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# Soil conservation and water harvesting to improve community livelihoods and fight land degradation in the mountains of Syria

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Key words: participatory approach, community-watershed research, Olive, knowledge dissemination, climate change

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## List of abbreviations

| | |
|---|---|
| ACED | Assessment of Current Erosion Damage |
| EGU | European Geosciences Union |
| GCSAR | General Commission for Scientific and Agricultural Research – Syria |
| GEF | Global Environmental Facility |
| ICARDA | International Center for Agricultural Research in the Dry Areas |
| INRM | Integrated Natural Resources Management |
| IPCC | Intergovernmental Panel on Climate Change |
| JIRCAS | Japan International Research Center for Agricultural Sciences |
| SGP | Small Grant Program |
| SL | Syrian Lira (Pound) |
| SWC | Soil and Water Conservation |
| UNDP | United Nation Development Program |
| UU | Utrecht University (Netherlands) |
| WOCAT | World Overview of Conservation Approaches and Technologies |
| CCAFS | Climate Change, Agriculture, and Food Security |
| CGIAR | Consultative Group on International Agricultural Research |

## Executive summary

In the mountainous and arid regions of northwest Syria, water and land resources are under pressure from natural and human-induced forms of land degradation. This has resulted in lower incomes for families dependent on olive farming. This study explores the impact of natural resource management, supported by a micro-credit system, on the environment and the livelihoods of farming communities in the area.The aim of the project was to expand the implementation of water harvesting, soil conservation, and water-use efficient diversification technologies among communities. The problems associated with this included establishing practices to provide farmers with an income in both the short and long term, overcoming community resistance to these new practices, and financing the projects.

Investment in new techniques and systems is costly and returns are long term. A participatory approach was adopted to help overcome community resistance to the proposed changes. Promotional materials were circulated, increasing interest and awareness, and communities were actively involved in the planning and implementation of activities. To provide an income in the short term, farmers were encouraged to diversify. This reduced their vulnerability and promoted the sustainable use of resources.

To implement these measures, financing and the support of local Extension Departments was essential. Funding was obtained from the UNDP-Global Environmental Facility Small Grant Program to establish a community micro-credit system, with support from the Coca-Cola Foundation, ICARDA, the Agricultural Extension Services (Ministry of Agriculture), and the General Commission for Scientific and Agricultural Research. Loans were extended to 222 farming families to implement soil conservation strategies and water harvesting techniques. The allocation of loans was prioritized according to the degree of land degradation. This was assessed by integrating GIS-based land degradation priority maps and land tenure maps, and through discussion with the communities.

The project was successful, both in economic and environmental terms. The biophysical and socioeconomic monitoring systems at the field and watershed levels indicated a positive environmental impact. Assessment of the conservation measures showed that a few heavy rainfall events accounted for most of the total sediment loss from agricultural fields. The erosion-prevention practices adopted, such as semi-circular and continuous stone bunds, reduced rill erosion by up to 60%, capturing 3.2 tonne of soil per hectare.Furthermore, the project was fully supported by the community. Through diversification, farmers saw a positive socioeconomic benefit in the short term, which made them more receptive to investing in longer term land degradation mitigation activities. A range of profitable options meant that strategies could be tailored to each individual farmer's needs and capacity. This flexibility was essential to the success of the project.

The study provides a model for implementing land and water resource conservation strategies in mountainous, arid areas. A community-based plan prioritized the implementation of various interventions to optimize the positive environmental impacts, land productivity, and the use of water resources. The methods employed here could be extended to other communities across Syria and throughout similar Mediterranean regions.

In order to promote sustainable development which reduces the vulnerability of rural areas to climate change, support for soil conservation and water harvesting activities by appropriate public policies is indispensable.

## Introduction

Water and land resources are under pressure in the mountainous areas of the world's arid regions. Natural and human-induced forms of land degradation have resulted in ever decreasing income from olive fields in these areas. Most of these changes are reversible if wise conservation measures are implemented at the right time and in the right places.

Through farmers' participation, this project sought to implement water harvesting and soil conservation measures, which would improve land productivity and, therefore, improve the income of farmers.

The project helped to expand the implementation of water harvesting, soil conservation, and water-use efficient, diversification technologies in communities in the mountainous areas of northwest Syria (Figure 1). The development of community micro-credit systems and the active support of local Extension Departments are keys to the widespread and sustainable development of these areas. The Coca-Cola Foundation, the International Center for Agricultural Research in the Dry Areas (ICARDA), the Agricultural Extension Services (Ministry of Agriculture), and the General Commission for Scientific and Agricultural Research have helped two communities in the mountains of Afrin and Idlib to obtain money from the UNDP-Global Environmental Facility Small Grant Program to establish a community micro-credit system. The farmers in these communities have been requesting interest-free loans for water harvesting, soil conservation, and water-use efficient, diversification options on their land. In this project, the example of Maghara, (Figure 2), was used as the basis for out-scaling soil and water management technologies in communities in the mountainous areas of Bitiya (Figure 3). ICARDA, in cooperation with the local Extension Departments, provided technical support for the implementation. The impact of a micro-credit system, which supports natural resource management in the environment and the livelihoods of these communities, was assessed.

The project distributed loans to 222 farmers and their families, which helped them implement various soil conservation and water harvesting interventions as well as different diversification options. The distribution of loans was organized by integrating a geographic information system-based land degradation priority map with the communities' judgments and land tenure maps. This helped in the preparation of a community-based plan to prioritize the implementation of various interventions to optimize the impact on the environment, improve land productivity, and optimize the use of water resources. The biophysical and socioeconomic monitoring systems at the field and watershed levels indicated a positive environmental impact and highlighted different profitable options that suited the farmers' capacities and needs. Out-scaling a model, successful in one community to another, resulted in significant benefits for both communities, as well as for the surrounding ones. The dissemination materials (brochures, posters, conference abstracts, and videos) produced, and the training sessions and meetings were very helpful in raising the awareness of the communities involved. They enhanced their technical know-how as well as creating interest and awareness among the surrounding communities and in the scientific arena.

The farmer's perceptions of water harvesting and soil conservation interventions are very important determinants of adoption and should be carefully considered in addition to profitability. From a farmer's point of view, investment to prevent land degradation is costly and shows benefits only in the long run. However, diversification of agricultural activities, which leads to the sustainable use of resources, provides an opportunity to get short-term benefits and reduce the farmer's vulnerability as well as sustaining resources.

An assessment of the preventative measures showed that only a few heavy rainfall events accounted for most of the total sediment loss from agricultural fields. In this study, soil and water conservation practices reduced rill erosion by 60%, and captured 3.2 tonne of soil per hectare (t/ha), that would otherwise have been lost. The severity and frequency of these heavy rainfall events is expected to be aggravated by climate change and, therefore, suitable conservation practices coupled with an enabling environment should be implemented.

Helping communities to draw up plans to prevent land degradation and to apply sustainable practices and technologies, improves land and water use. The participatory approach builds on the main interest of the farmers, which is to secure and increase the production of olives. The results of the project could be out-scaled to the entire mountainous area of Syria and other similar Mediterranean areas, leading to a more productive and sustainable use of the land and water resources. Measures to prevent soil erosion and harvest rainwater are important for adapting to changing patterns of rainfall because of climate change.

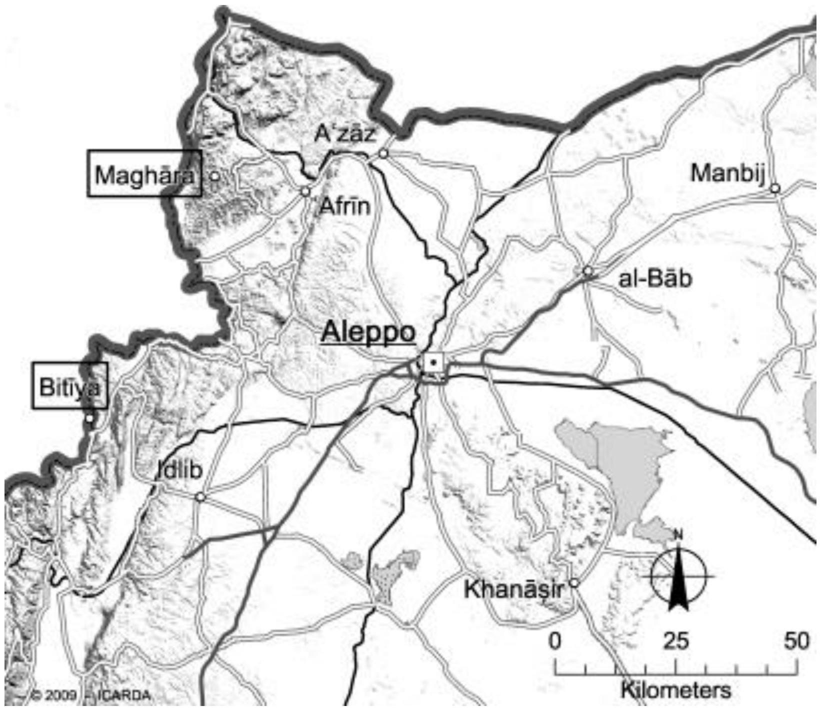



**Figure 1: Location of the two communities (Maghara and Bitiya) in northwest of Syria**

**Figure 2: An overview of Maghara area; forests are replaced with olive groves**

**Figure 3: An overview of Bitiya area; olive groves on steep slopes**

## Development of community-based maps and prioritization of soil and water conservation (SWC) implementations

Soil erosion by water is the most pressing environmental problem in the olive farms of Syria and other areas where the topography is very rugged, steep lands are cultivated, and rainfall is erosive. A recent international assessment has alerted the world to climate change, ecosystem and environmental degradation, and natural resources degradation. The high erosion rates in the mountainous areas of Syria arise in part because of natural processes. In particular, the high erosion rates result from the steepness of the terrain, these coupled with the heavy rainfall are exacerbated, in part, by inappropriate land use or agricultural management practices.

Conservation practices are based on designing and building, semi-circular, earthen, water-harvesting bunds around the olive trees. Farmers also are trying to reduce erosion by creating continuous stone walls or fences, which are comprised of plants arranged in horizontal lines across the field, and by increasing surface roughness with annual grass covering the sloping lands. Framers also are practicing tillage, using animals or mechanization, two or three times a year. The farmers did realize the extent of the erosion, but claimed that the investments needed to conserve the soil were too costly. It became clear that land degradation could only be stopped by conservation systems which enhance olive production and increase farmers' incomes on a sustainable basis.

As land degradation is increasing, land managers are looking for new methods to manage and monitor soil erosion, which provide targeted and cost-effective conservation interventions by identifying the most vulnerable landscapes, and by setting priorities. The modeling of erosion and deposition is an important approach, which can be used for land management, and to prioritize areas for implementing SWC. However, this approach is data demanding and it takes a long time to establish robust conservation plans which are easily understood by farmers and extension staff. Alternatively, the vulnerability map and the erosion prone areas can be extracted by applying spatial analysis on a geographic information system.

There has been a growing interest in the use of participatory approaches in the natural resource management, agriculture, and rural livelihoods sectors. The adoption of social participatory action, through the involvement of the local farmers, for assessing the resource base conditions has become an attractive methodology for many conservation and development studies. Farmer-participatory monitoring and evaluation of soil erosion risk assessments can help in managing natural resources.

In this project, a map of erodible land was created using topographic parameters for small catchments. With the active participation of the communities involved, areas of erosion were identified and targeted with the optimum SWCs measures to improve productivity and enhance environmental sustainability.

The target community is the village of Maghara (latitude 36°32’24” N) and (longitude 36°39’21” E), northwest of Aleppo, Syria (Figures 1 and 2). The area has a Mediterranean-type climate; it receives an average annual rainfall of 525 mm, concentrated between September and June. The mean annual temperature is 17°C. The soil is medium- to fine-textured, mostly shallow to very shallow, with low to medium organic matter content. Over time, the farmers have replaced native forest with olive groves, as well as almond, walnut, and different forestry plantations.

Geographic information system layers of flow accumulation, slope, and surface curvatures were derived to produce the priority erosion map (Figure 4). Flow accumulation was considered as relevant to this study, because it defines the locations of water concentration after rainfall and those locations are likely to have a high incidence of erosion. The consultation with farmers indicated that SWC measures implemented in fields which are located at lower positions within the catena (topographical sequence) are not effective because these fields receive erosive runoff from upper fields. The relation between slope steepness, land curvature, and risk of erosion is very well known, especially in these mountainous areas. Flow accumulation and slope have been classified into three categories (1 = high, 2 = medium, and 3 = low), and land curvature into two categories (1 = high and 2 = low). The classification was based on ranges of these values and a rationalization based on erosion severity. The classification was refined in the field using erosion evidence and the judgment of local farmers to create the final priority map. The use of a geographic information system facilitates many iterations to arrive at reasonable results, which were finally appraised by the community.

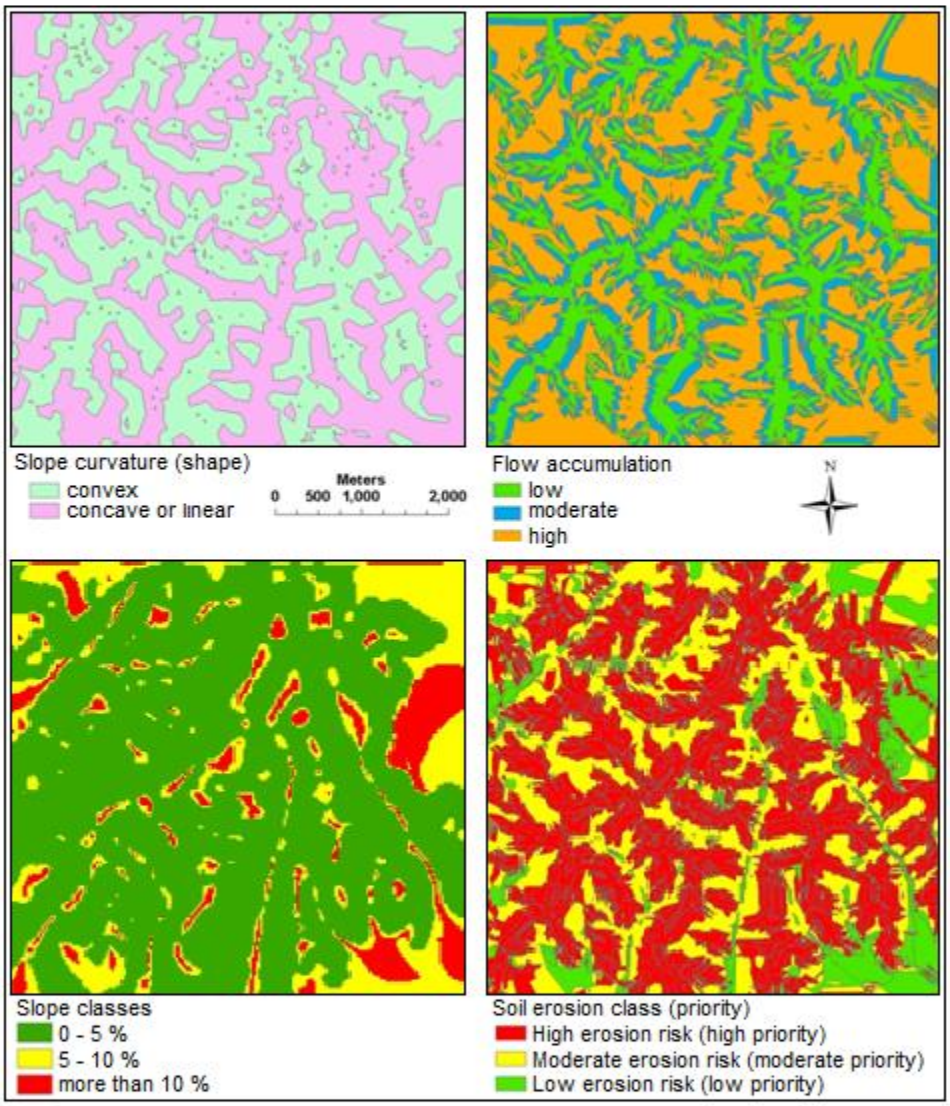



**Figure 4: Overlays of flow accumulation, slope, and curvature maps used to produce the land degradation priority map**

A field survey, using an aerial photo map and with the participation of the community, was conducted to draw the boundaries of the targeted farms, and establish the ownership and current conservation practices. The land ownership map was overlaid with the erosion map (Figure 5) to show the erosion status of the field and the conservation practices. This was used to define the priorities for SWC implementation. Sixteen fields (Figure 5) were randomly selected to verify the field erosion status and to produce the priority map. Community members were asked individually to present their perceptions of the erosion map and the extent to which it agreed with the eroded areas of their field.

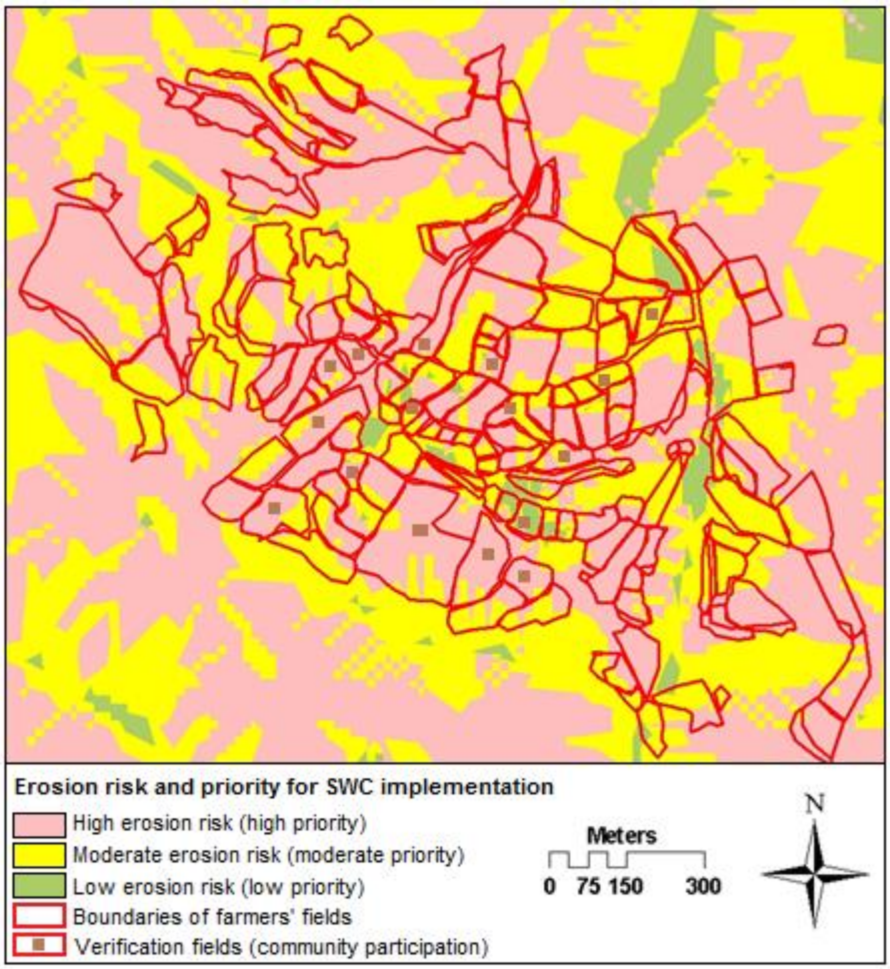



**Figure 5: Erosion risk (priority) classes overlaid with the boundaries of the farmers' fields and the location of the ground verification fields**

About two-third (67%) of the watershed lands were classified as areas with high erosion risk (high priority), 26 % fell into the medium erosion risk category, and just 7% assigned a low erosion risk. There was an obvious relationship between the distribution of areas with different erosion classes and the topographic parameters of flow accumulation, slope, and land curvature (Figure 4).

The priority map was overlaid with the boundaries of the farmers' fields. Some fields (verification fields) were visited with a group of farmers and the erosion risk (priority) indicated by the map was compared with field conditions. Farmers and scientist emphasized that the agreement between the map and the ground conditions was acceptable.

The farmers indicated that the erosion risk map categorized their fields into relevant classifications and, with guidance from the scientists, they indicated their willingness to use the map as a basis for prioritizing the implementation of SWC interventions. They found this rationale to be much better than the existing approach, where loans for implementing SWC interventions are distributed without taking into consideration a priority for the fields. They also indicated that such classifications, if accepted by the whole community, would avoid bias among the beneficiaries and would help to reduce erosion from neighboring fields which affected their fields. A community meeting was arranged, where the map and the whole approach was explained. In this meeting farmers, who participated in the verification of the priority map, stood side by side with the scientists to explain the approach and the benefits of adopting such a rationale in distributing loans to reduce erosion and improve productivity. The community approved this and confirmed that the classifications of their fields into different erosion risk classes should be used to prioritize the implementation of SWC interventions at the village (watershed) level.

In summary, the results showed that more than 64% of the fields were classified into high erosion risk areas. Accordingly, a community-watershed plan was established, revised, and approved by the community. Incentive loans to implement SWC measures were distributed to 100 farmers based on the priorities of their fields. Judged by local farmers, the ground truthing, using 16 randomly selected fields, indicated that 90% of the targeted areas were correctly identified using the erosion risk map. The calculated rainfall intensity for each 10 minutes showed that the maximum rainfall intensity was 120 mm/hr in October 2009 and that more than 80% of the fields were degraded. After two years, the measures had led to a marked improvement in soil conservation. The approach is straightforward and easy to comprehend by the community and provides scientifically-based rules to facilitate prioritization of SWC implementation in response to climate change.

## Field implementation of the water harvesting and soil conservation interventions

With the participation of the communities, promising interventions were identified and proper documentation to illustrate these was prepared in various forms (brochures, posters, and movies) (See appendices A and B). The World Overview of Conservation Approaches and Technologies (WOCAT www.wocat.net) was used as a source of information to produce these materials. The WOCAT database is rich in describing various soil conservation and water harvesting interventions with sufficient information and illustrations. In collaboration with the Departments of Agriculture in Afrin and Idlib and the General Commission for Scientific and Agricultural Research many field days and meetings were organized for the two communities to raise awareness about the importance of managing water and land resources. A technology fair was organized in two villages. During these fairs all potential interventions were displayed along with an explanation of each. The farmers took a close look at each technology and decided, after discussion with scientists and extension services, which sustainable land management approach was the most relevant to their fields and/or households. This proved to be a very efficient and informative way to select the best sustainable land management approach. Field sessions were also organized to train the farmers on various technical issues to facilitate implementation of the water harvesting and soil conservation interventions. During the field days, farmers, extension workers, and researchers exchanged experiences and discussed the options for the rehabilitation of degraded sloping land.

The project helped the two communities to secure money from the Small Grant Program of the UNDP-Global Environmental Facility Trust Fund in Syria. Maghara community received a grant of USD 50,000 and Bitiya community received a grant of USD 44,000. Each village or farming community elected a committee, called the Land Management and Diversification Committee. The farmers and their families could apply to the committee and clarify the measures and activities to be performed. The committee examined the applications and determined their priority for obtaining a loan according to the importance of the measures or activities to reduce erosion and improve income. The economic situation of the farmers and their families is taken into account along with their ability to repay the loan. The farmers and their family are required to repay the loan within two years. The committee examines all new applications and decides on the granting of loans to other farmers and their families in the village. This means that all the inhabitants of the village will benefit from these small interest-free loans, according to set priorities. Farmers can benefit more than once from the scheme. This experience was tested in Maghara and Khaltan in Afrin and was out-scaled to Bitiya in Idlib. There was a close collaboration between the communities in Maghara and Bitiya; experiences were exchanged and the Bitiya community benefitted from the Maghara experience.

**Figure 6: Technology fair (upper right) and training of the communities on implementing SWC interventions**

Farmers in Maghara and Khaltan villages, in Afrin, and Bitiya village, in Idlib, assisted in the evaluation of the usefulness of these measures to reduce erosion and thus increase the yield of olives, their impact on the environment, and in improving the sources of income.

During the project lifetime, 222 loans were distributed to farmers and their families. The distribution of fields where the soil conservation and water harvesting interventions were implemented is shown in Figure 7. The impact of implementing SWC technologies as well as reduced or no tillage practices was assessed and will be discussed later in this report.

It is anticipated that villages in steep areas, which suffer from soil erosion and reduction of productivity, will benefit from the efforts of these pioneer villages to foster implementation of SWC measures to control land degradation, improve productivity, and diversify income generating activities.

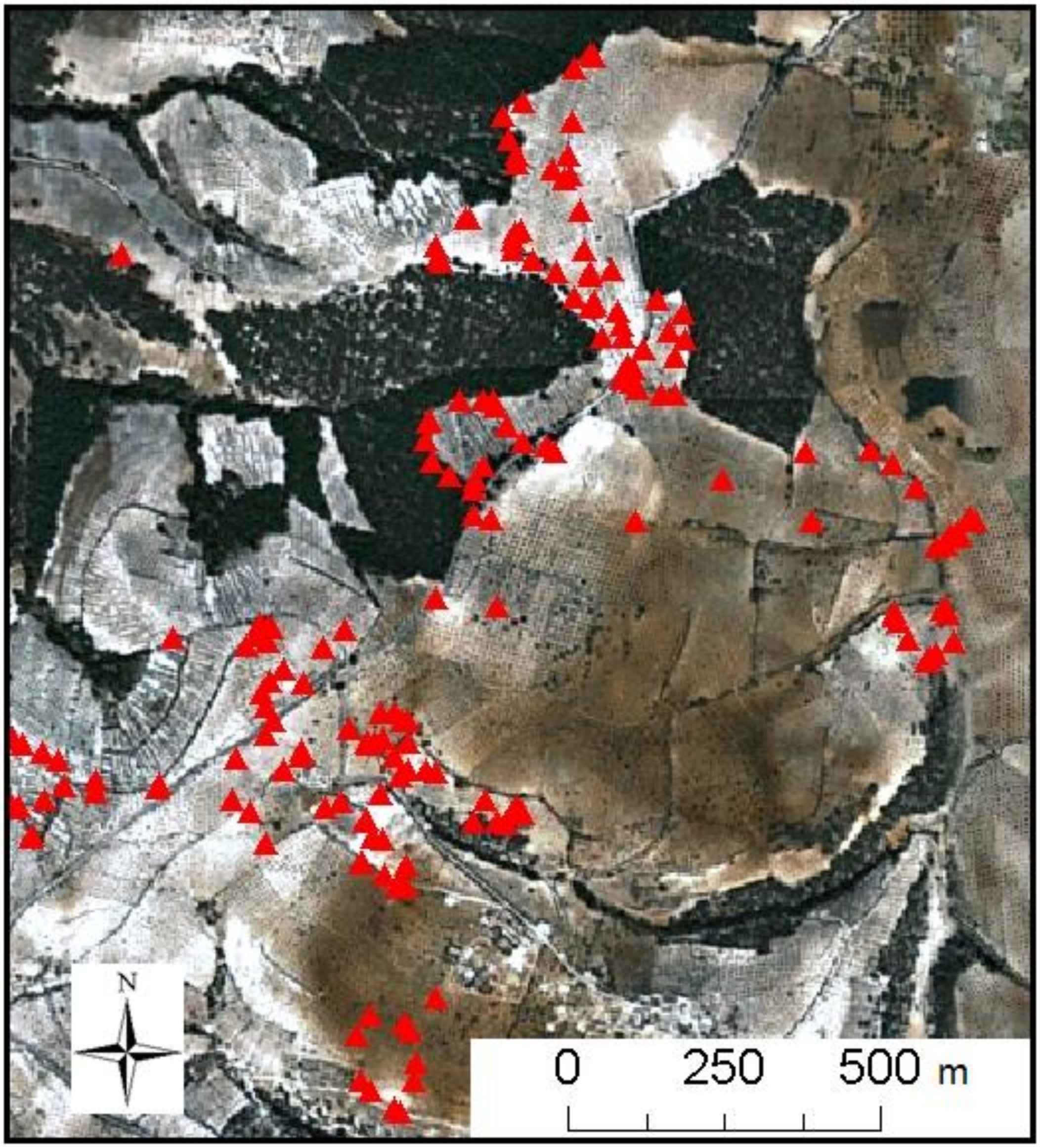



**Figure 7: Distribution of fields with soil conservation and water harvesting interventions in Maghara village**

## Assessment of the impact of farmers' SWC interventions in reducing soil and water losses

There are many methods for preventing soil erosion – fertilization, terracing, making SWC interventions, strip cropping, and contour plowing. However, there is little knowledge about the extent of soil loss and the optimal design of these interventions, so that the sustainability and effectiveness of these practices under variable temporal and spatial conditions is assured. A number of low-cost SWC interventions were implemented by farmers, but how effective these were in curbing soil loss has not been evaluated properly. It is important that when new practices are brought into use, their effectiveness in reducing the extent, rates, and frequency of water erosion needs to be monitored. The challenge is to adopt an easy and accurate method that enables assessment, within a reasonable cost and time, and at the same time, answers the questions raised by farmers, planners, and scientists.

Evaluation of the impact of SWC structures on soil erosion is indispensable in examining the outcomes from any project to protect agricultural lands from soil erosion and in building SWC structures which combat land degradation. The objective of this section is to evaluate the effectiveness of the SWC interventions implemented by farmers in reducing soil erosion under various field and rainfall conditions.

Eight agricultural fields, where SWC structures were implemented by the local farmers, were selected. Each field was characterized in terms of area, slope (steepness and curvature), soil, land use, and the characteristics of upslope field(s). Five fields had semi-circular stone bunds and three fields have continuous stone walls (Sakai, 2010).

Two agricultural fields were selected to compare rill formation in fields with and without SWC structures (fields 3 and 5, Figure 8). Part of the first field had semi-circular stone bunds and part of the second field had continuous stone walls; and each field has comparable parts without SWC structures. The assumption made here is that the difference in rill formation between the two parts of the field is mainly the result of the presence/absence of SWC structures. A number of measurements of both depth and width were taken for each rill to obtain an average cross-sectional area. These measurements of average cross-sectional area and length were used to calculate the volume and weight of soil displaced from the rill during a known period of time (between tillage and measurement time).

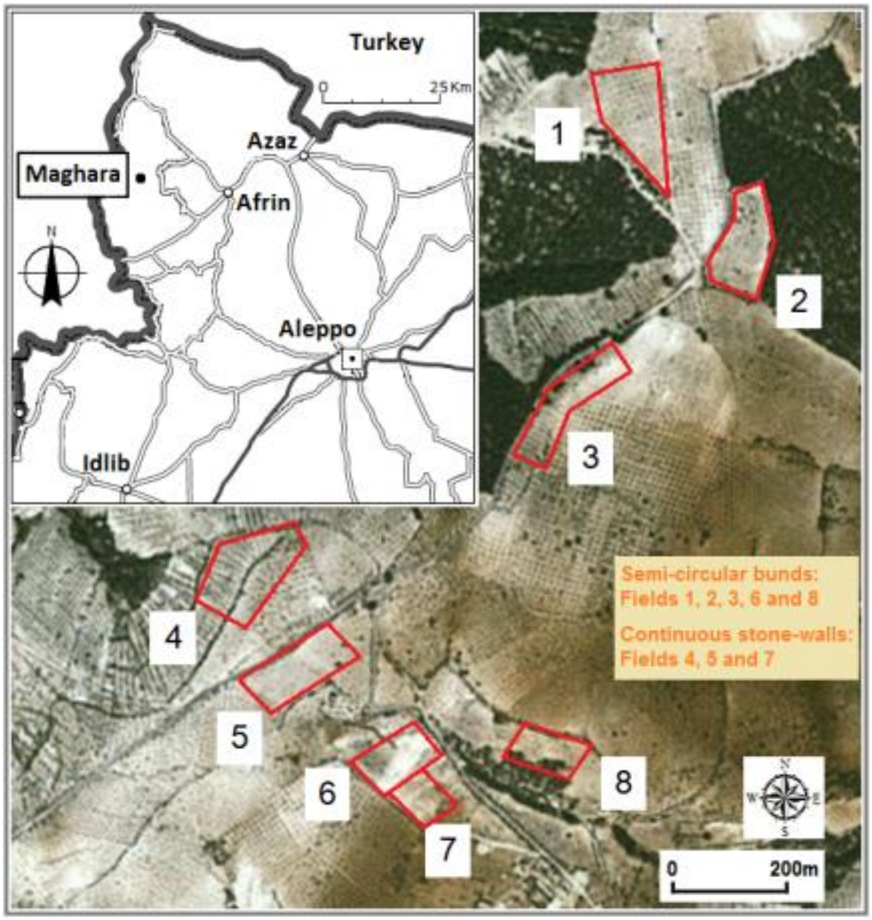



**Figure 8: Location of Maghara within Syria and location of farmers' study fields within Maghara village**

To estimate the volume of sediments captured by the SWC structures (semi-circular bunds and continuous stone walls), measurements using erosion pins were carried out at various dates over three rainy seasons (2008–2011). Two erosion pins (750 mm long, 8 mm diameter) were inserted behind the stone bunds. The height of the top of the erosion pin above the soil surface was measured at the time of installation (initial condition). The height of the top of the erosion pin from the soil surface was measured several times during the season. To estimate the amount of sediments accumulated behind the SWC structures, a simple mathematical equation was derived.

Meteorological data were collected from the weather station located at Yakhour village (5 km from the project site) for the first season and from a station installed in Maghara village for the second two seasons. The data included temperature, wind speed and direction, rainfall, and humidity. Daily rainfall measurements were also taken at Maghara village in cooperation with a farmer using a plastic rain gauge.

Comparing the results of the rill erosion assessment for two adjacent and relatively similar fields, one with SWC interventions and the other without, showed the effectiveness of the SWC interventions in reducing rill erosion (Table 1 and Figure 9). The semi-circular bunds reduced total rill erosion from 138.9 to 82.9 t/ha and reduced the number of rills from 25 to 13. Although soil loss is still high because of the field's biophysical condition and the extreme rainfall events, the reduction in rill erosion (56 t/ha) is appreciable. If the semi-circular bunds are integrated with some other management practices, such as conservation tillage, rill erosion could be reduced to tolerable limits under these harsh conditions.

**Table 1: Soil losses from fields with SWC interventions and from fields with no interventions**

| Parameter | Field 3a. Semi-circular bunds | Field 3b. No interventions | Field 5a. Continuous stone bunds | Field 5b. No interventions |
|---|---|---|---|---|
| Field area ($m^2$) | 1400 | 1400 | 3000 | 3000 |
| Average slope (%) | 37.1 | 38.7 | 29.9 | 26.8 |
| Number of rills | 13 | 25 | 0 | 26 |
| Total volume of rill ($m^3$) | 10.0 | 17.5 | 0 | 3.56 |
| Soil bulk density (Mg $m^{-3}$) | 1.16 | 1.11 | 1.12 | 1.15 |
| Soil loss (t/ha) | 82.9 | 138.8 | 0 | 13.6 |

The challenge with these small rills, which cause such high soil losses, is that farmers usually remove them by tilling the soil, not by finding a conservation means to reduce land degradation. These rills are only visible after a severe (high intensity) rainfall event. The amount of soil loss is high and, therefore, soil conservation intervention is needed.

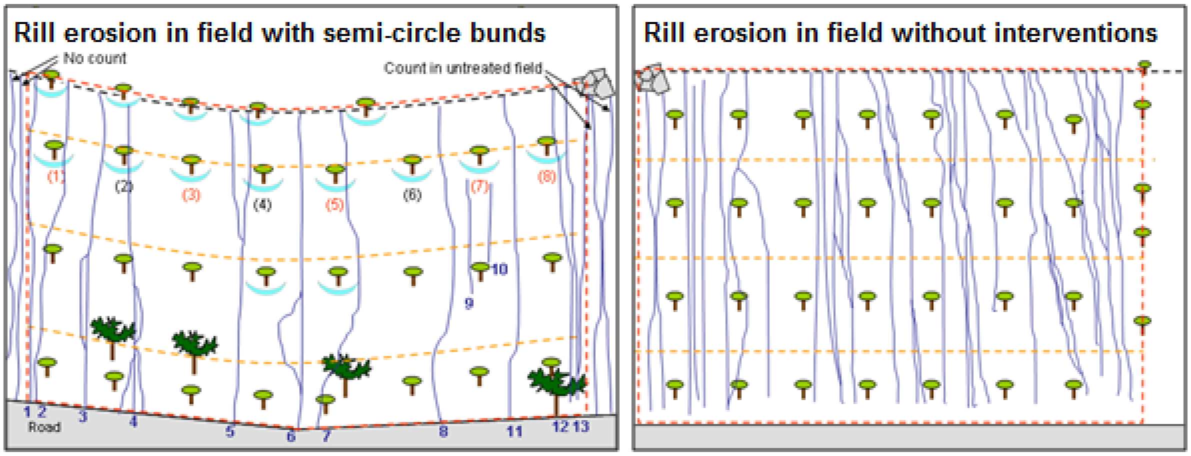



**Figure 9: A sketch showing the distribution of rills in a field with semi-circular bunds and a field without any interventions**

In the case of continuous stone bunds, no rills were observed on the field where the SWC intervention was implemented, while in the adjacent field without any interventions, 13.6 t/ha of soil loss was recorded, resulting from the 26 rills observed. Although the slope steepness was slightly higher for the field with continuous stone bunds, no rills were observed. This pointed to the positive effect of these stone walls in reducing runoff velocity and, consequently, erosion losses. One of the indirect effects of implementing contour stone structures is that the farmers are forced to follow the contour lines when they till their lands. In the absence of these walls, farmers usually prefer up-and-down the slope tillage. This enhances tillage erosion and provides small channels that facilitate the formation of rills as soon as a significant rainfall event starts.

The results for the second rainy season (2010/2011) agreed with those of the first season 2009/2010 (Figure 10). Despite the differences in climatic conditions and management between those two seasons, the differences in rill erosion between fields with and without SWC interventions is comparable. This indicated that the approach followed in this research to measure rill erosion and to assess the effectiveness of SWC interventions in reducing soil erosion and land degradation is reproducible. This approach is straightforward and is recommended in areas where estimates of the effectiveness of various SWC interventions in reducing rill erosion are needed. Implementing this approach for various fields and under different conditions will help conservationists to select the most suitable intervention(s) for different sets of conditions, which might help in reducing the impact of sever rainfall events in these areas.

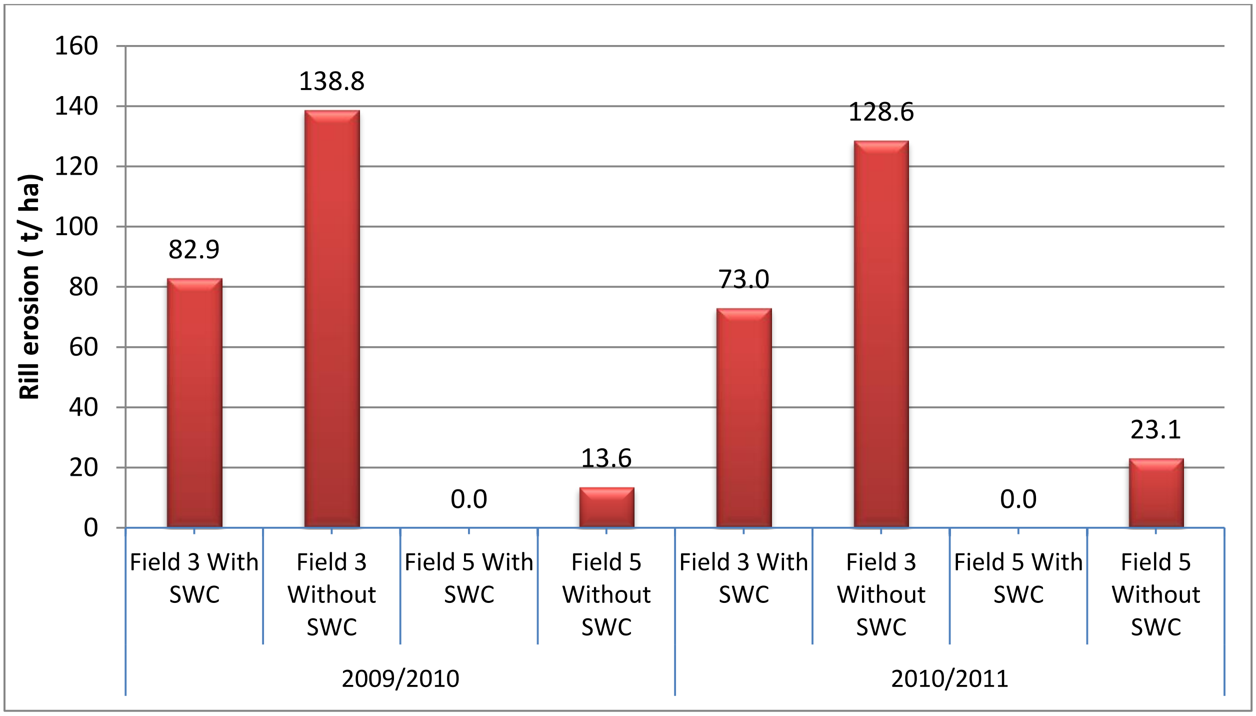



**Figure 10: Comparison of rill erosion for fields with and without SWC interventions during two rainy seasons**

The results showed that the amount of sediment captured by the SWC interventions varies significantly across different fields and rainfall events (Figure 11). Generally, more intense rainfall events resulted in more erosion and, therefore, more sediment is captured. It was estimated that a few rainfall events of high intensity are responsible for a high proportion of the annual soil loss in this mountainous area. The frequency and intensity of sever rainfall events is expected to increase in the future because of climate change and, therefore, implementing water harvesting and soil conservation interventions, in a rational and scientifically-based fashion, is needed to protect these lands from degradation. The efficacy of the water harvesting and soil conservation interventions is clearly shown. These sediments captured by the interventions would otherwise leave the fields and contribute to soil and water losses. This represents the direct impact of erosion on the field, the off-site impact on the environment through the pollution and sedimentation should also be considered.

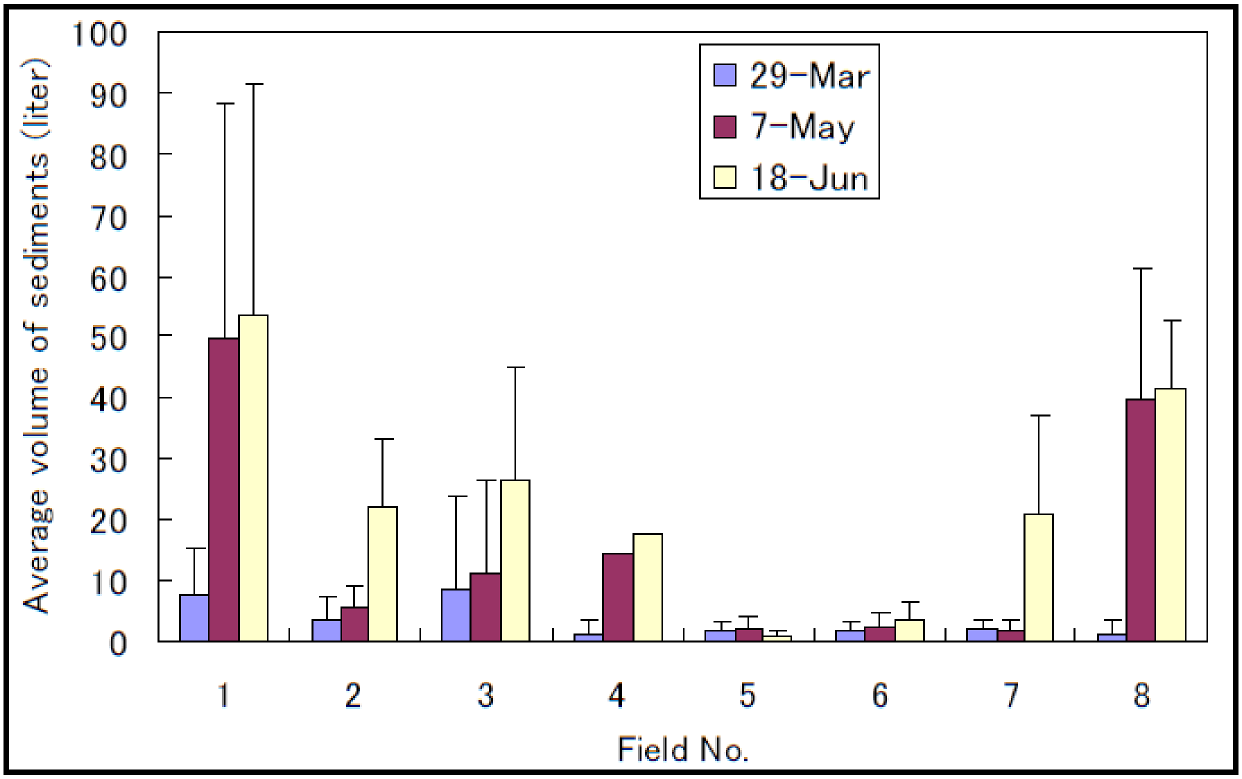



**Figure 11: Average sediment captured by SWC interventions for various fields for three rainfall events**

Another study was conducted to quantify the amount of hill slope erosion for an olive orchard with and without soil conservation structures in northwest Syria (Van der Zanden, 2011). Three olive orchards were used for the Assessment of Current Erosion Damage (ACED) measurements. In one selected field, three 2 m Gerlach troughs and eight small collectors were used for the measurement of surface runoff and sediment concentration.

Correlations between rainfall, runoff, and sediment data further showed that the rainfall intensity is the driving factor influencing the runoff and sediment load, indicating a common process of surface runoff and soil loss.

The results clearly showed the benefits of soil conservation and water harvesting interventions in reducing soil and water losses at the farm level (Figure 12). These benefits are useful in reducing soil and water losses and improving the productivity of the olive trees. The investment to implement these interventions is justified by the experimental results as well as by the farmers' observations of the improvements in yield and the reduction of soil and water losses.

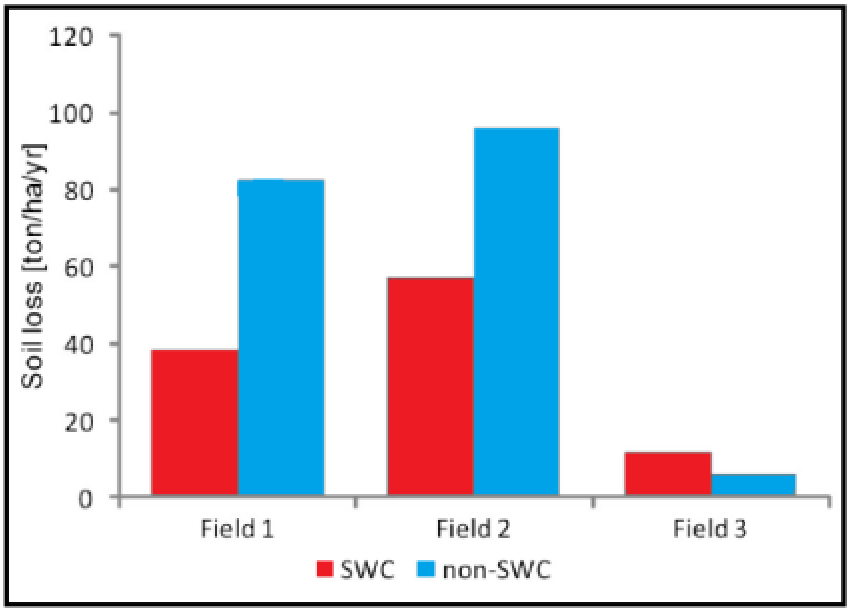



**Figure 12: Soil loss for fields with and without SWC interventions**

## Participatory approach and dissemination of knowledge among farmers and communities

A farmer-participatory approach was followed, involving a large part of the community in selecting options and conducting controlled on-farm experiments with farmer consultation. Meetings were organized in order to identify farmers' priorities and which land management practices would be the most suitable for them.

Following the results of the first meetings with the farmers, the researchers selected conservation practices ('agronomic' and 'structural' packages) which were cost effective and which would increase farmer income. The agronomic package included vetch intercropping or applying manure, in combination with less tillage. The structural package was a combination of agronomic practices and building a semi-circular bund and stone wall water harvesting terrace for each tree (Appendices A and B).

To ensure that the farmers had sufficient information on the available technologies, 'technology fairs' were organized. The objective was to expose the community to a number of possible options for soil conservation. Pioneer farmers, who are testing technologies by themselves in cooperation with ICARDA, were invited. During the fair, posters of SWC measures were prepared detailing their strengths, weaknesses, costs, and benefits. The following technologies were presented (Appendices A and B):

- Stone bunds (walls) following contour lines (continuous)
- Semi-circular stone bunds (only possible in fields where the trees are staggered)
- Stone bunds within the *wadi* floor (limited to some areas within the *wadis*)
- Addition of soil around the tree trunks with/without semi-circular bunds
- Addition of organic manure around the tree trunks with/without semi-circular bunds
- Reduced tillage (number of tillages and the tools used)
- Contour tillage (against the slope direction)
- Intercropping with cover crops (contour strips of vetch)

The farmers of the two communities were brought together at some of the meetings to exchange their experiences and knowledge. This exchange of views between farmers who had already experimented with the technologies and those coming new to the project was very important in accelerating the adoption of these technologies.

Proposing suitable technology is the first step in spreading adoption. Participatory research involving farmers in the different stages of designing technologies allows adapting the technologies to the farmers' priorities and constraints. The participatory technology evaluation gives a platform for interaction between farmers, scientist, and any other agents of development (extension office). It also increases the amount of information available to the farmers about the new technologies and permits the scientist to know the perception, the constraints, and the priorities of the farmers. The second main advantage of participatory research and of organizing such 'technology fairs' is that these activities increase the farmers' knowledge of the options available. This increased knowledge allows them to choose freely, with guidance from the scientists and extension services, the most suitable options for their particular circumstances.

In order to promote the participation of the communities and spread the information the following activities were executed:

- Meetings with farmers at each community and farmer-to-farmer exchange visits among different communities
- Preparation and distribution of media material such as:
    - Posters (Appendix A)
    - Brochures (Appendix B)
    - Documentary presentation (slides with sound) in collaboration with the UNDP- Global Environmental Facility Small Group Program in Syria
    - Posters presented at international conferences (Appendix C)
- Host visiting researchers, students, and trainees from the National Agricultural Research and Extension Systems and advanced research institutes of developing and developed countries. These meetings increase knowledge and broaden awareness about sustainable water and land management in mountainous environments
- Technical support was also provided to interested communities surrounding the selected ones. ICARDA included these activities in its widely distributed reports, publicity venues, and media in Syria and other countries in the arid region

- Make films documenting these activities (identifying the problems and the consequences of land degradation, possible solutions, and the micro-credit system)
- Document water harvesting and soil conservation technologies and approaches in a database published world wide – World Overview of Conservation Approaches and Technologies (WOCAT), www.wocat.org.

## Characterization of rural livelihood strategies and adoption and impact of SWC interventions

A survey covering all farmers in the two villages was completed. The purpose of the survey was to collect data on:

- Farmers' livelihoods and assets
- Production practices
- The SWC technologies which farmers have adopted
- Uses of micro-finance
- Farmers' experiences and perceptions of the technologies
- The productivity and environmental benefits that farmers have gained from the soil and water technologies.

The survey also included questions for capturing the cost/benefit data of the technologies, which then allowed a farm level economic feasibility analysis to be conducted. The analysis of this survey provided a complete assessment of the long-term sustainability and acceptability of the SWC technologies introduced into the villages. In addition it provided a strong message to farmers, extension services, and policy makers to support SWC technologies, including conservation agriculture, in these fragile soils and improve the welfare of these communities.

The survey indicated that the adoption of SWC technologies increased with time and generally at an acceptable level (Figure 13). However, determinants of adoption are numerous and depend on many factors, while the process of adoption is often misunderstood by researchers. To resolve these problems, the integrated natural resources management concept was used to deal with the complex situation of the defined area. It is within this framework, that the case study presented in this report has been designed.

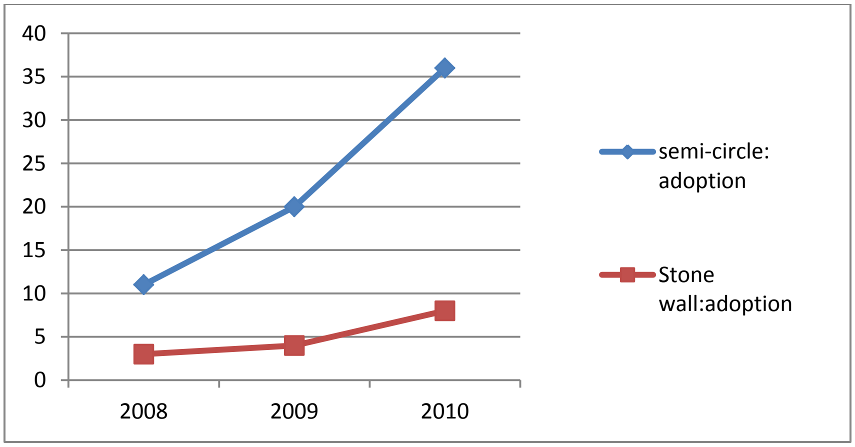



**Figure 13: Number of adoptions of semi-circular bund and stone wall SWC interventions 2008–2010**

Table 2 summarizes the main results from the cost/benefit analysis for the six different technologies promoted by the project. A description of these interventions, together with their benefits and constraints, can be found in Appendix A. These technologies include two different approaches. One is concerned with structures which help to reduce erosion and combat land degradation; it requires long-term investment. The other approach includes land management practices where the decision to practice or not can be made every year.

**Table 2: Cost-benefit analysis of SWC interventions**

| Technology | Number of years to be profitable | Profit after 5 years (SYP*/ha) | Profit after 10 years (SYP/ha) | Profit after 15 years in (SYP/ha) |
|---|---|---|---|---|
| **Semi-circular bunds** | 5 year | 3,439 | 43,289 | 88,059 |
| **Stone wall** | 7 year | -2,713 | 44,184 | 108,970 |
| **Adding soil** | 11 year | -20,551 | -8,664 | 13,742 |
| **Adding manure** | Profitable the first year if the yield increase is more than 30% | | | |
| **Intercropping** | Vetch generates cash; it is profitable by itself, even if there is no effect on the olive trees | | | |
| **Contour cultivation** | Profitable if the yield increase is more than 7 to 17% according to the number of tillages practiced per year | | | |

* USD 1 = SYP 46

The long-term benefits of both kinds of structures (semi-circular bunds and stone wall) are much greater than the long-term profit from adding soil. Indeed structures give cumulative benefits; they are investment for the present and the future generations. Yet adding soil is quite a popular practice among farmers, although it is not a sustainable technology. Adding soil or manure 'repairs' the on-site effect of erosion, but it does not protect the land from erosion. These practices have to be promoted in combination with the structures which can reduce erosion of the field. Moreover, SWC structures provide a benefit to the farmer by reducing erosion and thus improving land productivity; they also reduce the off-site costs of erosion, such as pollution and sedimentation.

The main advantage of intercropping is that it diversifies the sources of income and has a positive effect on the land (by reducing erosion and improving soil fertility). The analysis shows that all these SWC structures and practices are profitable for the farmers, but the structures are built mainly to provide long-term profitability. For adoption of the technologies to take place, projects have to take into account the financial constraints of the farmers. Another important determinant of adoption is the beliefs and the perceptions of the farmers about the technologies. Our cost/benefit analysis shows that adding soil is expensive and less profitable, however, there are more farmers adopting this practice than those using SWC structures, such as semi-circular bunds or stone walls. This could be partly explained by the farmers' perceptions of the technologies.

According to the farmers interviewed in November 2010, farmers globally have a good perception of the proposed technologies. They think these technologies substantially increase yields and even if the adoption rate is still in the initial stages, according to the age of the project, the farmer's adoption seems relatively acceptable.

Despite the participatory approach used for designing technologies and the meetings organized to inform farmers and increase their awareness about erosion and technologies, farmers' perceptions are not always consistent with the results of the cost/benefit analysis presented above. For example, farmers seem to think that adding soil is a highly profitable practice. Yet adding soil and manure are not the most profitable technologies for the farmers; however, they are the most common reason for requesting a loan, according to the register of the *sanduq* (micro-credit system) committee. These paradoxical behaviors can be explained by the farmers' perceptions of the technologies. Table 3 shows some of the results of the November 2010 survey; it summarizes the farmers' perceptions of each technology.

**Table 3: Benefits and constraints (limitations) of various interventions**

| Technology | Positive | Negative |
|---|---|---|
| **Intercropping (vetch)** | • Short-term profit; provides cash<br>• Benefit to olive trees (increases nitrogen content of soil and decreases erosion) | • In dry years there is competition between the olive trees and the cover crop<br>• Seeds are expensive |
| **Adding soil** | • Increases the yield a lot | • Gives profit after two years only<br>• Need road access |
| **Manure** | • Short-term effect: increases the yields by 50% after six months<br>• Better than fertilizers applied only every two or three years<br>• Can be applied even if no road access | • Expensive |
| **Stone wall** | • Better than semi-circular bunds (less constraints concerning tillage and picking olives)<br>• No need to add soil in the future<br>• Reduces soil and water losses | • No tractor tillage<br>• If many walls: tillage using a mule is difficult<br>• Expensive |
| **Semi-circular bunds** | • Very good impact on the yield<br>• Less erosion, better yield | • No tillage, hand weeding<br>• Increases the time needed to pick olives<br>• Only possible where trees are planted in staggered rows |

In addition to the interventions listed in Table 3, the following interventions and practices are adopted also by the farmers. Some of these were modified from the original project interventions by the farmers to suit their demands and capacities. This is a positive outcome which shows that the farmers are interested in reducing soil and water losses and improving productivity. The project encouraged and guided the modification of some interventions for the benefits of the farmers and to enhance adoption.

- **Contour tillage using mules:** farmers choose to use mules only if they have enough money, because using a tractor is cheaper, although most of the farmers know that mules are better than a tractor in reducing erosion and result in less damage to the tree roots. The project promoted using mules through small loans to the farmers.
- **Semi-circular bund using branches from pruning:** some farmers started to use the branches from pruning to construct some kinds of structures around the trees wherever stones were not available for constructing semi-circular bunds or stone walls and/or where tractor accessibility is a concern. However, there are a few concerns about plant pathology issues that need to be considered.
- **Modified technology:** some farmers started to modify the technologies proposed by ICARDA, especially, the stone walls. They try to achieve better results with less constraints. For example, they built their stone walls with enough space between them to be able to cultivate easily.

Adoption depends not only on the profitability of the technology, but also on the farmers' beliefs and perceptions. Knowing what the farmers' perceptions can be useful in two ways. First, it can explain why profitable technologies are not adopted by the farmers and so can help in understanding how to increase the adoption rate. For example, we could increase the training and information about technologies if perceptions are not consistent with reality. Second, the results of the qualitative survey about the technologies can help to improve the technologies themselves. This can help researchers develop technologies more suitable to the context and the practices of the farmers. Indeed some of the farmers' constraints are about problems or issues that scientists and farmers could not have expected when they developed the technology.

The success of this project is judged by two issues. First, technologies developed by participatory research are efficient in mitigating erosion, as well as profitable for the farmers. This is shown in the cost/benefit analysis and the study of the consequences of these interventions on soil and water losses. Secondly the problem of long-term profitability, faced using the current preferences of the farmers, is dealt in two ways. The micro-credit system increases cash availability while, at the same time, diversification is promoted. Farmers who diversify their agricultural activities have the opportunity to make short-term profits and reduce their vulnerability. Furthermore, importance was given to disseminating the information obtained from this project, right from the beginning. Using participatory research on technologies until the expansion of the project and the inter-village meeting, have played important roles in positively influencing the perceptions of the farmers about these technologies. Finally, the community-based management of the *sanduq* (micro-credit system) and of the project provides flexibility and a dynamic evolution to the project. Each village can adapt rules according to its own community. Suitability, profitability, flexibility, information dissemination, and self management are the keys to the success of this approach.

Even though the project is successful, the out-scaling of the project to other, similar area should be undertaken with some precautions. Indeed, as already mentioned above, the determinants of adoption depend on the area. We have to study to what extent our case study is valid before expanding its scale. For example, this project was designed for small and poor communities, highly dependent on one culture, and living in quite remote areas. Thus, it will not necessarily be suitable for all kind of villages in Syria or in the dry areas.

Moreover, it is important to understand the weaknesses of the project and address these before expanding it. In this case, some lessons have been learned already from this project. First, SWC structures, which are highly profitable, have to be particularly promoted as well as the land management practices, such as intercropping, which engender short-term profitability. However, this information was not available at the beginning of the project. At the same time, the development of diversified activities has to be increased. Indeed, in order to promote rural development, we have to think about developing off-farm activities as well as developing diversified agricultural ones. To improve awareness of the impact of such a project, it is important to collect data regularly and particularly at the different stages of the project. It is indeed the only way to provide some measure of the efficiency of the project. For a better analysis we need general data about yields, adoption, and migration as well as the socioeconomic data about households. It is only under these conditions that in the future we will be able to assess the impact of the project on the community and on the vulnerability of the villages.

Nevertheless, having taking into account the limitations in validity and despite a few practical problems, we consider that this project provides an interesting case study for expanding land conservation in Syria and similar mountainous areas. Moreover, the interventions promoted by this project are not so expensive, and the sum of the private and environmental benefits, as well as the long-term and indirect effects in this strategic high rainfall area, are expected to be much higher than the initial costs of the project.

Therefore, and in order to promote sustainable development in the context of climate change in Syria – which will increase the vulnerability of the rural areas – the support of public policies on land conservation projects is indispensable.

## Conclusions

The project's success was judged by various measures. The project's interventions were selected and implemented with the full participation of the communities. Those considered acceptable by the communities were adopted and the socioeconomic impact shows positive indicators – those selected were especially profitable in both the short and long terms. However, profitability alone is not enough to ensure adoption, the farmers' perceptions are equally important. Diversification of sustainable land management options is a key to providing short-term benefits, which encourage farmers to invest in land degradation mitigation activities. The effect on the environment also showed favorable results; semi-circular bunds reduced rill erosion by 40%, as compared with fields without such interventions, and reduced the number of rills formed. No rills were observed in a field with continuous stone bunds, while rill erosion from an adjacent field was as much as 13.6 t/ha.

A better adoption of water harvesting and soil conservation interventions was achieved by knowledge dissemination, implementation of a participatory approach at the early stages of the project, and assessing the impact. Adoption is also encouraged during the out-scaling to other communities by using the same approaches. Farmers should be able to select intervention(s), within a certain framework, and even to modify these to make them more suitable to their demands and capacities. The concept of self management and the administration of the micro-credit system by the community itself, allows for flexibility and dynamic evolution. Each village will adapt the rules that suit its own conditions.

The maps of erodible land, which were created using topographic parameters for small watersheds and which were integrated with the land tenure maps, helped identify and target the areas in which to implement soil conservation and water harvesting interventions. The community approved these maps as being good representations of the erosion risks in their fields. The maps provide an unbiased basis on which to organize the distribution of loans and this was welcomed by the community. The benefits in reducing erosion were also clear. The approach is straightforward and easy to understand by farmers and provides scientifically-based rules to prioritize areas for soil conservation.

To fight land degradation in these mountainous areas and to improve the communities' livelihoods soil conservation and water harvesting interventions should be promoted . These become more important under the different climate change scenarios, especially forecasting that expect increases in the frequency and severity of extreme events. Diversification options which empower the whole family also help in conserving the environment and generate short-term benefits which compensate for the costs of the long-term benefits of land degradation mitigation activities. This helps to increase adoption. An enabling environment, such as the micro-credit system, participation of the whole community in the design, implementation, and monitoring of the intervention, dissemination of knowledge to the farming communities, and the support of public policy are necessary features to fight land degradation and enhance livelihood in these mountainous areas.

# Project publications list – References

## Master theses (Appendix E)

Sakai, H. 2010. Farmers' participation in soil and water conservation practices and its effect on soil erosion in sloping olive groves in northwest Syria. MSc thesis. Arid Land Research Center, Tottori University, Japan.

Van der Zanden, E. 2011. Soil erosion control on sloping olive fields in northwest Syria. MSc thesis. Utrecht University, Netherlands.

## Conference posters and abstracts (Appendix C)

Ziadat, F., Al-Wadaey, A., Masri, Z., and Sakai, H. 2010. Adaptation to heavy rainfall events: watershed-community planning of soil and water conservation technologies in Syria. Geophysical Research Abstracts, Vol. 12, EGU2010-9237, European Geosciences Union (EGU) General Assembly.

Iizumi, Y., Masri, Z., and Ziadat, F. 2010. Semicircle stone bund to control soil erosion and harvest water for olive orchards on the semiarid hill slopes in Syria. Proceedings of the General Meeting of the Association of Japanese Geographers, Vol. 2010s.

## Research report

Closset, M. and Aw Hassan, A. 2011. Land and water management, diversification and micro-credit to combat land degradation and improve livelihoods in the mountains of Afrin. Unpublished research report, ICARDA: Aleppo, Syria.

## Other media material (including audio-visual)

- Soil conservation. In What's new at ICARDA, No. 11. 2012.
- Arresting land degradation in hillside olive orchards. ICARDA annual report 2011.
- Soil and water conservation interventions to fight land degradation and improve productivity in olive mountainous areas of Syria. Pamphlet (in Arabic and English) for farmers, communities, technicians, and extension staff.
- تطبيق تقانات حفظ التربة لمكافحة تدهور الأراضي وتحسين الأنتاجية في مناطق زراعة الزيتون الجبلية في سوريا
  http://icardablog.wordpress.com/category/publications/
- Six minutes documentary (slides with audio presentation). Land and water management, diversification and micro-credits to combat land degradation and improve livelihoods in the

mountains of Afrin. In collaboration with the UNDP- Global Environmental Facility Small Grant Program.

### Posters and brochures (Appendix A, B and C)

Twenty minutes documentary movie entitled Soil and Water Conservation in the Olive Mountains of Syria. In Arabic with subtitles in English. Available at: http://www.youtube.com/watch?v=UX6-0Yy9OoI and http://www.youtube.com/watch?v=44_BsA4B4iQ

## Appendix A: Posters describing different soil and water conservation interventions

# حائط حجري بعكس الميل (مع خطوط الكنتور)

# Continuous stone bunds (walls) following contour lines

**Requirements:**

- Cost of stones (subject to availability, transportation)
- Construction skills and labour cost
- Design and determination of contour lines

**Benefits:**

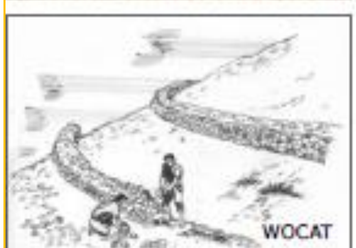
- Capture and store runoff water
- Reduce losses of soil
- Reduce losses of nutrients
- Maintain soil depth
- Reduce slope length and steepness
- Improve yield (long-term)
- Encourage contour tillage

**المتطلبات:**

- تكاليف الحجارة (النقل ، توافرها ...)
- تكاليف البناء و العمال
- تصميم وتحديد نقاط البناء

**الفوائد:**

- تخزين المياه الجارية وتقليل سرعتها
- تخفيف انجراف التربة
- تخفيف انجراف المواد المغذية
- الحفاظ على عمق التربة
- تخفيف درجة الميل وطوله
- تحسين المحصول على المدى البعيد
- تشجع على الحراثة الكنتورية





اقواس نصف دائرية (يمكن تنفيذه في الحقول التي اشجارها متوضعة بشكل متعاكس)

# Semi-circular stone bunds (only possible on staggered tree fields)

**Requirements:**

- Cost of stones (subject to availability, transportation)
- Construction skills and labour cost
- Need staggered trees layout

**Benefits:**

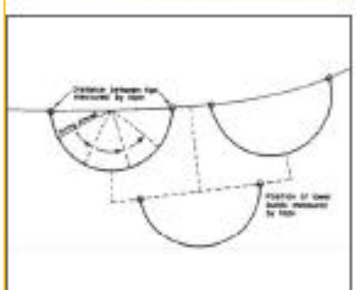
- Capture and store runoff water
- Reduce losses of soil
- Reduce losses of nutrients
- Maintain soil depth
- Level terrace around the tree (reduce slope)
- Improve yield (long-term)
- Reduce number of tillage & encourage contoure tillage

**المتطلبات:**

- تكاليف الحجارة (النقل ، توافرها ....)
- تكاليف البناء و العمال
- يحتاج لترتيب معين للاشجار (بشكل متعاكس وليست مرتبة على خط واحد)

**الفوائد:**

- توقيف وتخزين المياه الجارية
- تخفيف انجراف التربة
- تخفيف انجراف المواد المغذية
- الحفاظ على عمق التربة
- تسوية مسقط الشجرة
- تحسين المحصول على المدى البعيد
- تقليل عدد مرات الحراثة وتشجيع الحراثة الكنتورية



# حائط حجري في مجرى الوادي

# Stone bunds within wadi floor (limited to some areas within wadis)

**Requirements:**

- Cost of stones (subject to availability, transportation)
- Construction skills and labour cost
- Need relatively flat area around wadi (land ownership)

**Benefits:**

- Reduce stream bank erosion
- Avoid sediment migration and sedimentation (pollution)
- Level terrace around the wadi (suitable land for trees and other crops, new areas for cultivation)
- Source of soil for addition near tree trunk

**المتطلبات:**

- تكاليف الحجارة (النقل، توافرها ....)
- تكاليف البناء و العمال
- امكانية توافر ارض مستوية حول الوادي

**الفوائد:**

- تخفيف الانجراف على الضفاف
- تخفيف انجراف المواد المغذية التخلص من انجراف الترسبات وتجنب ملوثاتها
- تسوية الارض في الوادي حيث تصبح جيدة للزراعة (اشجار، محاصيل..)
- مصدر جيد للتربة لاضافتها تحت مسقط الأشجار

# الزراعة البينية بغطاء نباتي مثل البيقية/ خطوط نباتية طبيعية

# Intercropping with cover crops (contour strips of vetch)/ Natural vegetation strips

**Requirements:**

- Vetch seeds and cultivation
- Combined with other measures
- Goat or sheep to feed the vetch
- Contour tillage
- Or no tillage between trees & use herbeside to control weeds

**Benefits:**

- Additional source of income and fooder
- Capture and store runoff water
- Reduce losses of soil
- Reduce losses of nutrients
- Maintain soil depth
- Add organic matter to soil
- Better soil conditions

**المتطلبات:**

- بذور بيقية وزراعتها
- يمكن دمجه مع اجراءات اخرى
- اغنام / ماعز لتغذيتها بالبيقية
- يلزم فلاحه بعكس الميل
- أو عدم الفلاحة بين الأشجار ومكافحة الاعشاب بالمبيدات

**الفوائد:**

- مصدر اضافي للدخل والعلف
- تخزين المياه وتقليل سرعتها
- تخفيف انجراف التربة
- تخفيف انجراف المواد المغذية
- الحفاظ على عمق التربة
- اضافة المواد العضوية للتربة
- تحسين خواص التربة





# تقليل الفلاحات (عدد الفلاحات والادوات المستخدمة)/ الفلاحة بعكس الميل

# Reduced tillage (number of tillage and tool used) & Contour tillage (against slope direction)

**Requirements:**

- Determination of contour line (one line per regular-topography field)
- Use mule instead of tractor
- Could be combined with other measures
- Till one or two times a year only

**Benefits:**

- Better soil physical conditions
- Saving money and efforts
- Reduce losses of soil
- Improve yield
- Capture and store runoff water
- Reduce losses of nutrients
- Maintain soil depth

**المتطلبات:**

- تحديد خط الكنتور
- استعمال الفدان بدل الجرار
- يمكن دمجه مع اجراءات اخرى
- الفلاحة مرة او مرتين في السنة فقط

**الفوائد:**

- تحسين الخواص الفيزيائية للتربة
- توفير النقود والجهد
- تخفيف انجراف التربة
- تحسين الأنتاج
- تخزين المياه وتقليل سرعتها
- تخفيف انجراف المواد المغذية
- الحفاظ على عمق التربة

(More erosion)

Tillage | No tillage

فلاحة مع الميل
انجراف

بدون فلاحة
انجراف أقل

# اضافة تراب و/أواضافة سماد عضوي حول جذع الشجرة مع أقواس حجرية

# Addition of soil and/or organic manure around tree trunk with semi-circle

**Requirements:**

- Cost of manure and transportation (source, availability)
- Cost of transporting soil & availability
- Fermentation to avoid environmental problems
- Combined with other measures

**Benefits:**

- Better rooting conditions
- Source of nutrient
- Improve yield
- Better soil physical conditions
- Reduce losses of soil

**المتطلبات:**

- تكلفة السماد العضوي والنقل( المصدر، توافره)
- تكلفة نقل التربة وتوافرها
- تخمير السماد العضوي لتجنب المشاكل البيئية
- يمكن دمجه مع اجراءات اخرى

**الفوائد:**

- تحسين الاوضاع للجذور ونموها
- مصدر للغذاء
- تحسين الأنتاج
- تحسين الخواص الفيزيائية للتربة
- تخفيف انجراف التربة

# بدائل التنوع الحيوي ومصادر جديدة للدخل
# Biodiversity and income generating options

2. Mushrooms
زراعة الفطر

1. Honeybees keeping
تربية النحل

3. Medicinal herbs
زراعة النباتات الطبية

4. Soap made
صناعة الصابون

5. Handicraft from olive tree wood
منحوتات يدوية باستخدام خشب الزيتون

6. Grape products
منتجات العنب

## Appendix B: A brochure illustrating alternatives soil conservation and water harvesting interventions

### For better resolution, follow the link:

http://icardablog.wordpress.com/2012/02/29/%D8%AA%D8%B7%D8%A8%D9%8A%D9%82-%D8%AA%D9%82%D8%A7%D9%86%D8%A7%D8%AA-%D8%AD%D9%81%D8%B8-%D8%A7%D9%84%D8%AA%D8%B1%D8%A8%D8%A9-%D9%84%D9%85%D9%83%D8%A7%D9%81%D8%AD%D8%A9-%D8%AA%D8%AF%D9%87%D9%88%D8%B1/

وبدعم من مؤسسة كوكا كولا العالمية، ومرفق البيئة العالمي، برنامج المنح لصغيرة، استطاع المزارعون في الأراضي المرتفعة ذات الميول الشديد والمزروعة بالزيتون في شمال غرب سورية تأسيس صناديق لدعم المزارعين لمكافحة انجراف التربة وزيادة الإنتاجية وتحسين دخل العائلة، من خلال منح المزارعين قروض صغيرة بدون فائدة.

وتقوم القرية – بمساعدة من إيكاردا – بتقديم مقترح للحصول على منحة لمساعدة سكان القرية، بمن فيهم النساء، للقيام بتدابير صيانة التربة بهدف الحدّ من انجرافها وكذلك للقيام بنشاطات مختلفة لتنويع مصادر الدخل سعياً لزيادة دخل الأسر ومكافحة تدهور الأراضي. وتقوم كل قرية أو مجتمع زراعي بانتخاب لجنة لإدارة الأراضي وتنويع مصادر الإنتاج، حيث يقوم المزارعون وأسرهم بتقديم طلبات للجنة لبيان التدابير والنشاطات المراد تنفيذها. بدورها، تقوم اللجنة بدراسة الطلبات وتحديد أصحاب الأولوية في الحصول على القرض، حيث يقوم المزارع وأسرته بسداد القرض على مرحلتين، أي خلال سنتين. كما تقوم اللجنة بدراسة طلبات جديدة ومنح قروض لمزارعين آخرين وأسرهم في القرية، مما يعني أن جميع سكان القرية سوف يستفيدون من القروض وفقاً للأولويات، كما يمكن للمزارعين الاستفادة أكثر من مرة من تلك القروض.

هذا وقد أسهم المزارعون في قريتي خالطان والمغارة في عفرين بمحافظة حلب وفي قرية بتيا في محافظة إدلب بتقييم فائدة هذه التدابير والنشاطات على صعيد الحدّ من الانجراف وبالتالي زيادة محصول الزيتون، وكذلك على صعيد تأثير هذا الانجراف في البيئة وتحسين مصادر الدخل. نهيب من القرى المجاورة التي تعاني من مشكلة انجراف التربة في المناطق ذات الانحدار الشديد الاستفادة من هذه القرى الرائدة وتنفيذ تدابير ونشاطات لتحسين الدخل وزيادة المحصول ومكافحة انجراف التربة.

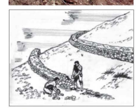
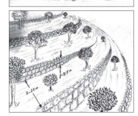
## حائط حجري بعكس الميل (مع خطوط الكنتور)
## Continuous stone bunds (walls) following contour lines

**Requirements:**
- Cost of stones (subject to availability, transportation)
- Construction skills and labour cost
- Design and determination of contour lines

**المتطلبات:**
- تكاليف الحجارة (النقل ، توافرها ....)
- تكاليف البناء و العمال
- تصميم وتحديد نقاط البناء

**Benefits:**
- Capture and store runoff water
- Reduce losses of soil
- Reduce losses of nutrients
- Maintain soil depth
- Reduce slope length and steepness
- Improve yield (long-term)
- Encourage contour tillage

**الفوائد:**
- تخزين المياه الجارية وتقليل سرعتها
- تخفيف انجراف التربة
- تخفيف انجراف المواد المغذية
- الحفاظ على عمق التربة
- تخفيف درجة الميل وطوله
- تحسين المحصول على المدى البعيد
- تشجع على الحراثة الكنتورية


## أقواس نصف دائرية
## (يمكن تنفيذه في الحقول التي اشجارها متوضعة بشكل متعاكس)
## Semi-circular stone bunds
## (only possible on staggered tree fields)

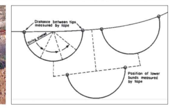
**Requirements:**
- Cost of stones (subject to availability, transportation)
- Construction skills and labour cost
- Need staggered trees layout

**المتطلبات:**
- تكاليف الحجارة (النقل ، توافرها ....)
- تكاليف البناء والعمال
- يحتاج لترتيب معين للاشجار

**Benefits:**
- Capture and store runoff water
- Reduce losses of soil
- Reduce losses of nutrients
- Maintain soil depth
- Level terrace around the tree (reduce slope)
- Improve yield (long-term)
- Reduce number of tillage & encourage contoure tillage

**الفوائد:**
- توقيف وتخزين المياه الجارية
- تخفيف انجراف التربة
- تخفيف انجراف المواد المغذية
- الحفاظ على عمق التربة
- تسوية مسقط الشجرة
- تحسين المحصول على المدى البعيد
- تقليل عدد مرات الحراثة وتشجيع الحراثة الكنتورية





## الزراعة البينية بغطاء نباتي مثل البيقية / خطوط نباتية طبيعية
## Intercropping with cover crops (contour strips of vetch)/Natural vegetation strips

**Requirements:**
- Vetch seeds and cultivation
- Combined with other measures
- Goat or sheep to feed the vetch
- Contour tillage
- Or no tillage between trees & use herbeside to control weeds

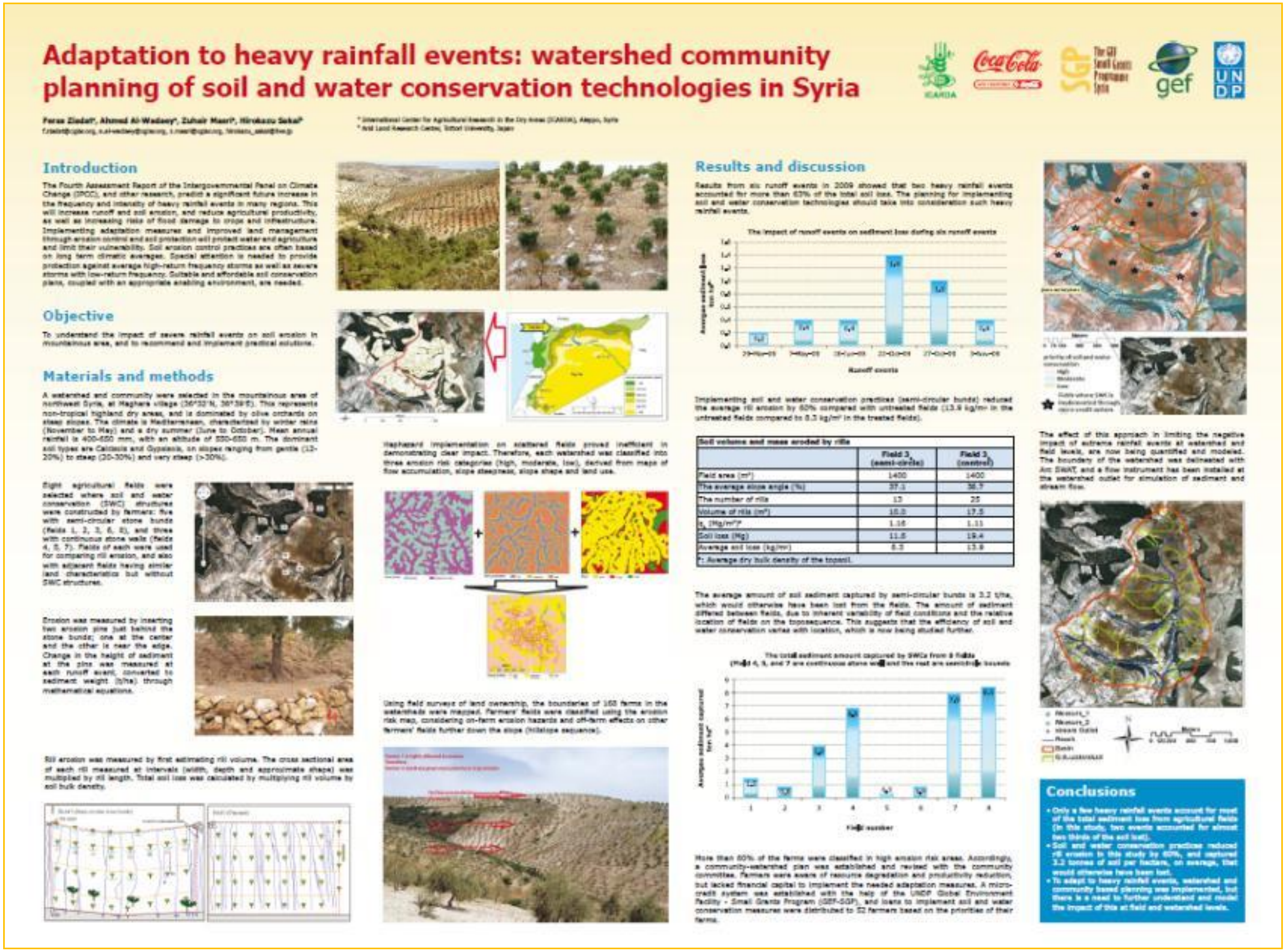
**المتطلبات:**
- بذور بيقية وزراعتها
- يمكن دمجه مع اجراءات اخرى
- اغنام/ماعز لتغذيتها بالبيقية
- يلزم فلاحه بعكس الميل
- أو عدم الفلاحة بين الأشجار ومكافحة الاعشاب بالمبيدات

**Benefits:**
- Additional source of income and fooder
- Capture and store runoff water
- Reduce losses of soil
- Reduce losses of nutrients
- Maintain soil depth
- Add organic matter to soil
- Better soil conditions

**الفوائد:**
- مصدر اضافي للدخل والعلف
- تخزين المياه وتقليل سرعتها
- تخفيف انجراف التربة
- تخفيف انجراف المواد المغذية
- الحفاظ على عمق التربة
- اضافة المواد العضوية للتربة
- تحسين خواص التربة




## Appendix C: Poster presented at the European Geosciences Union, Vienna, 2010



## Appendix D: Published news about soil conservation experiments within olive fields


What´s new at ICARDA

International Center for Agricultural Research in the Dry Areas

Issue no. 11 / 2012


### Soil conservation

Olive trees are a major component of Mediterranean farming systems; but inappropriate land management practices have accelerated soil erosion in many olive production areas, especially those located on sloping land. A new study, which began this season, combines field trials with modeling to examine the benefits of two kinds of interventions: low-cost semicircular stone bunds surrounding individual trees, to harvest runoff water and reduce erosion; and alternative weed control methods to replace the common practice of tillage.

Measuring water runoff from experimental plots. The results will help design effective, low-cost structures for soil conservation and water harvesting.

The experimental field is located on a 10-15% slope, and contains 114 ten-year old olive trees. The trial includes six 'treatments': trees with and without stone bunds, and three weeding methods (herbicide, a motorized weed cutter, and the common practice of tillage using a cultivator). Researchers used 'Gerlach troughs' to measure water runoff and soil loss. Experiments on soil loss and erosion management require several seasons to allow definitive conclusions; but preliminary results show clearly that stone bunds provide substantial benefits for little investment; and that the two new weeding methods cause considerably less soil disturbance and erosion, and are less expensive, than the common practice of tillage.

For more information contact Dr Feras Ziadat, soil conservation and land management specialist, email F.Ziadat@cgiar.org

### صيانة التربة

تعدّ أشجار الزيتون مكوناً رئيساً في نظم الزراعة المتوسطية؛ على أن الممارسات غير المناسبة لإدارة الأراضي سرّعت إنجراف التربة في عدة مناطق لإنتاج الزيتون، وبخاصة تلك الواقعة على أرض منحدرة. تجمع دراسة حديثة بدأت هذا الموسم تجارب حقلية مع نمذجة لفحص الفوائد من نوعين من التدخلات: سدود صخرية شبه دائرية قليلة التكلفة تحيط بأشجار مفردة لحصاد مياه الجريان السطحي وخفض الإنجراف؛ وطرائق بديلة لمكافحة الأعشاب الضارة لتحل مكان الممارسة الشائعة للحراثة.

قياس ماء الجريان السطحي من القطع التجريبية. ستساعد النتائج على تصميم فاعل/كفء، وبنيات قليلة التكلفة لصيانة التربة وحصاد المياه

يقع الحقل التجريبي على منحدر بميل 10-15%، وبه 114 شجرة زيتون بعمر 10 سنوات. تتضمن التجربة ست "معاملات": أشجار مع أو بدون سدود صخرية، وثلاث طرائق تعشيب (مبيدات الأعشاب، حشاشة أعشاب آلية، والممارسة التقليدية للحراثة باستعمل الكلتيآتور). استخدم الباحثون "أحواض Gerlach" لقياس الجريان السطحي وفقد التربة. وتتطلب التجارب حول فقد التربة وإدارة الجريان السطحي عدة مواسم للسماح بالحصول على استنتاجات نهائية؛ على أن النتائج الأولية تظهر بوضوح أن السدّات الصخرية تؤمن فوائد عظيمة لاستثمارات قليلة؛ وأن طريقتي التعشيب الجديدتين تسببان اضطراباً وانجرافاً للتربة أقل بكثير، وهما أقل تكلفة من الممارسة الشائعة للحراثة.

لمزيد من المعلومات، يمكن الإتصال بالدكتور فراس زيادات، إخصائي صيانة التربة وإدارة الأراضي، بريد إلكتروني F.Ziadat@cgiar.org

# Arresting land degradation in hillside olive orchards

Olives have been grown in northwest Syria since ancient times. Even now, olives are a major source of income for small-scale farmers. The area planted with olives has increased substantially in recent decades. However, traditional land-husbandry practices have not kept pace with the intensification and expansion of olive production into steeper areas. A project in Khaltan, Afrin, funded by the Coca Cola Foundation and the Global Environment Facility Small Grants Programme, and led by ICARDA, is working with communities to tackle land degradation in steep olive orchards.

## PREVENTING DEGRADATION

In real life, managing water and land is complex. In hillside olive orchards, location-specific land conservation measures that protect the soil and, at the same time, enhance the productivity of olive trees are important. The first step was to work with the village community to map land ownership, topography, and erosion. Geographic information systems (GIS) were used to layer the sets of information, producing a map showing levels of land degradation across the community watershed. The map indicated the areas where most urgent action needed to be taken.

Science plus self-help: the community in Afrin builds simple stone structures to reduce water runoff and soil erosion.

## MICRO-CREDIT AND TECHNICAL SUPPORT

The community then managed the distribution of 222 small interest-free loans provided by the project to enable farmers in degradation hotspots to apply cheap and easy soil and water conservation techniques. All the work was organized and carried out by the community. Farmers and their families, with technical backstopping from local extension services of the Ministry of Agriculture and Agrarian Reform and the General Commission for Scientific Agricultural Research, constructed water-harvesting and soil-retention structures – stone walls, bunds, and mini-terraces – to hinder surface runoff, conserve moisture and soil, allow organic matter and plant nutrients to accumulate, and maintain soil fertility.

A few heavy rainfall events accounted for most of the sediment loss from fields – two events accounted for almost two-thirds of the soil lost. The soil and water conservation practices reduced rill erosion by 60%, and captured 3.2 tons of soil per hectare that would otherwise have been lost.

## PARTICIPATORY APPROACH

Helping communities draw up plans to prevent land degradation and to apply sustainable practices and technologies will improve land and water use. The participatory approach builds on the main interest of the farmers, which is to secure and increase olive production. The results of the project will be beneficial for the whole Afrin mountain area, and other similar Mediterranean areas, leading to more productive and sustainable use of the land.

Measures to prevent soil erosion and to harvest rainfall could become important for adapting to changing patterns of rainfall due to climate change. The project will expand work to Bitya, Idleb, and surrounding villages where no-tillage and weed control technologies will be tested to improve olive yields.

FOR FURTHER INFORMATION CONTACT
Feras Ziadat    Email: F.Ziadat@cgiar.org

## Appendix E: Masters theses

UNITED NATIONS UNIVERSITY

Farmers' participation in soil and water conservation practices and its effect on soil erosion in sloping olive groves in northwest Syria

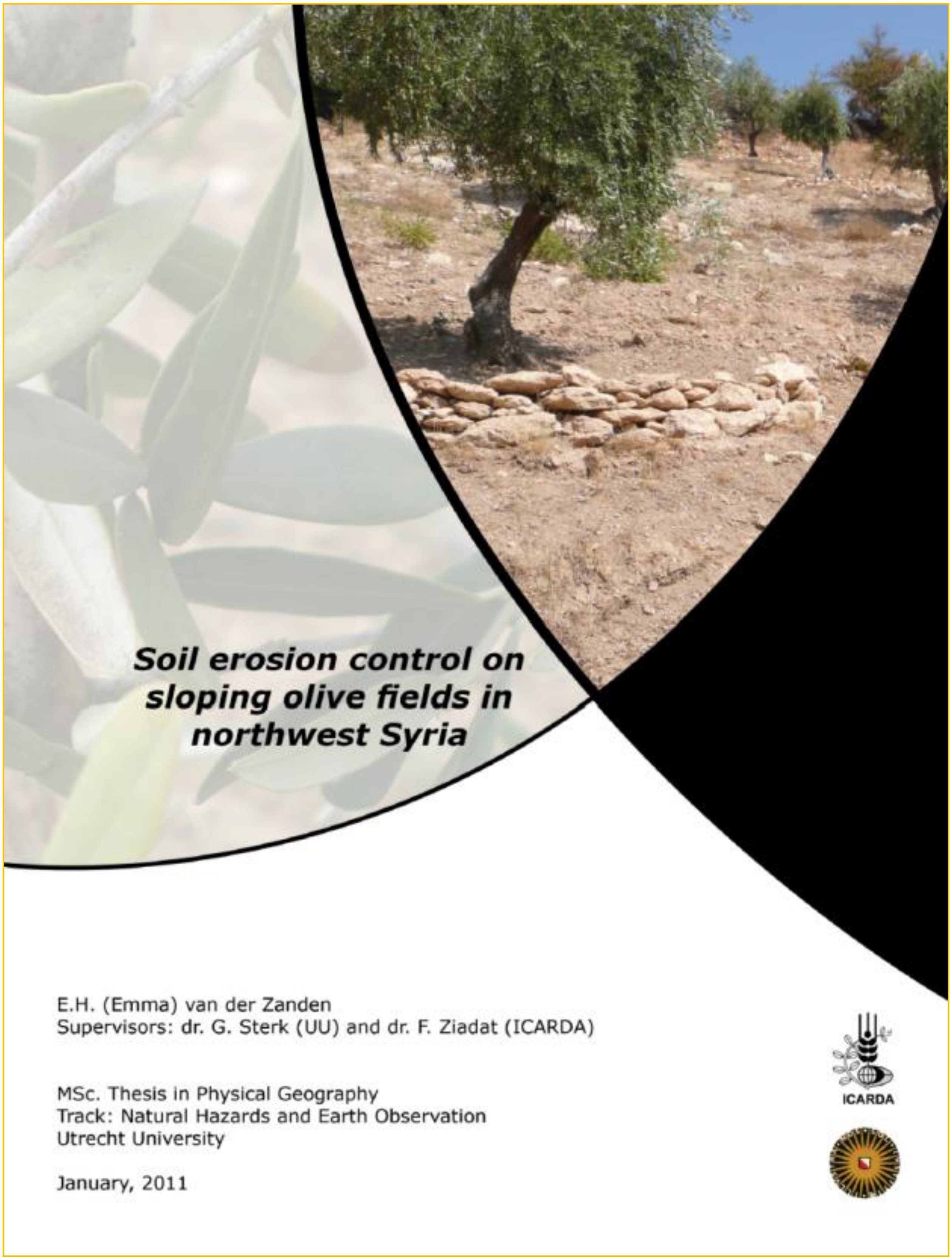
Hirokazu Sakai

MSc Program (08-09)

Supervisors

· International Center for Agriculture Research in the Dry Areas (ICARDA),
  Theib Oweis, Adriana Bruggeman, Feras M. Ziadat

· Arid Land Research Center, Tottori University,
  Mitsuhiro Inoue



**Soil erosion control on sloping olive fields in northwest Syria**

E.H. (Emma) van der Zanden
Supervisors: dr. G. Sterk (UU) and dr. F. Ziadat (ICARDA)

MSc. Thesis in Physical Geography
Track: Natural Hazards and Earth Observation
Utrecht University

January, 2011

ICARDA

# About ICARDA and the CGIAR

Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is one of 15 centers supported by the CGIAR. ICARDA's mission is to contribute to the improvement of livelihoods of the resource-poor in dry areas by enhancing food security and alleviating poverty through research and partnerships to achieve sustainable increases in agricultural productivity and income, while ensuring the efficient and more equitable use and conservation of natural resources.

ICARDA has a global mandate for the improvement of barley, lentil and faba bean, and serves the non-tropical dry areas for the improvement of on-farm water use efficiency, rangeland and small-ruminant production. In the Central and West Asia and North Africa region, ICARDA contributes to the improvement of bread and durum wheats, kabuli chickpea, pasture and forage legumes, and associated farming systems. It also works on improved land management, diversification of production systems, and value-added crop and livestock products. Social, economic and policy research is an integral component of ICARDA's research to better target poverty and to enhance the uptake and maximize impact of research outputs.

CGIAR is a global research partnership that unites organizations engaged in research for sustainable development. CGIAR research is dedicated to reducing rural poverty, increasing food security, improving human health and nutrition, and ensuring more sustainable management of natural resources. It is carried out by the 15 centers who are members of the CGIAR Consortium in close collaboration with hundreds of partner organizations, including national and regional research institutes, civil society organizations, academia, and the private sector. WWW.cgiar.org