Jordan's National Economic and Development Strategy, and add momentum to the legislative and regulatory reforms.
1.5.2 Trade liberalization

In recent years, Jordan has taken many steps at multinational, regional and bilateral levels to open its economy to international competition and expand trade. In addition to liberalizing trade in goods and services through its WTO membership, Jordan has made commitments on the WTO Agreements. In 1998, Jordan joined the Euro-Mediterranean Association Agreement, and is a member of the Arab Common Market Agreement and the Arab Free Trade Area Agreement of 1998. Jordan has entered into several bilateral agreements with other Arab countries and European trading partners to promote trade and investment and entered in 2000 into a Free Trade Agreement with the United States. Memberships in these agreements illustrate the changes that have occurred over half a decade. The agreements stipulate that member countries must reduce trade-distorting policies in agriculture such as domestic support programs.

1.5.3 Import Policies

Historically, Jordan's import regime was restrictive and characterized by high tariff and non-tariff barriers. Since late 1989, there has been a notable change in the direction of trade liberalization through gradual reduction of tariff and non-tariff import restrictions. In 1995, new import policies were set to eliminate import bans on all food items, and at the same time established a new tariff system in which importers have to pay a tariff rate of 30 percent of the value of products, plus 20 percent surcharges and taxes. Onions, garlic, potatoes, dried legumes, red meat, and animal feed are exempted from tariffs and surcharges. Jordan joined the World Trade Organization (WTO) in 2000, and as a result had to lower its weighted average of tariff to 12 percent over a period of ten years in equal annual cuts. All its non-tariff restrictions are converted to tariff based duties.

1.5.4 Export Policies

Traders of agricultural products are allowed to export without restrictions; all that is needed to engage in export activity is a certificate of registration of the business enterprise. In addition, Jordan has adopted an export promotion plan since 1989 with the aim of reducing the anti-export bias, increasing manufacturing exports, diversifying economic activity, and attracting more foreign investment. Several export incentives were introduced. The main incentive schemes are: duty drawback systems, duty exemption of production inputs, export credit guarantee, pre-shipment-rediscoun ting, and encouraging exporters to participate in national, regional and international trade fairs.
References


II. Mountain benchmark site of Lebanon

Output 1: Increased water availability for agriculture and promotion of indigenous as well as improved techniques for soil-water storage and micro-catchment water harvesting

Activity 1: Site selection

Objective:

- Selection of the benchmark site and delineation of the watershed borders

Methodology:

Site selection was based on criteria, visits to potential sites and discussions among members from the different partners (LARI, Green Plan, Ministry of Agriculture, IFAD Project and ICARDA). The main criteria were: representativeness of the mountainous agro-ecosystems; limited availability, of water resources; slopes which are the characteristics of mountainous areas; level of poverty; presence of the communities using the natural resources in the area; presence of IFAD-funded development projects and accessibility to the site.

Progress:

A project area called Marjhine was chosen in the northern part of the Mount Lebanon chains. Marjhine is mountainous area with poor farmer community. It is also a potential site for the implementation of the IFAD/HASAD project.

Activity 2: Site characterization

Objectives:

- Biophysical and socioeconomic characterization
Methodology:

- Conduct a Rapid Rural Appraisal
- Develop a household detailed questionnaire
- Collect the data using the questionnaire
- Collect data on soil, climate, topography, land cover, water resources, etc…
- Conduct the sedimentation monitoring and measurements

Progress:

1. Biophysical characteristics

Location and geographic boundaries:

- Marjhine is a depression area located at the northern part of Lebanon with a surface area of about 28 km² (Fig. 1). It is located 60 km away from the closest city called Hermel at the northern part of the Bekaa Valley. The site is situated within the municipal boundaries of the City of Hermel. Unlike the Hermel City which is located in the Orontes River Watershed (Assi River), Marjhine is part of a neighboring watershed called Charbine Basin (Fig. 1). Charbine Basin extends from Marjhine toward the north-eastern international border between Lebanon and Syria. The entire basin drains into Syria while Marjhine depression has a karst-type water outlet and it is still unclear where the swallowed water goes (karistic water outlet of the depression). The watercourse of the depression is completely closed and enters directly underground in a karistic phenomenon. The depression is along the major fault (Yammouneh fault) that crosses Mount Lebanon (western mountain chain of the country). At the northern segment of the fault, “pull-apart” basins stretches in depressions such as Marjhine (Ata and Yan, 2011).

Geomorphology:

- As a depression, Marjhine topography is a plain surface surrounded by mountains (Fig 2a). The lowest altitude in the plain is 1700 m. Therefore, Marjhine has the characteristics of mountainous climatic conditions. Agriculture is being practiced within the plain and on the piedmont. The depression has a north to south length of about 10 km and a west to east width of about 4 km. The average slope is 11-13%. At the middle of Marjhine depression, the plain has slope gradients of 0-8% with limited portion of gradual slopes (8-15%) (Fig 2b). The piedmont slope ranges between 15 and 30% which increase the potential for constructing terraces. Slope gradients of above 30% are very limited across the project area.
Figure 1. Location of Marjhine depression at the north of Mount Lebanon and Marjhine depression inside the Charbine Basin that drains to Syria.

Figure 2. a. Elevation of Marjhine. b. Slope gradient of Majhine.
Precipitation and temperature:

- Annual precipitation in the Marjhine area ranges between 900 and 1200 mm (Fig 3a) (Plassard, 1971). Although the area is characterized by a considerable amount of rainfall, crops still suffer drought in summer periods because the rainfall is concentrated in a short winter period only (November through April).
- The mountainous climatic conditions of Marjhine cause the presence of a shorter crop season when compared to lower elevation agricultural lands. Crops are often subjected to frost damage during midsummer to early fall.
- Winter cereal crops are cultivated during early fall and harvested later than lower altitudes agricultural lands of Lebanon. Low temperatures in winter period are followed by colder and wetter spring that lengthens the wheat productive season.
- Measured records of rainfall and temperature at the depression do not exist. The project team plans to install an automated weather station at the project site.
- Since 2009, at an area called Ehden located at the south west of Marjhine, the lowest temperature recorded was -6.5°C while the highest has reached 33°C.

Figure 3. (a) Precipitation and (b) geological stratigraphy of Marjhine.
**Geology:**

- The stratigraphy and tectonic of the area is generally a depression closed by mountains within the Mount Lebanon chain. Marjhine is located at the regional fault called “Yammounah fault” related to the rift system of the Dead Sea (Fig 3b). The geology of the area is characterized by the predominance of carbonate rocks, with a special emphasis on limestone and dolomite. The rock sequence of the exposed rocks starts from Middle Jurassic to the west of the plain until Quaternary deposits at the plain surface. Marjhine is a subsided area due to the faulting and uplifting of the existing rocks. The depression is filled by thick sequence of alluvial and colluvial deposits with an average depth of about 30m. The stratigraphy starts from the upper Jurassic to Cenomanian (Fig 4a). Rock structures are intensive in the area of concern due to the impact of Yammounah fault, which is an active fault that caused the appearance of secondary faults and fracture systems in the area (Fig 4b). Therefore, many aspects of mass movement occur and making many parts of the area unstable (landslides, colluvial drifts, rock crumbling, etc). Folded structure exists at different scales and among different lithologies.

![Diagram of stratigraphy and faulting in Marjhine area](image)

Figure 4. (a) Stratigraphy and (b) faulting in the Marjhine area.
Soil characteristics:

- The soil of Marjhine is of alluviums and colluviums characteristics mainly at the plain areas (Fig 5a). Landslides and colluviums are mainly found to the west of the project area. Precipitation has considerably affected the soil formation through sedimentation and soil erosion. The lower plains have received for ages the eroded soils of the surrounding mountains. Yellow mountain soils and red soils are soils of the elevated areas. The plain was also affected by periods of flooding and swamp like lands and this might be due to the low infiltration rate of the fine-textured soils that predominate in the site. A potential future action to alleviate the flooding problem would be the installation of drainage enhancement structures along the agricultural parcels.
- On the other hand, it appears that most of the drilled wells face the problem of sandy soils at the deep layers. This deep sandy soil layers causes the loss of water pumps and pipes inside the wells because of the unstable characteristics of deep soil horizons. Few shallow soil samples were gathered throughout the plain.

Soil erosion:

- Marjhine area has undergone forest cutting and overgrazing for ages. Signs of gully soil erosions were found at the surrounding mountains. Abundant terraces are also present at the piedmont. The soil erosion risk map shows approx. 70% of the area as having low risk to soil erosion (Fig 5b), the area of landslides has the highest soil water erosion risk. It can be expected that the soil erosion increase with continuous land degradation and the current climatic changes especially the phenomenon of torrential rains.

Figure 5. (a) Soil map and (b) soil erosion risk map (Darwish et al., 2006) of the area of Marjhine.
Hydrology, water sources and land use characteristics:

- There is a major intermittent watercourse in the area, which carries considerable amount of water during the wet season and the subsequent snow melting period in spring time. Rainwater forms natural water-logged temporary ponds within the valley plains. There are many channeling systems constructed to divert water during summer time into several agricultural lands in the region but they require rehabilitation. There is a major contribution from snow melt in recharging surface and groundwater. Marjhine is annually covered by snow, where the snow depth may reach 3m in some instances. There are number of karstic (along conduits) and fault springs in the area with a flow of less than 1 m$^3$/s (Fig 6a). The existence of high fractured rocks permits easy recharge of melted snow into deep ground. The infiltration was estimated at 35-40% of the precipitated water.

- Marjhine has an important portion of land occupation as grasslands, followed by field crops (13.8%) and fruit trees (Figure 6b).
2. Socioeconomic characterization

- A field survey sheet was prepared and farmers at the area were surveyed for their cropping patterns and important agricultural practices. Farmers’ feedbacks were listed to ascertain the problems they face. According to the survey, farmers require more knowledge of new agricultural practices. Farmers use furrow and basin irrigation with limited use of sprinkler and/or drip irrigation. Irrigation scheduling is not well practiced irrespective of the irrigation technique used. New varieties are also required that resist the mountainous climatic conditions for both field crops and fruit trees. Water shortage happens in summer peak periods. It also appeared that frost damage in late growing season is frequent and on my crops (potato, summer vegetable, etc.). Winter cereals are cultivated with only one variety because farmers do not have the access to other mountainous cultivars.
- The gathered field survey data are still under analysis and investigation, the final result will be shown in the next report.

Activity 3: Implementation of proper on-farm water harvesting techniques (micro techniques) and identifying potential locations to intervene on the watershed scale (macro techniques)

Objectives:

- Development of maps of potential water harvesting and soil conservation systems/techniques for the sub-watershed and the watershed using GIS

Methodology:

- Establish biophysical criteria on rainfall and soil characteristics, topography and land cover
- Collect data on these parameters
- Use GIS to draw maps
- Develop GIS modeling for water harvesting on the watershed scale

Progress:

GIS data are gathered for the watershed scale (see Activity 2 of output 1) which will allow locating potential areas for implementing water harvesting techniques on the macro and micro scale
Activity 4: Calibrations and validation of SWAT model

Objectives:

- Investigate the actual site environmental situation
- Modeling the environmental and socioeconomic impact of introducing water harvesting/soil conservation systems/technologies
- Define indicators of impact monitoring based on biophysical characterization and socio-economic interventions (economic values, yield, moisture content, erosion, organic matter, NDVI high resolution, biodiversity, sedimentation) at field and watershed levels
- Collect baseline information for selected indicators, and selected representative sites.
- Design monitoring plan for four years
- Run SWAT model.

Progress:

Field visits and a workshop were carried out with the ICARDA specialists in order to build scenarios for using SWAT or other potential models for watershed managements; the area was divided between macro and micro scale which will allow to work on watershed modeling and on crop modeling size.

Output 2: Best-bet technological packages that improve agricultural productivity, generate higher incomes and better economic returns and livelihoods for small-scale farmers in mountain watersheds

Activity 1: Introduction of new cropping systems and fodders under water harvesting/soil conservation techniques

Objectives:

- Improvement of crop and animal productivity, optimization of land productivity and usage, crop diversification, pasture rehabilitation and controlled grazing

Methodology and progress:

- Outline and design rangeland field trials (pasture seeds) (under establishments)
• Outline and design rangeland demonstration plots (shrubs) (under establishments)
• Intercropping under fruit trees: A key farmer Mr. Hussein Ali Nasser Eddine was contacted in purpose of installation of alfalfa fodder crop under its fruit trees after application of sub-surface water irrigation techniques. Three forage companies were also contacted in purpose of delivery of a winter cold tolerant seeds.

Activity 2: Monitoring sediment and water quality at one of the main tributaries

Objective:

• Investigating water quality and sedimentation
• Examining soil water erosion

Methodology:

• Apply GIS analysis in order to extract the suitable tributary for the establishment of a gauging station. The suitability criteria will be chosen according to the length of the drainage system and the size of the area that is drained. Land cover will also be analyzed such as percent of forest area, bare rocks, etc;
• Construct a gauging station on one of the main tributaries that lead to Marjhine depression or sub-watershed. The station will measure water flow and water quality (sediments);
• Install erosion monitoring pins in different places along the tributary area. Settling basins will also be established;
• Collect water samples in late fall, 2011 (November – December, 2011), spring (May, 2012) and summer 2012. Water chemical properties as well as total coliforms will be analysis at LARI laboratory;
• Collect climatic data using a weather station that will be installed at the sub-watershed. The weather will include all necessary parameters for the computation of ET0 (for other purposes and activities).

Progress:

Location for installation of the equipment for monitoring purposes has been identified and will be installed on the main tributary that fills the water harvesting reservoirs. The required equipment is under study for purchasing them. Different companies have been contacted for quotations on different instruments.
Activity 6: Supplemental irrigation of wheat

Objective:

- Introduce improved and adapted varieties of wheat under supplemental irrigation

Methodology:

- Demonstration trials with improved varieties of wheat will be compared to the farmers’ crop and irrigation management practiced in the area
- Demonstration trial on seed rates of wheat

Progress:

- An area of 10 ha was cultivated with three different wheat cultivars (planted on 17 October 2011) and the first irrigation was performed in late October 2011.
- Different seed rates were also practiced on Salamouni wheat cv. to improve productivity by unit of land area.

Output 3: Institutional and policy options (TIPOs)

Activity 1: Analyze local institutional for common resource used management (Water, rangeland, forest, ...)

Objective:

- Determine the effects of property rights & institutional arrangements on land and water use

Methodology:

- Review and analyze the existing information
- Interview and discuss with the stakeholders
Progress:

We are gathering information on local institutions concerning property rights and the work will continue for the next year. An association was established at the project area which will work on water allocations.

Activity 2: Policies that affect mountain regions

Objectives:

- Description of existing and recommendation of alternative policies for Mountains development

Methodology:

- A review and interview of policy makers

Progress:

A review on existing policies concerning the development of Mountains has been conducted.

Output 4: Capacity building

Progress:

Training on the application of SWAT model
III. Mountain benchmark site of Morocco

Output 1: Increased water availability for agriculture and promotion of indigenous as well as improved techniques for soil-water storage and micro-catchment water harvesting

Activity 1: Site selection and preliminary characterization

Objective:

- Delineate the border and select the benchmark site.

Methodology:
The selection of the site was based on criteria and visits to potential sites. The criteria were developed and agreed upon during a meeting that was conducted by INRA-Morocco team, representatives from extension services and IFAD development project in Boulmane and the Ministry of Agriculture. The criteria used are: representativeness of the mountainous agro-ecosystems; limited availability of water resources; slopes which are the characteristics of mountainous areas; level of poverty; presence of the communities using the natural resources in the area; presence of IFAD-funded development projects and accessibility to the site. The meeting was followed by a visit to three potential sites (one in Guigou and 2 others in Boulmane area).

Progress:
The site of Talzemt in Boulmane area was selected.

Activity 2: Socioeconomic and bio-physical characterization of the watershed
2.1: Preliminary socio-economic characterization of the site:

Objective:

- Describe and identify the socio-economic characteristics of the community of Talzemt

Methodology:

Secondary data were collected and a household survey was conducted. The detailed analysis of survey of farmers located in different villages of the community is in progress.

The main source of available information on the community is the result of the 1994 and 2004 censuses.

Progress:

A participatory workshop where the farmers were involved showed that, despite the demographic dynamics of the rural municipality, the community is characterized by a high unemployment rate and the tendency of people to leave the town to look for other jobs opportunities; and this resulted in a decrease in population. Moreover, the proportion of people achieving a higher educational level is extremely low due to the difficulty to access education. Even access to primary education is difficult in some villages.

The workshop identified local actors and their roles, relationships between stakeholders and the identification of the actors on the local dynamics of development. The roles of the key actors are defined by the participants as shown in the list below:

- Representatives of local authorities (Sheikh, Mokaddem and local representatives of the Ministry of Interior based Immouzzer Marmoucha) are in charge of organization and security.
- Rural Municipality: Linking the administration with the citizens. Among the 13 members of the Municipal Council, 6 have a university degree.
- Elected representatives in local institutions: Representatives of the population
- Local antennas of various administrations (education, health, post office, equipment): training, infrastructure and services
- Local associations (agricultural): Organization of people and farmers. These very recent associations were created between 2004 and 2009 and they are sometimes led by local authorities.
- Cooperatives: Improving the production, marketing and organization of farmers. The efficiency of these cooperatives is low because of various reasons, such as conflicts of interest, lack of support from the administration, non-compliance with operating rules.
INRA Meknes is trying to help the members of these cooperatives. Two actions have been conducted in the year 2011. One is on providing support to grow apples and improve irrigation practices, the other aims to introduce cattle farming for meat initiated by an immigrant.

Venn diagram of the actors of the territory of the rural community of Talzemt is presented below:

The rural municipality as an institutional actor and local authorities are driving the dynamics of development in the municipality of Talzemt. It should be noted that the role of associations and cooperatives is very low. This is probably related to the recent creation of these organizations. The frequent lack of education of the population may also explain a certain passivity of the population. The relative isolation reinforces the passivity and the inhabitants have little connection with the CT (local extension services). The nearest CT is located at a distance of 80km from the community. Similarly, supply retailers are located far from Talzemt. The technical supervision, the confrontation with new ideas and the sharing experiences are limited.

Despite the fact that there are limited opportunities for investment collectively, we think that the municipality has some capacity to invest if we take into consideration its budget for the past years (Table 1).

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<thead>
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<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue (MAD)</td>
<td>6 477 057,00</td>
<td>11 204 164,00</td>
<td>12 424 681,00</td>
</tr>
<tr>
<td>Expenditures (MAD)</td>
<td>2 525 133,00</td>
<td>4 928 302,00</td>
<td>3 760 062,00</td>
</tr>
<tr>
<td>Excess (MAD)</td>
<td>3 951 924,00</td>
<td>6 275 862,00</td>
<td>8 664 619,00</td>
</tr>
</tbody>
</table>

The individual investment opportunities are usually very limited for the following reasons:

- Small size of the farms;
- Land use plan: a few lands "Melk" (private property) are owned by one person who can invest in Agricultural production. Most of lands are collectively owned; so this does not favor investment;
- Low production: Most of the income earned comes from sheep production, especially before the feast of sacrifice, and the sale of fruit trees products. Therefore the incomes from agriculture come only at certain times of the year. Most of the other agricultural products are used for home and farm consumption (especially food and fodder).
Table 2: Flow of local agricultural products

<table>
<thead>
<tr>
<th>Flows to the domestic market</th>
</tr>
</thead>
<tbody>
<tr>
<td>output</td>
</tr>
<tr>
<td>Apples, cherries, potatoes, Sheep</td>
</tr>
<tr>
<td>Sale of livestock, particularly sheep in the souks of Immouzer Marmoucha, Missour, Guigou and during the feast of sacrifice.</td>
</tr>
</tbody>
</table>

The sectors of handicrafts and tourism are not yet structured to provide an input of money.

Institutional credit agencies (banks) are almost absent. Only an association of micro-credit called, “Amana” may grant micro-credits from 5000 to 10000 MAD for over 18 months. The association operates from Immouzzer Marmoucha. The diagram below shows the main socio-economic constraints in Talzemt community.
Small farms

Low capacity for innovation and investment

Legal status of land: collectively owned land

Low cash flow

Limited credit available to small amounts

Low level of education

Low technical training, support centres are far from farmers

Limited use of a collective organization (cooperative ...)

In order to overcome the individual weaknesses

Low investment capacity of the farms
2.2. Agronomic diagnosis of the site of Talzemt:

Objective:

- To describe the existing production systems and identify their potentialities and constraints

Methodology:

A questionnaire was developed and validated by a multi-disciplinary team in different meetings at INRA-Meknes. The team visited the site and conducted a detailed survey of farms. The analysis of the collected information is in progress. The preliminary results are presented below.

1. Structure of farms

The farms are small and 98% of them have less than 5 ha and more than 80% of the land is collectively used. Land use in Talzemt is presented in the chart 1. The rangeland represents 37% of the area, whereas the cropped part is 19% from which 18% is under rainfed farming and only 1% is irrigated (261 ha).

Chart 1: Land use in Talzemt.

2. Main productions

The crops grown in Talzemet (Chart 2) are cereals, legumes, forages, vegetables, fruit trees. However, cereals are the most dominant (3512 ha), followed by fallow (860 ha).
Chart 2: Main crops grown in Tazemt.

Table 3: Areas of the main crops in Talzemt.

<table>
<thead>
<tr>
<th>crops</th>
<th>cereals</th>
<th>legume</th>
<th>forrage</th>
<th>vegetable</th>
<th>fruit trees</th>
<th>fallow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>3512 ha</td>
<td>30 ha</td>
<td>20 ha</td>
<td>30 ha</td>
<td>272 ha</td>
<td>860 ha</td>
</tr>
</tbody>
</table>

3. Production system in rainfed areas

In this system, grain crops (cereals) are dominant. The production of these non-irrigated crops is low and primarily used for household consumption. The areas (Chart 3) of barley, durum wheat, bread wheat and corn are 57%, 29%, 11% and 3%, respectively. This shows the importance of barley as a feed and food.
Since the climate risk in the area is high, the purchase of inputs is strictly limited. Certified seeds are rarely used and many farmers rely on seeds produced from their own or neighbors’ previous harvests. No mineral fertilizers are purchased and only the manure produced on farm is used. The most rotations practiced by farmers are: wheat-barley, wheat-fallow or barley-barley.

Tillage is often limited to covering the seeds by one plow in spring. Weeding is usually manual, and weeds are used as feed for livestock.

4. Crop production and cropping system in irrigated areas

Products of irrigated fruit trees and vegetables are consumed directly by the farm members; whereas, production of potatoes is for sale. Under irrigated conditions, the relatively big farmers use certified seeds and apply mineral fertilizers and chemical herbicides to cereals and forage crops.

The products that are sold in the market are, in order of importance, potato, onion, turnip, carrot, beans and peas.

The main fruit trees grown are apple and almond. These trees were introduced, as part of a project called "PMVB" (Projects targeting the improvement of agricultural production in the rainfed areas).

A survey conducted with fruit growing farmers demonstrates the specificity of these farms (table 4).
Table 4: Some characteristics of the farms producing fruits.

<table>
<thead>
<tr>
<th></th>
<th>Number of farm surveyed</th>
<th>average agricultural area per farm</th>
<th>Irrigated agricultural area per farm</th>
<th>number of parcels per farm</th>
<th>Average parcel size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>15</td>
<td>17,73 ha</td>
<td>4,23 ha</td>
<td>7,73</td>
<td>2,3 ha</td>
</tr>
<tr>
<td>Almond</td>
<td>7</td>
<td>16,57 ha</td>
<td>1,71 ha</td>
<td>16</td>
<td>1,0 ha</td>
</tr>
</tbody>
</table>

As the table shows, the size of the farms that produce fruits is well above the local average. The fields are also less fragmented, especially in the case of apple trees growers. For the almond trees, there is a difference between the old orchards that were often installed during the project PMVB on very small plots and orchards that are newer and larger in size. The possibility of getting income from these crops encourages farmers to invest in inputs: fertilizers, pesticides. However a number of technical errors are observed:

- Planting densities are too high, especially for the almond
- There is little replacement of trees within apple orchards
- Pruning of apple trees is practiced by only 2 of the 25 producers, resulting in a decrease in size and alternating production
- The supply of fertilizers made on apple does not respect the balance between the three elements N, P, K: for a unit of nitrogen N, it is necessary to provide 0.5 units of P, 1.25 units K and 0.8 unit of Ca as shown in the table below obtained after investigation. The nitrogen is still favored over potassium.
- The frequency of irrigation of apple trees is often very low in some farms because the occurrence of the irrigation water turn is 25 days.

In some cases there is introduction of improved technologies. For example the recent orchards are planted with almond varieties (Ferragne-Ferraduelle) that are less subject to frost. Apple orchards have been planted recently with the Gala variety which is more stable in production in the absence of pruning than the varieties Golden Delicious. Starking Delicious may also be well suited to local conditions.

With the crop management techniques used by most of the farmers, the average apple yield does not exceed 12 tons/ha in good years; although the potential yield with these varieties is about 40 to 60 tons/ha; and in the project area, some farmers manage to produce up to 36 tons/ha. Similarly, average yields of almonds is 0.8 tons/ha; but with a range of performance ranging from 0-4 tons/ha. The farmer reaching the highest level of performance is the only one who applies some supplemental irrigation and practices relevant agricultural techniques. The constraints of crop production in Talzemt are presented in the diagram below.
Low cash flow

Limiting risk-taking

Choice of cultivation techniques depending on the level of

Crops in rainfed areas: high level of risk

Minimization of risk: very low level of inputs

Irrigated crops: Drought risk is limited

Input

Distance from sources of supply

Low level of training

Low productive crops for domestic consumption (feed and food)

Some technical errors: Average or poor performance
2.3: Physical characteristics of Talzemt watershed.

Objectives:

Describe the site and collect data for suitability analysis and modeling.

Methodology:

The methodology is based on the collection and analysis of existing secondary climate, soil and water resources data.

1. Climate

Collection of secondary data

Only some general information on climate is available. The closest weather station to the site is located at approximately 100 km; so a weather station is needed to collect actual information. According to the available data, the average annual rainfall reaches 400 mm per year and is a limiting factor in the rainfed areas, especially that the soil depth is low and this limits its capacity to function as a water tank. The average annual temperature is around 20 °C, with a wide range: during summer, temperatures reach 32 °C, while minimum temperatures are approximately -15 °C in December and January. The area has also known episodes of climatic events such as hail and frost (90 days per year).

2. Land and soil characteristics

Land and topography

Based on a soil map at a scale of 1/100 000, the diversity of soil formation in the area led to the definition of four classes of soil: Crude, Minerals, Unsophisticated, and Calcimagnesian “fersialitiques”. Data collected during the investigation and initial observations confirmed that we have six different soil types. The first analyses performed on soil samples taken from the irrigated area show that the soil has the following characteristics: very fine texture (40% clay, 25% fine silt, coarse silt 18%), low organic matter content (1.2 to 1.5%), high rates of lime (limestone total of 12 to 14%, 3 to 6% of active lime), basic pH, low presence of phosphorus, magnesium, iron and zinc, and low salinity.

The altitude varies from 1500 to 3000 m with predominance of high altitudes in the south-west of the area. Indeed, the topography is composed
of mountains (70%), valley (10%) and plateau (20%) (Data extracted from the documents of the Provincial Directorate of Agriculture of Boulemane).

According to the observed slope classes, the terrain is very rugged with a high proportion of slopes greater than 10% (38% of the area has a slope > 15%). The slope, the terrain (the stones are frost-shattered limestone), the absence, in some areas of soil cover, are all risk factors for erosion.

**Grid sampling**

The collection of secondary data showed a little evidence on the detailed nature and distribution of soils. In discussions during the workshop held on 19 and 20 October, 2011 with ICARDA scientists, it was suggested to the Moroccan team to cover the whole territory of the commune by taking samples on a grid. The grid sampling provides retaining sampling according to mesh 50 m by 50 m.

Each point will be characterized by the location, soil depth, slope, soil structure, importance of traces of erosion, type of use, stoniness and possibly, plowing. Texture, aggregate stability, the content of organic matter, nitrogen, phosphorus, pH, and stoniness will be determined in the laboratory.

The coordinates of points taken and the analysis results will be used, using ArcMap to generate a soil map of the watershed studied.

For the map of land use, the high-resolution satellite image of the study area is being acquired from the Royal Centre for Remote Sensing (CRTS).
Structures to limit erosion

The various site visits revealed that no land management structures to limit erosion (no walls, no planting and no contour lines of perennial plants) exist in the area. This brings the idea of considering the implementation of some soil conservation structures on part of the study area, particularly in order to measure their effectiveness in the context of efforts to improve the protection of soil and the infiltration of water.

System to fix sediments

We will adopt the system used by our Jordanian colleagues (Photo below). 3 or 4 structures will be installed in the watershed. The presence of a technician is required to monitor the proper functioning of the system and regular harvesting of water and sediment in the tanks.

3. Water

Variability of the river flow and erosion

The municipality of Talzmet extends on both sides of the river on which Tamghilt seven dams were built for agricultural purposes. We also observed the presence of 47 wells and 11 water sources used as sources for irrigation. The flow of these resources is highly variable and follows the irregular rhythm of rainfall.

The Tamghilt river often creates floods that cover in particular the left bank which has less steep slope. These floods can have a devastating effect on the land; but can also cause deposition of the sediments. The right bank, steeper and traditionally occupied by rangeland and forests, is more prone to erosion due to runoff from heavy rainfall events. The cropping of this relatively new bank accentuates erosion, due to the loss of perennial vegetation.
Strength: Water availability and good quality

Analyses of water samples (table 5) from seven sources indicate that the pH varies between 6.4 and 7.4, and mineralization between 220 and 270 mg/l for six sources. For one of the sources, the mineralization rate reached 316 mg/l. The water quality is quite satisfactory for irrigation.

Table 5: Water quality.

<table>
<thead>
<tr>
<th>Water sources</th>
<th>pH</th>
<th>Conductivity (μS/cm)</th>
<th>mineralization (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>6.54</td>
<td>361</td>
<td>258</td>
</tr>
<tr>
<td>S2</td>
<td>7.23</td>
<td>364</td>
<td>261</td>
</tr>
<tr>
<td>S3</td>
<td>7.31</td>
<td>371</td>
<td>266</td>
</tr>
<tr>
<td>S4</td>
<td>7.33</td>
<td>374</td>
<td>268</td>
</tr>
<tr>
<td>S5</td>
<td>6.41</td>
<td>442</td>
<td>316</td>
</tr>
<tr>
<td>S6</td>
<td>7.42</td>
<td>295</td>
<td>227</td>
</tr>
<tr>
<td>S7</td>
<td>7.44</td>
<td>312</td>
<td>240</td>
</tr>
</tbody>
</table>

Constraints: poor social management of water resources

Despite the existence of several sources of water (groundwater and surface water), the supply is insufficient to meet the needs of agriculture, which is growing. Indeed, water resources are unevenly distributed across the territory and water flows vary during the seasons and between years. Group interviews on how to access and manage water resources and individual interviews to analyze the experience of the conversion of water rights in Aït Ouallagh have identified the following items. The farmers' access to water is very uneven depending on their location. Indeed, the mode of distribution of water diverted from the river is governed by a priority of the upstream above downstream water users with non time-limited use for the former. These water turns can have a variable timing length depending on where the farm is located. At Tayroute location for example, the water turn is 25 days with a relatively low flow which is insufficient to irrigate the small plots of each of the farmers.

Management is community-based. The water users association created by the initiative of the administration is not functional. However, local initiatives and groups can overcome these problems. To improve the situation, we observed two types of strategies among farmers:

- Strategies to abandon collective irrigation rotation and to develop water turns that are limited in time. There was a successful experience in Aït Ouallagh, which was due to a participatory process initiated by a local leader for credible establishment of a new water
turn, calculated according to the needs of the plantations and areas irrigated by water availability;

- Individual strategies among wealthy farmers, through the digging of wells deep enough to secure access to water.

Since the major challenge remains to secure access to irrigation water for all farmers, the feasibility of drip irrigation is one potential option to explore.

Another constraint is the status of Seguías (irrigation canals): not all are lined with concrete material, and the condition of some them leads to loss of irrigation water. Only 8 of 50 Seguías are partially lined with concrete in usually less than half of their length. In total, less than 12% of the irrigation network, nearly 26 km, was lined with concrete.
2012 WORK PLANS
I. Benchmark site of Jordan

Output 1: Increased water availability for agriculture and promotion of indigenous as well as improved techniques for soil-water storage and micro-catchment water harvesting

1. List of Activities

- Selection of the benchmark site (completed)
- Characterization of the watershed
- Identification of a proper land use
- Identification, selection and assessment of performance of WH structures/soil and water conservation
- Evaluation of environmental and socio-economic impact of interventions (watershed and field level, modelling)
- Development of guidelines of water harvesting site selection and technical feasibility
- Inter-cropping system

2. Details of activities

Activity 2: Watershed characterization

Objective:

- Biophysical characterization of the watershed to identify proper land use

Methodology:

- Develop criteria for the suitability of different area for different land uses/interventions (Water Harvesting and Soil and Water Conservation)
- Collect the required data: digital map, soil, land use, topography, slope, rainfall, in addition to relevant surveyed sites with descriptive information.
- Overlay analysis using GIS to identify the land mapping units.
- Match the process of land use requirement with attributes of land mapping units
- Map different potential land uses with the limitations of possible types of land use (suitability map using survey data, map A).
- Develop and provide a map of potential land use using overlay of available layers (Moderate Resolution Imaging Spectroradiometer (MODIS)-Normalized Difference
Vegetation Index (NDVI) time series 2000-2011, 250 m resolution, with slope, current land use, soil…. etc.) (map B)

- Overlay the two maps (A & B) and draw conclusions
- Compare the existing land use to the potential suitability for different land uses

Starting date: July 2011  Completion date: May 2012

<table>
<thead>
<tr>
<th>Millstone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A database on biophysical characteristics of the watershed</td>
<td>May 2012</td>
</tr>
<tr>
<td>Maps of potential land uses</td>
<td></td>
</tr>
</tbody>
</table>

Activity 3: Identification of a proper land use

Objective:

- Integrate biophysical characterization with the socio-economic aspects to identify proper land use.

Methodology:

- Prepare a cadastral map and integrate it with the community development plan
- Integrate the cadastral map with land suitability maps within the sub watershed that is located within the village boundaries.
- Organize a meeting of the whole team to discuss and finalize land use plan for the whole village.

Starting date: July 2011  Completion date: July 2012

<table>
<thead>
<tr>
<th>Millstone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenarios for proper land use proposed</td>
<td>July 2012</td>
</tr>
</tbody>
</table>
Activity 4: Identification, selection and assessment of the performance of WH structures/Soil and water conservation

Objective:

- Evaluate the performance of water harvesting structures / soil conservation interventions

Methodology:

Identify the type and location of water harvesting / soil conservation interventions
Design procedure for evaluation for each type of intervention
Collect secondary and field data
Assess the performance of water harvesting / soil conservation interventions

Starting date: July 2011  Completion date: July 2012

<table>
<thead>
<tr>
<th>Millstone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>WH / Soil conservation structures located and described</td>
<td>February, 2012</td>
</tr>
<tr>
<td>Procedures of the evaluation of the interventions designed</td>
<td>March, 2012</td>
</tr>
<tr>
<td>Required field data collected</td>
<td>May, 2012</td>
</tr>
<tr>
<td>The structures performance assessed</td>
<td>July, 2012</td>
</tr>
</tbody>
</table>

Activity 5: Evaluation of environmental and socio-economic impact of interventions
(Watershed and field level, modelling)

Objectives:

- Assess the impacts of the project interventions on farming systems, rural livelihoods, and the environment (land and water resources)

Methodology:

- Define indicators of impact monitoring based on biophysical characterization and socio-economic interventions (economic values, yield, moisture content, erosion, organic matter, NDVI high resolution, biodiversity, sedimentation) at field and watershed levels.
- Collect baseline information for selected indicators, and selected representative sites.
- Design monitoring plan for four years
Starting date: July 2011  Completion date: July 2014

<table>
<thead>
<tr>
<th>Millstone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDVI, analysis of baseline data and reporting</td>
<td>June 2012</td>
</tr>
</tbody>
</table>

Activity 6: Development of guidelines of water harvesting site selection and Technical feasibility

Objective:

- To develop guidelines for successful implementations of water harvesting / soil conservation interventions in the mountainous area.

Methodology:

- Revise and report the site selection for implementation of water harvesting / soil conservation interventions.
- Follow up with other activities and collect information about the performance of these interventions.
- Describe biophysical and socio economic conditions to achieve sustainable implementation of these intervention.
- Prepare guideline to describe implementation of water harvesting / soil conservation intervention (include requirements, benefits and any precautions).

Activity 7: Inter-cropping system

Objective:

- To introduce a combination of fodder crops under water harvesting systems in order to improve livestock feed availability and reduce erosion

Methodology:

On-farm trials will be conducted with different management of area between rows of atriplex:

- Treatment 1: Atriplex in Contour ridges + no vegetation between ridges
- Treatment 2: Atriplex in Contour ridges + Native vegetation between ridges
- Treatment 3: Atriplex in Contour ridges + a forage species between ridges
Output 2: Best-bet technological packages that improve agricultural productivity, generate higher incomes and better economic returns and livelihoods for small-scale farmers in mountain watersheds

1. List of activities:
   - Study water demand and supply for the optimization of water use
   - Study crop water requirements by using available models and RS techniques to conduct suitability analysis at watershed scale
   - Introduce and test supplemental and deficit irrigation for major crops within the study site
   - Test and introduction of herbal and medicinal plant

2. Details of activities

Activity 1: Study water demand and supply for the optimization of water use

Objective:
   - Assess water resources demand and supply

Methodology:
   - Collect required data on climate and water resources
   - Calculate crop water requirements for the major cultivated crops, and provide technical information regarding the available water resources, and water shortages, and best water management practice under the prevailing conditions
Activity 2: Study of crop water requirements using modeling and remote sensing techniques

Objective:

- Model water demand and supply using crop water and remote sensing techniques.

Methodology:

**Data collection:**

- Monthly or daily climatic data for study area (temperature, relative humidity, solar radiation, and wind speed)
- Temporal satellite images of study area (one each month, starting in October 2011) with a resolution of (10-30 m)
- Field spatial data about irrigated areas
- Land cover maps provided by the GIS unit

**Calculations:**

- Calculation of CWR of different crops using available data according to FAO-56 paper.
- Calculation of monthly NDVI values, using high resolution satellite images.
- Comparison between high resolution NDVI values, and those available at the Drought Monitoring Unit/NCARE (MODIS 16 day – 250 m).
- Study the correlation between CWR and NDVI, to develop a model to predict CWR using Satellite images for the watershed.
- Study changes in the irrigated area by comparing long term record of NDVI 250 m data with recent images.

**Starting date:** Jan 2012  
**Completion date:** August 2013

<table>
<thead>
<tr>
<th>Millstone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop water requirement calculation</td>
<td>End of December 2012</td>
</tr>
</tbody>
</table>
Activity 3: Introduce and test supplemental and deficit irrigation for fig and pomegranate trees within the study site

Objective:

- To introduce and test supplemental and deficit irrigation using appropriate irrigation system.

Methodology:

- Select 4 or 5 representative farms (proper farm and collaborative farmer) (July end of January 2012)
- Install drip irrigation systems (reservoir, head unit, and pipes network) in these farms to be used as demonstration sites (Jan – Feb 2012)
- Use different levels of irrigation amount (deficit irrigation) to irrigate Orchard by using water meter: divided the farmer field into three sub-plots
  - Sub-plot 1: Farmer irrigation technique
  - Sub-plot 2: Drip irrigation with Full water requirements (FWR)
  - Sub-plot 3: Drip irrigation with 70% of FWR
- Measure soil moisture at critical stages, the amounts of water applied and fruit production and quality under different levels of irrigation levels (March, 2012-Septembeber 2013)
- Three Farms of vine orchards and three Farms of fig orchards will be selected with cooperation with local community at the end of January 2012, to conduct deficit irrigation treatments of 70% of water requirement using drip irrigation and compare the results with farmer irrigation technique and Full water requirements (FWR) using drip irrigation requirement.
- Irrigation system design and implementation will be conducted from January to the end of March to be ready for use in the begging of next 2012 production season of Vine and Fig.

Starting date: January 2012  Completion date: September 2013

<table>
<thead>
<tr>
<th>Millstone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary data from the field</td>
<td>Sept 2012</td>
</tr>
</tbody>
</table>

Activity 4: Test and introduction of herbal and medicinal plant

Objective:

- Improve the economic situation of the farmers by introducing new cultivation practices and new crops such as herbal and medicinal plants.
Methodology:

- Installation of drip irrigation systems (Reservoir, head unit, and pipes network) for several farms to be used a demonstration sites for other farmers.
- Conduct trials with two irrigation water levels: Full water requirement and 70% of FWR on Thymus and Salvia. Species
- Provide training for the framers for the new cultivation practice and packaging equipment.
- Thyme and salvia transplanted was already prepared to be ready to plant at farmer field in the end of winter season and at the beginning of spring 2012. Trials with two irrigation water levels: Full water requirement and 70% of FWR on Thymus and Salvia will be conducted using drip irrigation after selection proper sites in watershed.
- Provide training for the framers for the new cultivation practice and packaging equipment.
- **Starting date:** January 2012 **Completion date:** September 2013.

<table>
<thead>
<tr>
<th>Millstone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary data from the field</td>
<td>Sept 2012</td>
</tr>
</tbody>
</table>

Output 3: Institutional and policy options (TIPOs)

Activity 1: Existing policies of land and water management and use in the mountainous areas

Objective:

- To identify and describe the existing policies in the mountain areas.

Methodology:

- Review the literature to inventory existing policies and recent policy changes in the mountainous areas
- Collect secondary data about policies from the Ministry of Agriculture, Ministry of Water and Irrigation, Department of Statistics, Agricultural Resource Management Project-Phase II, the relevant projects and studies and any other available references.
• Determine technical, institutional and policy constraints affecting the adoption of improved technologies.
• Analyze local institutional arrangement for common resources use and management (water, land, forest,…etc)

Starting date: January, 2012   Completion date: March 2012

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reviewed information of existing policies</td>
<td>January –February 2012</td>
</tr>
<tr>
<td>Report on existing policies prepared</td>
<td>March 2012</td>
</tr>
</tbody>
</table>

Activity 2: Institutional set-ups and farmers associations of land and water management and use in the mountainous areas

Objectives:
• To assess the role of community organization and NGO in mediating common resources use.

Methodology:
• Participatory Rapid Rural Appraisal (PRRA) to assess the existing associations and evaluate their characteristics, capacities, organization, memberships, potential roles and abilities to handle collective water storage structures, interventions and activities of the Program.
• Develop recommendation for enhancing collective action for common resources use

Starting date: January 2012   Completion date: March 2012

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection and analyzed</td>
<td>end of January 2012</td>
</tr>
<tr>
<td>Reporting data</td>
<td>March 2012</td>
</tr>
</tbody>
</table>
Activity 3: Recommendation of alternative policies and farmers’ organization for implementation of developed technologies & structures

Objectives:
- To recommend alternative policies and farmers’ organization that allows the implementation of the developed technologies and structures in the mountainous area

Methodology:
- Review literature and result of PRRA
- Description of policies that affect mountain region
- Develop policies recommendations to improve the livelihood of mountainous community and enhance implementation of improved water harvesting / soil conservation and irrigation interventions.

Starting date: April 2012  Completion date: (April - June 2012)

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Literature review and PRRA result</td>
<td>April, 2012</td>
</tr>
<tr>
<td>Policies description development recommendation</td>
<td>May – June 2012</td>
</tr>
</tbody>
</table>

Output 4: Capacity building

Activity 1: Training for farmers, farmer-led water user associations, IFAD projects staff, NARS researchers and extension specialists on the design and management of water, land and crop management systems/techniques

Objective:

Improve the capacity of national team including farmers and women to implement and sustain activities beyond the project lifetime.

Methodology:
- In consultation with ARMPII define training needs of different stakeholders
- Design training program
- Suggested training:
✓ Women community training (pickling of wild species, bringing wild species into cultivation to relief pressure on Wild habitat, training on wild conservation and utilization of MH plants)
✓ School student training and establishing educational M&H gardens.
✓ Field days
✓ On the job training (irrigation management, implementation and maintenance of water harvesting/soil conservation interventions, improved farming practices)
✓ Other training needs evolved during the project implementation.

**Starting date:** March 2012  
**Completion date:** end of the project.

**Activity 2: Country, regional level Training systems/techniques (To be organized with other country)**

✓ Modeling; Irrigation (Cropwat & RS) –
✓ Design of implementation & maintenance of WH & SWC (planning within watershed concept)
✓ Training workshops (study tour)
✓ Suitability analysis & LUP
✓ Rangeland & livestock management
✓ Irrigation management

**Starting date:** July 2012  
**Completion date:** end of the project.
II. Benchmark site of Lebanon

Output 1: Increased water availability for agriculture and promotion of indigenous as well as improved techniques for soil-water storage and micro-catchment water harvesting

1. List of activities:

Activity 2: Site characterization

Activity 3: Implementation of proper on-farm water harvesting techniques (micro techniques) and identifying potential locations to intervene on the watershed scale (macro techniques)

Activity 4: Calibrations and validation of SWAT model

2. Details of activities:

Activity 2: Site characterization

Objectives:

- Biophysical characterization
- Socioeconomic characterization

Methodology:

- Conduct a Rapid Rural Appraisal
- Develop a household detailed questionnaire
- Collect the data using the questionnaire
- Collect soil, climate, topography, land cover, water resources, etc…
- Sedimentation monitoring and measurements

Starting date: January, 2011

Completion date: Jul, 2012
Activity 3: Implementation of proper on-farm water harvesting techniques (micro techniques) and identifying potential locations to intervene on the watershed scale (macro techniques)

Objectives:

- Development of maps of potential water harvestings and soil conservation systems/techniques for the sub-watershed and the watershed using GIS

Methodology:

- Establish biophysical criteria on rainfall and soil characteristics, topography and land cover
- Collect data on these parameters
- Use GIS to draw maps
- GIS modeling for water harvesting on the watershed scale

Starting date: Nov, 2011  Completion date: December, 2012

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification of locations and establishment of structures</td>
<td>Dec 2012</td>
</tr>
<tr>
<td>Digital data preparation</td>
<td>Dec 2012</td>
</tr>
</tbody>
</table>
Activity 4: Calibrations and validation of SWAT model

Objectives:

- Investigate the actual site environmental situation
- Modeling the environmental and socioeconomic impact of introducing water harvesting/soil conservation systems/technologies

Methodology:

- Define indicators of impact monitoring based on biophysical characterization and socio-economic interventions (economic values, yield, moisture content, erosion, organic matter, NDVI high resolution, biodiversity, sedimentation) at field and watershed levels
- Collect baseline information for selected indicators, and selected representative sites.
- Design monitoring plan for four years
- Run SWAT model.

Starting date: Nov, 2011  Completion date: December, 2011

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gathering required data for SWAT model</td>
<td>Jan 2012</td>
</tr>
<tr>
<td>model implementation</td>
<td></td>
</tr>
<tr>
<td>Model application</td>
<td>Dec 2013</td>
</tr>
</tbody>
</table>

Output 2: Best-bet technological packages that improve agricultural productivity, generate higher incomes and better economic returns and livelihoods for small-scale farmers in mountain watersheds

1. List of activities:

Activity 1: Introduction of new cropping systems and fodders under water harvesting/soil conservation techniques

Activity 2: Monitoring sediment and water quality at one of the main tributaries
Activity 3: Introducing adopted new irrigation techniques, conserving water and raising its productivity.

Activity 4: Introduction of new cherry and apple rootstocks varieties adapted to Marjhime.

Activity 5: Scheduling regulated deficit irrigation of fruit trees for optimizing water use efficiency (cherry & apple).

Activity 6: Wheat varieties trials under supplemental irrigation for maximum profit.

Activity 7: Various irrigation techniques on Potato with Deficit Irrigation.

Activity 8: Frost activity.

2. Details of activities:

Activity 1: Introduction of new cropping systems and fodders under water harvesting/soil conservation techniques.

Objectives:

- Improvement of crop and animal productivity.
- Optimization of land productivity and usage.
- Crop diversification.
- Pasture rehabilitation.
- Controlled grazing.

Methodology:

- Rangeland site selection (protection criteria to be discussed with the local community).
- Identification and collection of native pasture seeds in the project site.
- Review and analyze the actual rangeland situation in the project and define weaknesses and opportunities for improvements.
- Reseeding of native species with high quality.
- Plantation of shrubs.
- Establish shrubs’ nursery at LARI’s station.

- Site selection and identification of key farmers and provide guidance on the selection of crops for intercropping with fruit trees with focus on the animal husbandry and irrigation system.

- Selection of improved varieties with high water use efficiency, nutritive value and water stress tolerance,…)

Starting date: Jan, 2012  
Completion date: December, 2014

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey and data collection for actual situation and potential spp.</td>
<td>April, 2012</td>
</tr>
<tr>
<td>Carry out experimental demonstration plots</td>
<td>Jul, 2014</td>
</tr>
<tr>
<td>Fodder-shrubs nursery</td>
<td>Jul, 2014</td>
</tr>
<tr>
<td>Training on farmer-based seed production system</td>
<td>Dec, 2012</td>
</tr>
</tbody>
</table>

Activity 2: Monitoring sediment and water quality at one of the main tributaries

Objective:

- Investigating water quality and sedimentation
- Examining soil water erosion

Methodology:

- GIS analysis will be applied in order to extract the suitable tributary for the establishment of a gaging station. The suitability criteria will be chosen according to the length of the drainage system and the size of the area that is drained. Landcover will also be analyzed such as percent of forest area, bare rocks, etc.
- A gaging station will be constructed on one of the main tributaries that lead to Marjhine depression or subwatershed. The station will measure water flow and water quality (sediment).
- Installing of erosion monitoring pins in different places along the tributary area, settling basins will also be established.
- Water samples will also be collected in late fall 2011 (November – December, 2011), spring (May, 2012) and summer 2012. Water chemical properties as well as total coliform will be analysis at LARI laboratory.
- Measuring climatic parameters through the installation of a weather station at the subwatershed. The weather will include all necessary parameters for the computation of ETo (for other purposes and activities).
Starting date: Oct, 2011  Completion date: December, 2014

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installing the gaging station, erosion pins and settling basins</td>
<td>Nov 2011</td>
</tr>
<tr>
<td>Weather station installation</td>
<td>Nov 2011</td>
</tr>
<tr>
<td>Field water sample collection</td>
<td>Dec 2013</td>
</tr>
</tbody>
</table>

Activity 3: Introducing adopted new irrigation techniques, conserving water and raising its productivity

Objectives:

- Introduction of drip irrigation as a water efficient saving technique, used to assess the production of newly improved field potato varieties.
- Testing an irrigation scheduling method, that could be easily adopted by farmers, to identify the effects of different irrigation regimes on the growth and yield of drip-irrigated potato.

Methodology:

Two experiments will be carried out at Marjhine area, El Hermel casa in the fields of two or three farmers.

Factor 1: Variety

- 2 newly improved spring potato varieties (V1 and V2), will be grown for three consecutive growing seasons, May-August 2012, 2013 and 2014.

Factor 2: Irrigation water regimes

- T_0_: The amount of irrigation water applied will consider the water surface evaporation (Ep) measured by a pan Class A.
- T_{0.5}: The amount of irrigation water applied will be 0.50 times of water surface evaporation (Ep) measured by a simple pan that the farmer can buy from market.
- T_{0.75}: The amount of irrigation water applied will be 0.75 times of water surface evaporation (Ep) measured by a simple pan.
- T_1_: The amount of irrigation water applied will be 1.00 times of water surface evaporation (Ep) measured by a simple pan.
- T_{1.25}: The amount of irrigation water applied will be 1.25 times of water surface evaporation (Ep) measured by a simple pan.
Experimental design: a randomized block design

Data collection

- Weather data
- Soil physic-chemical characteristics
- Irrigation scheduling: The amount of irrigation water applied will be 0.50, 0.75, 1.00 and 1.25 times of water surface evaporation (Ep) measured by a simple pan that the farmer can buy from the market (K=0.50, 0.75, 1.00 and 1.25). At the same time, a pan Class A will be used to monitor irrigation amounts for treatment T0.
- The soil moisture content will be monitored by using sensors or gravimetric method.
- Plant sampling and measurements
  ✓ The plant development and phenological stages will be monitored regularly by means of dates and duration of each phase. Plant sampling will be done many times during the whole season, almost regularly on a two weeks basis.
  ✓ The standard plant measurements will include, plant density after emergence, plant height, leaf area index, % of canopy cover, weight of above ground biomass and tubers, yield and number of potato tubers at harvesting.

Starting date: Jul, 2012
Completion date: December, 2014

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey to identify the common agricultural practices in the area</td>
<td>March 2012</td>
</tr>
<tr>
<td>Selection and preparation of experimental field</td>
<td>May 2012</td>
</tr>
<tr>
<td>Carry out demonstration experiments</td>
<td>August 2014</td>
</tr>
<tr>
<td>Farmers field visits</td>
<td>August 2014</td>
</tr>
<tr>
<td>Training on irrigation techniques (drip irrigation, irrigation regimes,…)</td>
<td>July 2014</td>
</tr>
</tbody>
</table>

Activity 4: Introduction of new cherry and apple rootstocks varieties adapted to Marjhime.

Objectives:

- Use of healthy and genetically authentic varieties
- Widening the maturity calendar for cherries and apples especially with late varieties
- Establishment of super high density orchards using dwarfing rootstocks such as M9 and Bad9 for apple and Gisela5 for cherries for their high productivity, uniformity and enhancing the fruit quality
- Good Agricultural Practices (including integrated pest management)

Methodology:
- Soil sampling (one sample for each demoplot)
- Physical and chemical soil analysis
- Soil analysis for verticillium, nematodes and phytophthora
- Collected climatic data
- Choice of the right rootstocks and varieties well adapted to the pedo-climatic conditions
- Establishment of the new orchards
- Implementation of a prototype (including planting system, GAP etc.)

**Starting date:** Jul, 2011  
**Completion date:** December, 2014

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil sampling for survey</td>
<td>September 2011</td>
</tr>
<tr>
<td>Chemical and physical soil analysis</td>
<td>September 2011</td>
</tr>
<tr>
<td>Soil analysis for verticillium, nematodes and phytophthora</td>
<td>November 2011</td>
</tr>
<tr>
<td>Climatic Data collection</td>
<td>August 2011</td>
</tr>
<tr>
<td>Choice of the right rootstocks with quantity needs to cover the region</td>
<td>September 2011</td>
</tr>
<tr>
<td>study and offer to the farmers add the quantity needed to the demoplot</td>
<td></td>
</tr>
<tr>
<td>Irrigation system for the demoplot</td>
<td></td>
</tr>
<tr>
<td>Good Agricultural practices (pruning, thinning, summer pruning, IPM etc)</td>
<td>December 2014</td>
</tr>
</tbody>
</table>

**Activity 5: Scheduling regulated deficit irrigation of fruit trees for optimizing water use efficiency (cherry & apple).**

**Objectives:**
- Increase in land and water productivity.
- Introducing drip irrigation techniques on fruit trees.
- Minimizing irrigation and nutrient loss through leaching.
- Determine an Irrigation plan for the approximate interval and run time is to provide a theoretical basis for irrigation scheduling and water budgeting.

**Methodology:**
- The on-farm trials will be carried at Marjhine with one farmer who have apple tree.
- Scheduling of irrigation will be based on both soil moisture and tree responses before making management decisions. The amount of irrigation will be 50% of water surface evaporation and water stress should be applied only during the vegetative growth period when fruit is growing slowly.
The stages of fruit growth for a given variety can be determined by tagging several fruit and shoots and weekly measuring their circumference and length with a tape measure. Converting fruit circumference to volume (volume=0.02X (circumference)^3) gives a true indication of fruit weight. This technique is simple and the measurements are useful for adjusting irrigations, especially where shoot growth continues despite high soil water deficits.

To implement deficit irrigation, we need an accurate description of the growth periods. Stages of fruit growth for different fruit varieties can be readily determined by tagging several fruit and shoots on a tree and making weekly determinations of their circumference (diameter) and length with a tape measure. Fruit diameter can be converted to relative volume by cubing. The majority of shoot growth occurs during this period of slow fruit growth. Thus, regulated deficit irrigation is applied for the first 70-80 days after bloom. The majority of fruit growth occurs in the remaining 6-8 weeks to harvest.

The trial will be conducted on 0.25 Denom (100 trees)

Soil moisture monitoring will be conducted using soil moisture sensors: Tensiometer and RDI scheduling requires measurements of soil moisture. In shallow rootzone, soil moisture will be measured at two depths; in deep rootzone (0.6m) soil moisture is measured at three depths.

The gypsum block is preferred over other methods of determining moisture because it measures soil water suction, which relates to the level of water stress on the trees, it is the only instrument capable of measuring soil suction in the range suitable for RDI. It is inexpensive, robust to handle and simple to install.

Alternatively, soil samples may be collected with an auger and the moisture content assessed. This is much less accurate than gypsum block method, but may be useful to assess wetted depth and moisture below the top 0.05 m depth.

The following is a list of necessary steps implementing regulated deficit irrigation:

- Dig up a tree to determine the rootzone distribution width and depth (80 percent of total)
- Determine the wetting pattern of the irrigation system and estimated the wetted rootzone
- Develop a season irrigation plan for run time and interval based on soil type and E class A or average reference evapotranspiration.
- Install soil moisture sensors (preferred measure is soil suction using gypsum block tensiometer) - at 0.3 m and bottom of rootzone in shallow soil, at 0.3 m, 0.6 m and bottom of rootzone in deep soil

During regulated deficit irrigation period:

- Measure and record soil suction and irrigate when the entire rootzone dries out to a minimum of 200kPa
- Irrigate to wet the top 0.3m of the rootzone
- Measure and record soil moisture 6-12 h after irrigation
- Irrigate when the wetted rootzone soil at 0.3 m depth out to 200kPa
- Measure evaporation or ET0 interval between irrigations (irrigate in future years based on this evaporation interval
- Repeat steps 3 to 6.
During rapid fruit growth

- irrigate to wet at least the top 0.6 m of rootzone
- measure and record soil suction 6-12 h after irrigation and if the soil is dryer than 50 kpa in clay soil at 0.6m apply more irrigation
- Irrigate when the wetted rootzone soil soil suction at 0.3 m depth dries out of 50kPa.
- Measure evaporation or ET0 interval between irrigations irrigate in future years based on this evaporation interval
- Repeat steps from 2-5.

**Starting date:** Jul, 2011  
**Completion date:** December, 2014

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduction of experiments</td>
<td>End of the project</td>
</tr>
<tr>
<td>and data collection</td>
<td></td>
</tr>
</tbody>
</table>

**Activity 6: Wheat varieties trials under supplemental irrigation for maximum profit**

**Objectives:**

- Comparison between Wheat cultivars in Marjhine to choose the more productive adapted variety to be adopted by farmers.
- To examine the efficiency of supplemental irrigation on some cultivars of Wheat.

**Methodology:**

- Two trials: Trial 1: Durum Wheat & Trial 2: Bread Wheat
- Total area for two trials on durum & bread wheat: 108 x 288 = 1944 m²
- Experimental Design for each trial: Split-plot
- Factors: Cultivars & Irrigation
- Main-Plots:
  - Treatment 1: Rainfed only (Without Supplemental irrigation)
  - Treatment 2: One supplemental irrigation by sprinklers at Heading stage or in Milk ripe stage according to weather conditions.
Sub-Plots:
- Treatment 1 = Local Variety adopted by major farmers in Marjhine
- Treatment 2 = Variety 2
- Treatment 3 = Variety 3
- Treatment 4 = Variety 4

Starting date: Oct, 2011  Completion date: December, 2014

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trials conduction, data collection and analysis</td>
<td>Sept of each year</td>
</tr>
</tbody>
</table>

Activity 7: Various irrigation techniques on Potato with Deficit Irrigation

Objectives:
- To determine an efficient irrigation system on Potato at Marjhine.
- To investigate the effect of various techniques of irrigation with deficit irrigation regime on the growth, the development, on Water Use Efficiency and yield of Potato.

Methodology:
- Cultivar: Spunta, Holland origine, class Elite, size 35 - 45mm
- Total field area: 1,5 Ha
- Experimental Design: Split-Plot
- Main Plots:
  - Treatment 1: Control, Surface conventional irrigation
  - Treatment 2: Sprinkler irrigation
  - Treatment 3: Mini-Sprinkler irrigation
  - Treatment 4: Drip T-Tape irrigation
  - Treatment 5: Drip GR irrigation
- Sub-Plots:
  - Treatment 1: Water amount is 100% of ET0 (calculated from Weather station data or from Bac Class)
✓ **Treatment 2**: Water amount is 50% of ET0 since mid-cycle or flowering stage

- **Parameters**: during potato growth many parameters can be collected.

**Starting date**: March, 2012  
**Completion date**: December, 2014

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trials conduction, data collection and analysis</td>
<td>Sept of each year</td>
</tr>
</tbody>
</table>

**Activity 8: Frost activity**

**Objective**:  
- Help farmers follow a special techniques and agricultural practices to overcome frost events of the late summer (late productive season).

**Methodology**:  
- Field crop will be chosen directly on ground in collaboration with farmers. Different leaf nutritive ingredients will be used under various dosages as different treatments to search the optimal dose to tolerate frost.

**Starting date**: March, 2012  
**Completion date**: December, 2012

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivating</td>
<td></td>
</tr>
<tr>
<td>Data collection</td>
<td>Late summer 2012</td>
</tr>
<tr>
<td>Harvesting</td>
<td>September 2012</td>
</tr>
<tr>
<td>Treatments for frost</td>
<td></td>
</tr>
<tr>
<td>Report</td>
<td>December 2012</td>
</tr>
</tbody>
</table>

**Output 3: Institutional and policy options (TIPOs)**

1. List of activities
Activity 1: Analyze local institutional for common resource used management (Water, rangeland, forest,..)

Activity 2: Policies that affect mountain regions

2. Details of activities

Activity 1: Analyze local institutional for common resource used management (Water, rangeland, forest,..)

Objectives:

- Determine the effects of property rights & institutional arrangements on land and water use

Methodology:

- Review the common property rights.
- Inventory the institutional arrangement & property rights of common resources.
- Apply participatory methods to determine and describe collective action.
- Conduct land survey and water uses.
- Assess the role of community organizations and NGO's in mediating common resources use.
- Develop recommendations for enhancing collective actions for common resource use.

Starting date: July, 2011

Completion date: December, 2013

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collecting data and inventories</td>
<td>Dec 2012</td>
</tr>
<tr>
<td>Reviewing data</td>
<td>Dec 2013</td>
</tr>
</tbody>
</table>

Activity 2: Policies that affect mountain regions

Objectives:

- Description of existing and recommendation of alternative policies for Mountains development
Methodology:

- Inventory and review rural development policies targeting mountain regions.
- Assess the impact of macro and sector policies on a mountain region.
- Review the role of targeted development programs for mountain areas.
- Develop policies recommendations to improve the livelihoods of mountains communities.

Starting date: July, 2012
Completion date: December, 2012

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collecting data</td>
<td>July 2012</td>
</tr>
<tr>
<td>Analyzing data</td>
<td>Dec 2012</td>
</tr>
</tbody>
</table>

Output 4: Capacity building:

The list is exhaustive and the implementation Depends on the availability of funds and in agreement with ICARDA

This output remains a necessity throughout the project period (up 2014)

| Research institutions and extension trainings | Regional (short term trainings) (travelling workshops and visits to sites) (master students for long term training) (short term trainings) (optional training: degree training for a long term from LARI or other institutions) - Models related to irrigation - irrigation techniques - suitability analysis - remote sensing for irrigation use - techniques for water conservation - soil conservations - design of hydrological studies - water harvesting techniques - joint activities with WLI activities - training on new irrigation techniques. - and regional (GIS modeling) - irrigation management models and watershed |
managements models
- GIS (introductory, suitability analysis)

<table>
<thead>
<tr>
<th>Farmers needs of trainings</th>
<th>1. Implementing the irrigation systems, technical issues - choosing the suitable irrigation system, how to install the irrigation system by crops, new varieties, good agricultural practices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Site visits (to make farmer interest to our techniques)</td>
</tr>
<tr>
<td></td>
<td>3. Bookkeeping of farm level (might be done in the future)</td>
</tr>
<tr>
<td></td>
<td>4. Local farmers, farmer associations, extensions.</td>
</tr>
</tbody>
</table>
III. Benchmark site of Morocco

Output 1: Increased water availability for agriculture and promotion of indigenous as well as improved techniques for soil-water storage and micro-catchment water harvesting

1. List of activities

Activity 1: Identification of potential water harvesting and soil conservation systems

Activity 2: Identification, selection and assessment of the performance of existing water and soil conservation structures

Activity 3: Evaluation of the environmental and socio-economic impacts of the interventions

2. Details of activities

Activity 3: Identification of potential water harvesting and soil conservation systems and identification of proper land use (suitability analysis)

Objective:
- Develop maps of potential water harvestings and soil conservation systems/techniques for the sub-watershed and the watershed using GIS

Methodology:
- Establish biophysical criteria on rainfall and soil characteristics, topography and land cover
- Collect data on these parameters
- Use GIS to draw maps

Starting date: Sept, 2011  Completion date: Sept, 2012

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection</td>
<td>May, 2011</td>
</tr>
<tr>
<td>Maps; annual report</td>
<td>Sept, 2012</td>
</tr>
</tbody>
</table>
**Activity 4: Evaluation of environmental and socio-economic impact of interventions (watershed modelling)**

**Objective:**

Validate and apply SWAT model (Soil and Water Assessment Tool) to assess soil loss, sediments yield and water yield in the watershed.

**Methodology:**

1. **Modeling approach (Model description)**
   
   - SWAT is a physically based hydrologic model that requires physically based data (Jacobs and srinivasan, 2005). This model subdivides large river basins into homogenous parts and then analyses each part and its interaction with the whole basin. SWAT is spatially distributed, so that these parts can interact. The model simulates hydrology, pesticide and nutrient cycling, erosion and sediment transport. Input consists of files, information from databases and information from a GIS interface. More specific information can be entered singly, for each area or for the watershed as a whole.

2. **Data collection**
   
   - For this model various input data will be collected from different sources: climatic inputs data (daily precipitation, maximum/minimum air temperature, wind speed and relative humidity) will be collected from neighboring meteorological stations, spatial input data (DEM, land use /land cover and soil); the land use map will be driven from satellite image by using ENVI software and soil map will be developed by CPCS method. Further, the data base will be incorporated into the SWAT to reclassify the land use and soil. The input data will be prepared for the required format by SWAT model. The integration of data in SWAT is in the following order: i) DEM, ii) Land use, iii) Soil, iv) Slope, v) Meteorology.

3. **Watershed delineation**

4. **Model calibration and validation**
   
   - The model will be calibrated by comparing simulated data versus observed data. Then we will choose the parameters that will be used for model calibration. Calibration and verification will be performed for a selected period;
   - Definitions of scenarios of watershed management;
   - Model run: to study the impact of different scenarios on soil losses;
   - Analysis and comparison for simulations: to identify the most efficient practices.
Starting date: Sept, 2011          Completion date: Jun, 2014

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection; annual report</td>
<td>December, 2012</td>
</tr>
<tr>
<td>Data collection and watershed model test; annual report</td>
<td>December, 2013</td>
</tr>
<tr>
<td>Calibration of the model and scenarios of watershed management; final report</td>
<td>June 2014</td>
</tr>
</tbody>
</table>

Activity 5: Identification, selection and assessment of the performance of existing water and soil conservation structures

Objective:

- Evaluate the performance of existing water and soil conservation structures in Talzemt watershed.

Methodology:

1. Soil conservation
   - First, we will start with an inventory of the existing techniques of soil conservation: Contour bench terraces, cordons, semicircular bunds... The existence and the knowledge of these techniques by the farmers will be verified. At the same time, the importance of the erosion will be estimated by a survey and visits in the sites.
   - Secondly, the effect of these arrangements will be estimated. However, if the inventory confirms the absence of such arrangements, the approval of the farmers will be looked to insure the success of collective operations of the interventions. Some of the arrangements will be supported by partners of the project. These demonstration arrangements will concern various crossed techniques; arrangement of stony cords, plantation of trees in ravines and realization of impluvium for example.

2. Rainwater harvesting systems
   - The main objective of this part is to review and analyze, identify constraints and developed water harvesting projects in the site.
   - The review is designed to overview the water-harvesting systems and how they can contribute for development.
   - The existing SWC techniques will be evaluated to provide guidance (guide) for the planning, design, implementation and management of SWC systems.
   - The review is based on the existing data and visits to the sites where ancient, indigenous and new water harvesting and soil conservation works are present.

Starting date: Nov, 2011          Completion date: Feb, 2014
Output 2: Best-bet technological packages that improve agricultural productivity, generate higher incomes and better economic returns and livelihoods for small-scale farmers in mountain watersheds

1. List of activities

Activity 1: Test and introduction of Improved crop management packages in mixed cropping systems
Activity 2: Feasibility study of reconversion to drip irrigation project
Activity 3: Conduct suitability analysis of the technologies at the large scale and outline corresponding technical bulletins

2. Details of activities

Activity 1: Test and introduction of Improved crop management packages in mixed cropping systems

Objective:

- Improve water productivity of the mixed cropping systems through farmer support using improved technical practices.

Methodology:

- Analyze and assess the technical performances of the actual mixed cropping systems under irrigation as well as under rainfed. It is intended in the first step to survey and monitor the farmers’ practices in conducting different crops from planting to harvest and understand the strategies of the farmers, their successes and failures. We will survey also the irrigation practices and methods and finally characterize the techniques used under rainfed.
After this survey, propose various agronomic and irrigation packages and options to improve the farmers’ practices and hence the efficiencies (water productivity, yields, and quality). Integrated crop management (ICM); integrated pest management (IPM) and post-harvest approaches will be used. On-farm and micro-level soil/water harvesting techniques will be tested under rainfed systems in order to catch more water for almonds and associated crops for suitable productivity and at the same time reduce run-off and erosion to protect the irrigated areas.

- Test and introduce new irrigation methods and techniques in combination with ICM/IPM, mainly supplemental irrigation, deficit irrigation and drip irrigation in addition to the improvement of the actual irrigation practices (rehabilitation of canals, cisterns).
- In order to optimize the use of the scarce water resources, experiments will address the conjunctive use of surface water and ground water (wells) whenever these resources are available.
- Introduce, whenever is required, new varieties and or new species that have proven appropriate and promising under similar environment in mountains conditions (wheat, vegetables, trees, roses, legumes...)
- Conduct simple on-farm trials to compare the farmers practices with improved packages using the experimental design with one factor and without replications. However a minimum of five farmers for each on-farm trial is required for statistical analysis.

Starting date: Sept, 2011
Completion date: Dec, 2013

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agronomic diagnostic of actual mixed cropping systems; annual report</td>
<td>December, 2011</td>
</tr>
<tr>
<td>Data collection and analysis; annual reports</td>
<td>Dec 2013,</td>
</tr>
</tbody>
</table>

Activity 2: Feasibility study of reconversion to drip irrigation project

Objective:
- Study the feasibility of individual and collective reconversion of surface irrigation to drip irrigation.

Methodology:
- Use the results of the activity 1 in Component 3, which deals with Local Institutional Framework (Analysis of collective management of water as a common property resource) to conduct this activity.
- Investigate the possibility of the introduction of drip irrigation in the watershed: We will analyze the Knowledge, Attitudes and Practices (K-A-P) of farmers in relation to drip irrigation, based on a grid analysis, including a scale for measuring attitudes. The results should help identify target groups for reconversion to drip irrigation. The process will
take into account the objectives of irrigation, characteristics of the target groups (production system, right of water and the degree of affinity between members).

- Once the target group is identified, and after validation with the community, the implementation of the reconversion project could be funded by the Moroccan Agricultural Development Fund (FDA).
- Identify needs and water resources in the area selected and design the drip irrigation system and propose several alternatives.

Starting date: Jan, 2012  Completion date: Dec, 2012

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of an approach to support reconversion to drip irrigation project</td>
<td>Jan, 2012</td>
</tr>
<tr>
<td>Design of a drip irrigation system</td>
<td>June 2012</td>
</tr>
<tr>
<td>Scientific publication (Process of collective reconversion to drip irrigation)</td>
<td>December 2012</td>
</tr>
<tr>
<td>Publication of a methodological guide for collective reconversion to drip irrigation (for use by WUAs and agents of development)</td>
<td>December 2012</td>
</tr>
</tbody>
</table>

Activity 3: Conduct suitability analysis of the technologies at the large scale and outline corresponding technical bulletins

Objective:

- Develop suitability maps
- Disseminate the developed technologies

Methodology:

- Develop suitability analysis criteria;
- Collect the data required for suitability analysis
- Use GIS tool to draw interventions suitability maps
- Conduct demonstration trials in farmers’ fields using improved packages

Starting date: Jan, 2012  Completion date: Dec, 2014
<table>
<thead>
<tr>
<th><strong>Milestone</strong></th>
<th><strong>Completion date</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Collect secondary and experiments data</td>
<td>Dec, 2013</td>
</tr>
<tr>
<td>Production of maps and technical bulletins</td>
<td>Sept 2014,</td>
</tr>
</tbody>
</table>

**Output 3: Institutional and policy options (TIPOs)**

1. **List of activities**

Activity 1: Local Institutional Framework  
Activity 2: Description and analysis of policies that affect mountain regions  
Activity 3: Value chain analysis of fruit trees commodities and alternative for higher efficiency

2. **Details of activities**

**Activity 1: Local Institutional Framework**

**Objective:**

- Analysis of collective management of natural resources  
- Common intervention for local development and identification of opportunities for good governance.  
- Analysis of collective management of water as a Common Property resource

**Methodology:**

- A work of basic diagnosis will be carried out based on the available administrative documentation at the local public actors; the local authority and the Center of agricultural (CT) in this particular case. The inquiry so collected will be completed by an institutional analysis of the active civil organizations through individual interviews with the persons in charge of these organizations centered on their current and future strategies. Focus groups including local civil leaders as well as representatives of public structures of development will be approached in the participative analysis of the local processes of management of natural resources and intervention for the local development. Propositions of improved alternatives on this subject will be discussed.  
- Across the site, we will analyze the social management of water in order to understand the logic of action, the potential constraints to sustainable management of the resource
(water rights, management of water, network maintenance). Various tools will be combined: landscape analysis (physical structure of the network), interviews with actors...

- The irrigation system will be analyzed in relation to the major changes in farming systems (interviews with the community, rapid approach of farms (representative samples) to deduce whether the system responds well to the needs of farmers.
- After analyzing the operating principles of system management, we will attempt to answer the question of how irrigators are trying to rehabilitate the irrigation system (understanding collective action: process and actors, individual strategies, evolution of local norms).
- We will analyze the process of creation of Water Users Association (WUAs as social innovation) and the interactions (real or potential) between the WUAs and community organization.
- The analysis model will use Institutional Analysis and Development (IAD, Ostrom, 1994). The IAD framework is thus a general language about how rules, physical and material conditions, and attributes of community affect the structure of action arenas, the incentives that individuals face and the resulting outcomes.

**Starting date:** Jan 2012  
**Completion date:** Jun, 2014

<table>
<thead>
<tr>
<th><strong>Milestone</strong></th>
<th><strong>Completion date</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory of institutional arrangement in the community</td>
<td>Jun, 2014</td>
</tr>
<tr>
<td>Report on local institutional framework in Morocco</td>
<td></td>
</tr>
<tr>
<td>Data collection and analysis.</td>
<td></td>
</tr>
<tr>
<td>Report of the role of local institution in the development.</td>
<td></td>
</tr>
<tr>
<td>Elaboration of a guide on good governance of natural resource and common intervention for local development.</td>
<td></td>
</tr>
<tr>
<td>Manual analysis of community irrigation systems.</td>
<td></td>
</tr>
<tr>
<td>Analysis of the functioning of the irrigation system, strengths and weaknesses of the system.</td>
<td></td>
</tr>
<tr>
<td>Synthesis of dynamic agricultural farms (typology of path).</td>
<td></td>
</tr>
</tbody>
</table>

**Activity 2: Value chain analysis of fruit trees commodities and alternative for higher efficiency**

**Objective:**

Analysis of the situation of the sector through:
- Analysis of production, commercialization and marketing channels.
- Analysis of the strategies of the stakeholders.
- Analysis of prices and their contribution in the agricultural income.
Proposition of forms of farmers’ organization to better valorization and commercialization of apple and almond.

Methodology:

The method of analysis of the fruit tree chain is based on four steps:

- The delimitation of the sector to define the objective of the study and to draw the main contours;
- The typology of stakeholders to understand the different type of stakeholders in the sector strategies;
- The study of the different price levels in the sector, and the margins and profits of the commercial actors at different levels of circuits;
- Analysis of the Organization of the sector that attempts to understand the relationships between actors and the rules governing these relations.

The main sources of information to be used are:

- Secondary data collected from the documents and studies on the sector of fruit trees and
- The primary data will be collected by conducting surveys of the different actors in the sector. Thus we need to survey more of fruit tree farmers, field investigations and other actors involved in marketing channels namely, intermediaries and wholesalers.

The research is based on the combination of several tools of investigation: observation, semi-structured interviews of groups. The content of each tool will be developed to collect appropriate information to achieve the objectives set by the research.

Starting date: Jan, 2012  Completion date: Dec, 2013

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delimitation of the fruit tree sector</td>
<td>Dec, 2013</td>
</tr>
<tr>
<td>Report on the strategies of the players in the sector</td>
<td></td>
</tr>
<tr>
<td>Report on prices of fruit and their contribution in</td>
<td></td>
</tr>
<tr>
<td>the agricultural income.</td>
<td></td>
</tr>
<tr>
<td>Proposition of forms of organization of farmers to</td>
<td></td>
</tr>
<tr>
<td>better valorization and marketing of the apple and</td>
<td></td>
</tr>
<tr>
<td>almond.</td>
<td></td>
</tr>
</tbody>
</table>

Activity 3: Description and analysis of policies that affect mountain regions

Objectives:
• The analysis of strategies and policies of development of mountain areas,
• Description and analyzing the place of the mountain in rural and human development policies,
• Description and analyzing policies and specific strategies of development of the mountains,
• Analyzing the programs and projects to improve the living conditions of the population in mountains areas.

Methodology:

The method used is based on the following steps:
• Collection of existing secondary information on the mountain (study, report, thesis, documents of development projects, etc.). The objective is to make a comprehensive analysis of strategies and policies of different interventions in mountain areas.
• Collect of the primary information through the realization of interviews with various regional and local officials.

Starting date: Jan, 2012  Completion date: Dec, 2013

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report on the importance of mountains to Morocco,</td>
<td>Dec, 2013</td>
</tr>
<tr>
<td>Report on the mountains in national and sector plans and planning strategy,</td>
<td></td>
</tr>
<tr>
<td>Inventory, analysis of the objectives, approaches and achievements of development projects in middle Atlas.</td>
<td></td>
</tr>
<tr>
<td>The place of the mountain in development initiatives (National initiative for human Development (NIHD), Social development agency (SDA), National help, decentralized cooperation, etc.).</td>
<td></td>
</tr>
</tbody>
</table>

Output 4: Capacity building

1. List of activities

Activity 1: Knowledge sharing and management
Activity 2: Analysis of local needs in institutional capacity building.
Activity 3: Institutional support for local development stakeholders
Activity 4: On-the-job training for farmers on tree pruning, irrigation management, post-harvest, IPM (local)

2. Details of activities
Activity 1: Knowledge sharing and management

Objectives:

- This program will focus on enhancing the capacity of national research and extension systems to disseminate integrated crop, livestock and natural resource management technologies using participatory community-based approaches. The team will benefit from training activities to increase the institutional capacities and to provide appropriate assistance programs to farmers. The main objective is to reach the maximum of the farmers, stakeholders and extension specialists. The approach is science-based and also taking into account the local knowledge to develop and test innovative and improved integrated water and management packages and tools.

Methodology:

- The activity will organize training activities to increase institutional capacities and to provide appropriate assistance programs to farmers. The main objective is to reach the maximum of the farmers, stakeholders and extension specialists.
- The tested and adapted management techniques and improved production techniques will be edited in the form of technical bulletins in local language to reach the maximum of the population. Farmers are ownership and they should have access to developed technologies through training and dissemination.
- The knowledge sharing will be accomplished through training sessions, communication and knowledge sharing through dissemination on the generated information. For the targeted farmers the project is intending to produce technical bulletins in local language for all improved and adapted technologies. We also intend to produce brochures, pamphlets and other means of dissemination (CDs, establish a website for the outputs of the project to benefit other similar zones in the country).

Starting date: Jan, 2012
Completion date: Dec, 2013

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>The availability of management techniques (water harvesting and soil conservation techniques); Organize workshops for sharing the generated knowledge Edit technical bulletins Production of brochures and other means of dissemination (CDs, website)</td>
<td>Dec, 2013</td>
</tr>
</tbody>
</table>
Activity 2: Analysis of local needs in institutional capacity building.

Objectives:

- Identification of local institutional alternatives for promoting sustainable natural resources management.
- Local development through targeted training.

Methodology:

- Collection and analysis of the available secondary informations.
- Survey directly the administration staff and local development actors in Talzemt, particularly the local community and civil organizations (interviews and focus groups).

Starting date: Jan, 2012  
Completion date: Dec, 2012

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection and analysis of the documentation</td>
<td>April, 2012</td>
</tr>
<tr>
<td>Interviews with the local development stakeholders</td>
<td>May, 2012</td>
</tr>
<tr>
<td>Data analysis and report writing</td>
<td>Dec, 2012</td>
</tr>
</tbody>
</table>

Activity 3: Institutional support for local development stakeholders

Objective:

- Strengthen of the local common knowledge and capabilities in management of natural resources and intervention for the sustainable development.

Methodology:

- Participative elaboration and implementation of a training plan.
- Realization of training courses for the benefit of the local associations and groups.
- Identification of experimental actions to be implemented in association with local -- community and/or civil actors.
- Frame and advising in institutional and technical support required by experimental actions carried by organized local initiatives relative to the sustainable management of natural resources and to the participative local development.
Starting date: Jan, 2012  Completion date: Jun, 2014

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participative elaboration of a training plan</td>
<td>2012</td>
</tr>
<tr>
<td>Training course</td>
<td></td>
</tr>
<tr>
<td>Realization of training courses</td>
<td>2012-2014</td>
</tr>
<tr>
<td>Technical and institutional frame and required support by experimental actions carried by</td>
<td>2012-2014</td>
</tr>
<tr>
<td>organized local initiatives relative to the long-lasting (sustainable) management of</td>
<td></td>
</tr>
<tr>
<td>natural resources and to the participative local development</td>
<td></td>
</tr>
</tbody>
</table>

Activity 4: On-the-job training for farmers on tree pruning, irrigation management, post-
harvest, IPM (local)

Objectives:

- From the collected data during the site characterization we have noticed that there is a big
gap between the generated technologies and the adoption by farmers. There is an urgent
need in demonstrating the advantages of improved cultural techniques and their impact in
improving considerably the obtained yields. These techniques are mainly adequate tree
pruning, irrigation management, post harvest and IPM. Following these recommendations, farmers could easily improve their production and consequently their income.
- We are approaching the diffusion of these improved techniques through on-job training
for famers in the watershed. Our goal is to reach the maximum of the farmers,
stakeholders and extension specialists.

Methodology:

- Organizes training for all deficient cultural techniques. These on-job training will be
organized following the main cultivated crops in the region. We intend to cover fruit tree
crops (tree pruning, fertilization, IPM and post harvest techniques), annual crops (variety
selection, seeding period, weed control, disease control and conditioning).
- Besides the on-job training we intend to edit technical bulletins for the main crops in the
watershed (fruit trees, cereals, food legumes and vegetables).
- As we intend to install demonstration trials in collaboration with farmers we plan to
organize Farmer field days to share knowledge with famers and extension specialists.
These field days will give us an opportunity to show the latest technologies developed by
research in these areas. Also, this will give us an opportunity to exchange information with farmers and get more in depth of local knowledge. This trial will be used as farmers field school (FFS).

Starting date: Jan, 2012
Completion date: Jun, 2014

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training of the farmers in the watershed</td>
<td>June 2014</td>
</tr>
<tr>
<td>Production of technical bulletins for main crops.</td>
<td></td>
</tr>
<tr>
<td>Organization of field days and FFS.</td>
<td></td>
</tr>
</tbody>
</table>
REGIONAL ACTIVITIES
Activities conducted in 2011

Technical support:

Before the inception workshop, ICARDA scientists made two visits each participating to provide technical backstopping.

The first visit aimed at pressing the project to the partners in each country, building up the project teams and selecting the benchmark site. This event was attended by NARS and universities scientists, extension and Ministries of Agriculture engineers and representatives from IFAD development projects.

The objective of the second visit was to help the partners in each country to finalize the preliminary work plans to be presented and discussed during the inception workshop.

Development of the plans of work (POW)

The preliminary work plans were presented by the national coordinators and discussed by the participants from the three countries and different institutions, including IFAD, during the inception workshop. It is worthwhile mentioning that the start-up (inception) meeting was delayed until June to give more time to the teams to select appropriate sites, identify major constraints on which the work plan development and adjustment should be based.

After the presentations and discussion of the preliminary work plans, the participants in the meeting three concurrent sessions were conducted where each activity was analyzed and approved. Recommendations were made to the Nationals to revise and detail their POW within weeks and send them to the ICARDA team for their inputs and finalization.

Training and workshops

ICARDA organized training in Amman, Jordan for participants from the three countries on SWAT model that will be used in the modeling and simulation of different scenarios of watershed management in the Mountains.

ICARDA organized, in Amman, Jordan a workshop for the three countries to discuss and decide on the methodologies of sampling and data collection for the suitability and modeling purposes.
Activities proposed for 2012

1. Technical support:
   • This will continue

2. Training:
   For training, we propose 3 activities:
   • A training workshop on “scheduling irrigation using Aquacrop and remote sensing”
   • On-the-job training on SWAT model. This will depend on data availability and progress.
   • Scientific writing (Journal articles, reports, presentations…)

3. Publications:
   • A newsletter of the project

4. Web site:
   • The project web-site will be developed.
BUDGET
Proposed Project Budget 2012

Table D-1. 2012 budget by country.

<table>
<thead>
<tr>
<th>Budget</th>
<th>Lebanon</th>
<th>Jordan</th>
<th>Morocco</th>
<th>Total /Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Operations</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Equipment</td>
<td>25,000</td>
<td>25,000</td>
<td>25,000</td>
<td>75,000</td>
</tr>
<tr>
<td>Meetings &amp; workshops</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Training and dissemination</td>
<td>5,000</td>
<td>5,000</td>
<td>5,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Total national budget</td>
<td>55,000</td>
<td>55,000</td>
<td>55,000</td>
<td>165,000</td>
</tr>
</tbody>
</table>

Table D-2. Summary of Regional and national budgets.

1. Regional Activities and Coordination

<table>
<thead>
<tr>
<th>Activity</th>
<th>Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publicaction</td>
<td>10,000</td>
</tr>
<tr>
<td>Regional Training Workshops</td>
<td>55,000</td>
</tr>
<tr>
<td>Technical Support &amp; Management</td>
<td>60,000</td>
</tr>
<tr>
<td>Sub-Total Regional Activities</td>
<td>125,000</td>
</tr>
</tbody>
</table>

2. National Activities            | 165,000|
3. Contingencies                  | 5,000  |
4. Indirect Costs                 | 44,250 |
Total budget 2012                  | 339,250|
## Statements of Receipts and Expenditures

**IFAD Grant 1226 ICARDA**  
**ICARDA Ref # 1218**  
**Amounts in US Dollars**

<table>
<thead>
<tr>
<th>Reported to Donor</th>
<th>Budget</th>
<th>January-June 2011</th>
<th>July-November 2011</th>
<th>Total Expenditures 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receipts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grants</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expenditures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td>200,000</td>
<td>3,793</td>
<td>21,302</td>
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<td>Operations</td>
<td>310,000</td>
<td>11,902</td>
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<tr>
<td>Equipments</td>
<td>240,000</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meeting and Workshops</td>
<td>40,000</td>
<td>28,985</td>
<td>24,732</td>
<td>53,717</td>
</tr>
<tr>
<td>Training and dissemination</td>
<td>60,000</td>
<td>-</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Indirect costs</td>
<td>150,000</td>
<td>7,885</td>
<td>7,423</td>
<td>15,308</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,000,000</strong></td>
<td><strong>52,565</strong></td>
<td><strong>65,408</strong></td>
<td><strong>117,973</strong></td>
</tr>
<tr>
<td>fund (Deficit)/Advance</td>
<td>-</td>
<td></td>
<td></td>
<td>117,973</td>
</tr>
</tbody>
</table>