

## CASE STUDY:

# JORDAN VALLEY PERMACULTURE PROJECT, JORDAN

Prepared by Permaculture Research Institute of Australia, for the report *“The Role of Environmental Management and Eco-Engineering in Disaster Risk Reduction and Climate Change Adaptation”* (ProAct Network 2008), available at [www.proactnetwork.org](http://www.proactnetwork.org)

## 1. BACKGROUND INFORMATION

The Jordan Valley Permaculture (JVP) project is a pilot project to rehabilitate 4 ha of otherwise nonproductive farmland in the southern Jordan Valley, under high salinity and drought conditions, using the integrated sustainable design science of Permaculture. The main environmental concerns for the Jordan Valley area, which led to this project are:

- ★ the increasing shortage of freshwater resources for human uses (especially for growing food);
- ★ the decreasing quality of freshwater resources due to high salinity of water and other pollution and the decreasing quality of farm system production.

### HAZARDS ENCOUNTERED

Hazards included drought and high salinity of soil and groundwater.

### PROJECT SCALE

The project area was approximately 4 ha and directly involved over 100 people from the area. Indirect beneficiaries comprised approximately 30,000 people.

The site is now being used as a training center for a regional water management program for all the agricultural communities within the Jordan Valley – therefore indirect beneficiaries have expanded with time.

The project was implemented by Nippon International Cooperation for Community Development (NICODD - Japan) in cooperation with the Hashemite Fund for Human Development (JOHUD - Jordan); both non-governmental organizations focused on rural community development.

The National Center for Agricultural Research and Transfer of Technology (NCARTT - Jordan) implemented an environmental monitoring program to study the impact of Permaculture on farms, soil, water, plants, animals and natural resources. Permaculture Research Institute (PRI) of Australia provided technical support and training.

## 2. PROJECT DESCRIPTION

The primary goal of JVP was to demonstrate the potential for improving human and environmental conditions in the Jordan Valley using low-cost, low-tech approaches. This is being done by developing a 10-acre (four hectare) pilot project using Permaculture techniques under high salinity and drought conditions.

The objectives are to:

1. rehabilitate otherwise unproductive farmland through an integrated environmental management model based on Permaculture;
2. improve the quantity and quality of agricultural production;
3. improve the livelihood and living conditions of the local people;
4. study the impacts of Permaculture on the soil, quality of plant and animal production, farm system and local environment.

### LOCATION AND CONDITIONS

The JVP site is located in the Kafrin area in the southern Jordan Valley, about 10km from the Dead Sea and 6km from the Jordanian-Palestinian border, in the Jordan River basin. The area is nearly flat, with very slight slope to the west. Rainfall is 100-150mm/year occurring mainly in two or three main events during the winter.

The area suffers from severe droughts and very low fertility in the soil. The soil is very low in organic matter and there is a general absence of natural vegetation cover. The present vegetation of the surrounding area includes only scattered wild plants that are tolerant of high salinity.

The dominant soil texture is fine silt. Soil structure is poor, which adversely affects soil productivity. Soil salinity is very high, which prevents cultivation of many agricultural crops (98.1 dS/m). Irrigation water is mainly from artesian wells, of salinity about 4dS/m. The area is exposed to frequent strong hot winds that cause erosion of the poorly structured soil. According to the Jordan Valley Authority, this land has been categorized as an extremely salty area.

The area is made up of a mixed population which includes traditional Bedouin tribes, and long-term refugees stemming from the creation of the state of Israel and displacement of local populations from within Palestine. The Jordan valley is the most productive farmland in Jordan, which, owing to climatic conditions and availability of irrigation water represents the breadbasket of Jordan – especially for warmth loving fruits and vegetables. For this reason, agriculture along with some tourism forms the key ‘industries’ of the Jordan Valley.

### Additional details on water resources/quality:

Jordan is an arid country with limited water resources, and considered one of the 15 most water deficient countries in the world<sup>1</sup>. The available renewable fresh water resources have decreased, while annual consumption continues to increase.

In fact, the yearly available renewable fresh water resources per person have dropped over 95% since 1946 from 3,400 m<sup>3</sup>/cap/year to less than 155m<sup>3</sup>/cap/year today. According to 2004 figures, Jordan's total water use was 866 million cubic meters (MCM) for a population of five million people.

And demand continues to increase with socioeconomic development in the country. Of the available resources, agriculture consumes the most at approximately 62.5%, domestic use consumes about 32.5%, industry consumes about 4.3% and rural use consumes about 0.8%.

Water sources include groundwater, surface water, fossil aquifers, brackish aquifers and treated wastewater. According to the 2004 estimates, total renewable water resources was estimated to be 780 MCM/year, including 275 MCM/yr from groundwater and 505 MCM/yr from surface water. However, of this total, only 70% was of economic use.

In addition, 143 MCM/year was estimated to be available from fossil aquifers and at least 25 MCM/yr from brackish aquifers after desalination. However, brackish aquifers were not fully explored. According to 1997 estimates, amounts of available treated wastewater were estimated to be 65 MCM/year. Of that amount, 56 MCM/year was used for irrigation in Jordan Valley.

Surface water resources distributed throughout 15 basins in Jordan. The long-term average base flow for all basins is about 359 MCM/year. Yarmuk River Basin is Jordan's greatest source of surface water, accounting for about 40% of the annual total. This includes water flowing from Syrian territories within the Yarmuk Basin. Yarmuk River is the major tributary of King Abdullah Canal, which is considered the main source for irrigation in Jordan Valley. Other surface resources include Zarqa River and several wadis that run from the highlands to the Jordan Rift Area. Zarqa River flow received treated wastewater from the As Samra treatment plant and other treatment plants serving Amman and Zarqa areas. The Jordanian Government has extensively developed surface water resources in Jordan with the priority being given to the construction of Dams and Irrigation Projects in the Jordan Rift Valley.

Groundwater is considered to be the major source of water in Jordan, and the only source of water in some areas of the country. Twelve groundwater basins have been identified in Jordan and most basins are comprised of several groundwater aquifer systems. The long-term safe yield of renewable groundwater resources has been estimated at 277 MCM/year. Some of the renewable groundwater resources are presently exploited to their maximum capacity and in some cases beyond safe yield. Overexploitation of ground water aquifers will contribute significantly to the degradation of ground water quality and endangers the sustainability of these resources for future use. The main nonrenewable groundwater resource in Jordan exists in the Disi aquifer in the South, with a safe yield of 125 MCM/ year for 50 years. Other nonrenewable groundwater resources are estimated at an annual safe yield of 18 MCM.

Treated wastewater is generated at 18 existing wastewater treatment plants in the country. The majority of treated wastewater is discharged into various water courses and flows downstream to

<sup>1</sup> Figure based on Total Actual Renewable Water Resources (TARWR) as calculated in AQUASTAT, the United Nation's Food and Agricultural Organization, in 2000 and 2005. <http://www.fao.org>.

the Jordan Valley for irrigation purposes. By the year 2020, it is expected that the volume of treated wastewater will reach to 220 MCM and will become a significant source for the total irrigation demand.

Not only has the total available quantity of freshwater resources steadily decreased, but so has the quality, due to high salinity levels caused by over-pumping of groundwater and lack of irrigation water management. Dumping of wastewater into surface waters has also increased pollution. This has been the case of the Khirbit Al-Samra treatment plant that dumped its wastewater into the Zarqa River, polluting the Amman-Zarqa basin.

### Additional details on quality of farm products:

The agricultural community in the Jordan Valley faces other problems besides water that affect the quality of farm products. This includes extensive use of chemical pesticides and fertilizers, water and soil pollution and solid waste pollution. These factors affect the quality of agricultural products and the sustainable use of natural resources.

In addition, agriculture faces other issues that affect the sustainability of the agricultural process, such as the marketing of agricultural products and competition with regional and international markets.

When considering the environmental characteristics of the Jordan Valley, it became apparent that several actions were required to improve the quality of agricultural products and ensure the sustainable use of resources.

These actions were:

- 1) study the environmental impacts of using low-quality water for irrigation and the impacts of agricultural chemicals on the quality of soil and plants;
- 2) greater efforts by national and international organizations to improve agricultural practices, management and quality of products;
- 3) reducing the negative impacts of conventional agriculture on soil, water, plants and the local environment; and
- 4) introducing new agricultural technologies, such as integrated pest management, organic farming and Permaculture.

### **DESCRIPTION OF ECOSYSTEM MEASURES APPLIED:**

An environmental monitoring program was implemented for the farm by NCARTT to assess the impacts of Permaculture practices on the farm and the natural resources. The program included periodic soil, water and plant sampling and analysis. Soil analysis included soluble ions, pH, salinity (EC), organic matter (OM%), texture, CaCO<sub>3</sub> and heavy metals. Water analysis included soluble ions, pH and salinity. Plant analysis included Nitrogen (N), phosphorous (P), potassium (K) and heavy metals. Crop yields and water use was also monitored, and compared with others in the area.

The 10-acre pilot farm was planted for agricultural production using the principles of Permaculture<sup>2</sup>. Permaculture depends on the application of specific agricultural patterns and practices that aim for sustainable use of soil, water, plants and animals by design. It is an integrated system for the environmental management of agricultural process, natural resources, local community and environment in one design system package.

## STARTING POINT OF THE PROJECT; MILESTONES

The 4 ha land area for the pilot farm was determined using standard surveying tools. Topography maps were prepared for the farm to show slope and contour lines. The farm was fenced and supplied with the necessary infrastructure services. An unnatural erosion gully is present running along the outside of the southern boundary of farm from east to west direction caused by road water run off concentration.

Rainwater harvesting contour swales<sup>3</sup> were designed and implemented from south to north direction. Swale size on the project site is 2-3m wide of concave rounded shape 1/2m deep channel and 1/2m high mound, two sides and exactly on contour, the swales mainly stretch across the farm from the north boundary to the south boundary from 100m to 250m in length.

Eight swales were excavated in total with a combined length of 1.5kms. The first swale established close to the road side of the farm collects most rainfall water from the road run off. Other swales were constructed along the farm in a way to collect the maximum amount of rainwater from the farm area itself and some from the erosion gully on the southern boundary in large rain events.

Each swale is connected to the erosion gully through a concrete pipe of 25cm diameter. Rainwater is collected at each cement pipe using a gabion silt trap made of rocks and stones, built just down hill from the entrance of each pipe to divert the runoff water through the pipe to the swales during the two or three large rain events each year.

Fine soil particles and organic matter are also collected with the harvested water to improve soil fertility. The end of each swale is connected to the next swale by an over flow spillway to allow for collection of extra water by the lower swale. Constructing the swales on exact contour allows for larger amounts of water storage in soil profile and prevents surface runoff also greatly reducing evaporation (see attached site diagram).

A plastic lined irrigation water storage dam was constructed in the farm and stocked with fish (tilapia). The dam is supplied with a water pump (8.5hp, 40m<sup>3</sup>/h) and filtration unit (sand and screen filter). A drip irrigation system is installed and supplied with viro-jet type drippers of 60 L/h discharge where each tree receives one dripper.

<sup>2</sup> Permaculture or "sustainable agriculture" is a system of design science established by Professor Bill Molison from Australia who studied the natural system characteristics and established the Permaculture system which creates sustainable human settlements protects the environment and improves the quality of agricultural products. For further information, visit <http://www.permaculture.org.au>

<sup>3</sup> Swales are water harvesting features created by precise earth works usually exactly on contour with a form in the shape of an excavated channel with a soft un-compacted mound on the lower side varying in size in relation to the size of land and profile of the landscape and the potential volume of water harvestable.

The drip systems are covered with soil and plant mulch materials to protect the system from sunlight and reduce irrigation water evaporation. A small concrete raised pond is established on the farm for the geese in their fenced area, and water from the pond is circulated to irrigation dam on daily basis to provide liquid nutrients for plants and refilled daily.

### Pilot Farm Planting

Planting was done on both swale sides along the full length of each swale. The upper side of each swale was planted with legume forest trees leucaena, acacia, parkennsonia, prosopis, casuarina, sesbainia sesbans, albizia julibriesens and others to fix nitrogen to the soil, and reduce evaporation through shade and wind shelter. On the lower side of the swales fruit trees were planted.

Tree spacing was 4m for most fruits and 8m for date palm trees. Trees were planted according to the following procedures: a hole was dug and first covered with old cotton cloths and old newspaper then manure and mulch (plant residue material) added then some soil. After this, the tree was placed in the hole and filled with soil until the hole was half full then putting another layer of mulch on until the hole was full then the hole covered with another layer of newspaper and more mulch. After planting the trees were irrigated thoroughly using the drip system making sure more than 1m<sup>3</sup> of soil was wet. Trees included olive, fig, guava, date palm, pomegranate, grape, citrus, carob, mulberry, and tuna cactus. Forestry and ornamental plants included berconsonia, julifolia, Casuarina equistifolia, Jasmine, Acacias, poplar eucalyptus, shrubs, ground covers flowers and others. Vegetables crops included tomato, pumpkin, Egyptian cucumber, onion, eggplant, garlic, pepper, rocket, parsley, radish, Jew's mallow, sesame, and others. Vegetables crops were planted between swales as contour rows incorporated with other vegetables and flowers.

Some vegetables were planted on the swales for comparison purposes. Barley and alfalfa were planted as legumes and forages for farm animals between swales. Manure was added to trees, vegetables and forage crops before planting and after planting on a regular basis (each 7-15 days period) to improve soil fertility.

Plants were irrigated according to their needs on a weekly basis. The amount of irrigation water used was much less than compared to conventional agriculture, even during spring and summer seasons, due to the storage of rainwater infiltrated into the soil profile during the winter season. Irrigation records were prepared for the farm to show and organize all irrigation operations. The irrigation source was well water of salinity 3.98dS/m.

Plant residue including banana leaves straw, weeds and others was used as soil mulching beneath trees and on soil surface. Residues were also used to cover all swales to conserve water, to prevent evaporation of the stored water and to improve soil physical, chemical and biological properties.

Animals raised on the farm included chickens, pigeons, turkey, geese, ducks and rabbits. Sheep and a dairy cow were also introduced once there were enough trees and plants growing that could be harvested for cut forage without over-taxing the system. Animals were introduced to achieve plant-animal integration, generate income and to provide manure for different crops. Animal housing was built using local materials like mud, straw, stone and others necessary materials.

### Plant Protection and Pest Control

Plant protection consisted of implementing agricultural practices to control pests on the farm. This included crop diversity to prevent fast spread in the case of pest infestation, planting herbs and flowers which attract natural pest enemies and planting repellent plants, such as lavender, rosemary, onion and garlic, with the main crops to repel and distract insect attacks.

In addition, other practices were implemented to protect plants such as irrigation scheduling, removal of infected plant parts and the use of natural materials for plant protection like sulfur or the extract of tobacco, onion, garlic, neem and Schinus molle. Farm care and maintenance done periodically, such as natural mulch addition, animal and plant care, farm clean up, preparation and use of compost also helps to reduce pests and disease.

### Public Awareness, Training and Local Community Involvement

At the beginning of the JVP project, public awareness activities were conducted, mainly in the form of Permaculture Design Courses for the local community. The courses were conducted to raise awareness of the project's concepts, Permaculture methods, practices and role in environment protection.

Activities focused on home gardens, usually maintained by women as a major target group, in addition to farmers, to raise their awareness and involve them in the project activities. Public awareness activities introduced also the pilot farm project for the community and explained its purpose. The local community participated actively in the public awareness activities conducted during the project period. These focused on Permaculture, environment conservation and other issues.

About 100 participants (50 male, 50 female) participated in the public awareness activities and Permaculture Design Courses. These activities were recognized as first stage project activities.

After this stage, the project conducted a practical training program for women groups to train them on Permaculture methods, tools, practices, rainfall harvesting techniques, plantation, soil conservation and management, safe plant protection, agricultural patterning, organic farming, composting, natural system characteristics, environment protection, small project management and others.

These training sessions were recognized as crucial to give women groups the necessary skill for implementing Permaculture projects. Training sessions were delivered by international Permaculture experts and other national experts. Thirty participants from local community received specialized training during this period.

In addition to local stakeholders (Ministry of Planning, Ministry of Agriculture, Ministry of Health, Ministry of interior and others), the JVP project established a committee from interested local community groups to continue awareness and training activities. The committee consisted of 10 members whose aim was to enhance community participation in the project in order to encourage them to play a vital role in the project implementation process, follow up project activities, farm progress, and other activities. The committee held regular monthly meetings to assess progress and conditions of the project.

A revolving fund mechanism was set up that aims to provide loans to local community members to implement small income-generating Permaculture projects at their household garden. Activities include animal raising, tree planting, Permaculture practices and others.

The JVP project established a four member committee from the project parties (donor, JOHUD and two representatives from the local communities) to manage the fund. The committee prepared bylaws for the revolving fund and was responsible to study, screen and make decisions for loan applications from local clients. It held regular meetings where it made decisions on applications.

As part of the community involvement, participants from the local community, especially women, participated in the application of Permaculture practices on the pilot farm. They followed up on farm design, establishment, and rainfall harvesting system construction, tree planting and daily farm routine activities. The impact of public awareness and training activities and adoption of new techniques by the local committee was evaluated during the project period.

## 3. RESULTS

### PLANT GROWTH UNDER PERMACULTURE PRACTICES

#### Fruit and Forest Trees:

After two years of monitoring the farm, when compared with other plants, the following plants showed a good growth and yield on the farm: olive, fig, date palm, guava, tuna cactus, and pomegranate. For forest and ornamental plants the following plants showed a good growth as well: leucaena, albizia, berconsonia, casuarina, acacias, prosopis julifolia, shinos moll, jasmine, eucalyptus and poplar. The percentage of success exceeded 90%, while grape and jujube success was 60% and 50% respectively.

Pomegranate and fig showed more intensive growth compared with other crops on the farm, even though the local community did not advise planting both of them due to the salt conditions of soils in the area. The application of Permaculture design and planting inside the swales with heavy mulch has had a great impact on the success of crops in the farm.

Legume forest trees incorporated in swales had a positive impact on fruit trees growth, while other fruit trees cultivated outside swales shows less growth. Legume trees improved the soil fertility, reduced direct sunlight on fruit trees and reduced wind stress, which had a positive result on fruit trees growth.

#### Vegetable Crops:

Most vegetable crops showed a great success under the Permaculture system. Eggplant, tomato, onion, garlic and Jew's mallow showed very good growth and yield, while pepper and pumpkin showed less growth due to infection with spider mite, shading from trees and late planting. Rocket, parsley and radish were also successful under the Permaculture practices. Plant care and sound agricultural practices had a great role in improving plant growth.

### Forages:

Barley and alfalfa were both planted on the farm to improve soil physical properties and to provide food for animals. They showed a good growth, despite the high soil salinity. Alfalfa is harvested periodically to feed animals while barley is harvested at the end of the winter season. The yield of crops is close to the yield of similar crops under conventional agriculture as practiced by neighboring local farmers. For example, barley yield is about 180Kg/dunum, where for the project was about 200Kg/dunum.

## WATER USE EFFICIENCY

Crop yields, with respect to water consumption, were generally high. Because much less irrigation water was applied under the Permaculture design system, water use efficiency values surpassed those of conventional agriculture. For example, onion yield was 13.3 ton/ha and the estimated water consumption was 254 m<sup>3</sup>/ha/season.

The water use efficiency was 7.59kg/m<sup>3</sup>. Barley yield was 2ton/ha and the estimated water consumption was 179m<sup>3</sup>/ha/season and the estimated water use efficiency was 17.98kg/m<sup>3</sup>. The amount of irrigation water estimated was based on discharge rate and the estimated time of irrigating target crops.

The evidence of minimum water use efficiency and water conservation is supported by the field observation from the farm. Irrigation water stopped on the farm during August, which is the warmest month in the area while no adverse effects or stress noticed on the plants and trees. This supports the hypotheses that Permaculture design practices have a great role in reducing water needs during summer on the farm.

Permaculture practices reduce water needs due to water harvesting and storage by swales, shading of fruits trees and vegetables by legume trees and use of plant residue as natural mulching for soil insulation and humus creation. In addition, some crops were planted to act as living mulches like portolaca, sweet potato which were planted throughout the fruit tree systems.

The reuse of wastewater from the goose pool and the use of drip irrigation also contributed greatly to increase of water conservation on the farm. As mentioned before, irrigation scheduling was once per week while for the conventional farms in the same area it is twice per week. The percentage of water saving is estimated to be about 40%.

## IMPACTS OF PERMACULTURE ON SOIL PROPERTIES AND PLANT PROPERTIES

### Irrigation Water Infiltration:

Selected soil properties were recorded before cultivation and after one year of establishment. Before the project, the soil had low water infiltration due to high silt content and high Sodium Adsorption Ratio (SAR) value as observed from high surface runoff during winter. Once the Permaculture system was established, water infiltration into the soil increased evidenced by no water staying on soil surface during irrigation.

The SAR value for soil extract was reduced after one year of establishment, which means less effect of Na on soil structure. The increase in water infiltration is due also to the use of natural mulching and planting of barley and alfalfa to improve soil physical properties. In addition, the zero tillage practice, which was maintained during the year, resulted also in improving soil structure due to less compacting.

### Soil Salinity:

Soil salinity in swales was reduced, as compared to the beginning of the project. There was also a significant reduction in soil salinity before and after one year due to the application of Permaculture design practices, even though the farm depends on saline water of about 4dS/m salinity for irrigation. Swales established in the farms resulted in collection and storage of rainwater that leached the salts from the soil. The use of natural mulching prevents water evaporation and prevents salts accumulation on soil surface. It also works as a buffer to reduce the long-term effects for salts on soil and plant.

### Soil Fertility, Organic Matter Content (OM) and soil pH:

The soil OM content increased through the continuous practice of using natural mulching from plant residue and composting of animal manure. Natural mulching improves the soil ecosystem by increasing the number and type of soil organisms and improving soil microbiology growth. In addition, legume crops and trees increased N-content and improved soil fertility. The reuse of waste water from the goose pool enriched the irrigation water pool and soil with many nutrients like N and P.

The use of natural mulching resulted in a decrease of soil pH, although the soils in the area are normally very alkaline. This is due to the decomposition of plant residues and production of humic acid as a by product of decomposition, which decrease soil pH.

### Plant Tissue Content:

The results of a selected analysis for some plants from the farm showed very low content of heavy metals, especially cadmium and lead where these metals are usually present in crops grown by farmers using chemical fertilizers, especially cadmium. This reflects the role of Permaculture in improving soil and plant quality. The content of plant nutrients (NPK) is within the average content which reflects the availability of plant nutrients in soil system.

## IMPACTS OF PERMACULTURE ON BIODIVERSITY CONSERVATION AND LOCAL FARM ENVIRONMENT

Permaculture practice depends on cultivation of native plants from the project area plus the diversity of crops on the farm including fruit trees, legumes trees, legume crops, vegetables, ornamentals, forages and others. The farm now has a large diversity of native birds, reptiles and small mammals. Many local species of plants like halophytes, weeds, flowers and others that were not present at the beginning of the project now grow on the farm due to the diversity of crops and other benefits under the Permaculture design practices.

The soil ecosystem has also greatly improved. Permaculture creates a good local environment for rehabilitation soil organisms. The soil under the mulch is enriched with many microorganisms that make the soil alive and improve the soil ecosystem.

Plants in swales, especially legume forest trees, provided many benefits to the farm, such as reducing wind speeds and creating local micro-climates appropriate for other plants like vegetables. In addition, the Permaculture practices such as not using chemicals and soil conditioners also improved the farm environment, natural resources conservation and agricultural products quality.

Farm animals completed the integrated system, creating important links between soil, plants, animal and back to soil in a natural cycle functioning as an ecosystem. Chickens scratch the soil continuously, eat insects and add manure to the soil. Pigeons eat insects such as flies and harvest seeds from the larger environment outside the farm, bringing in high quality nutrient in the form of manure.

Green plants now cover most of the farm area. The integration of plants and animal on the farm has resulted in a natural ecosystem of self dependence and the integration of farm inputs and outputs. The farm presents a pilot model for the sustainable management of natural and agricultural resources.

#### EFFECTS OF PERMACULTURE ON INSECTS AND DISEASES PROPAGATION

An ecosystem type of balance is present on the farm. Field studies have shown that insects and their predators are present on the farm. For example aphids are present, but so are many of their predators so they are continuously kept in check. During the project period, no serious infection occurred on the farm except a spider mite infection that was controlled using natural sulfur. The diversity of crops, trees, weeds, legumes, Permaculture practices and plants and animal integration all encouraged the ecosystem balance on the farm.

#### EFFECTS OF PERMACULTURE ON ENVIRONMENT AND LOCAL COMMUNITY

Permaculture is a new concept implemented in the area, and its impact on the environment and local community was very apparent. The normal practice in the project area is monoculture, where farmers use extensive amounts of fertilizers and pesticides which result in negative impacts on human and environmental health. With the implementation of the JVP project, the local community accepted and understood the application of Permaculture concepts and production of organic products and saw value in this approach.

The local community has shown great interest in following up project activities and training sessions. Handouts and technical information were given to participants to provide them with the necessary information. Locals, primarily women, made regular visits to the pilot farm to assess farm progress and the impact of Permaculture. The impacts of training activities were very clear on participants.

Participants gained new skills and practices in farm agricultural management, which is very important for the sustainable use of natural resources. Participants learned about other water resources activities, such as rainfall harvesting practices and grey water re-cycling and its uses. This taught them the importance of local natural resources.

Meetings held by local committees resulted in a positive impact on community involvement with the project activities. For example, women's groups who were trained in Permaculture practices implemented similar projects in their own home gardens. The project trained 30 women and men from

the community. Fifteen of them implemented Permaculture projects at their household garden. Most household Permaculture projects were implemented by women. The project gave technical assistance and small loans for them to implement Permaculture activities. This resulted in the realization by the local community of the importance of Permaculture and its impacts on their health issues.

#### 4. SUSTAINABILITY

The JVP project played a role in diversifying production patterns for plants and animal that improves product marketing and increases the return from the farm. The project launched a revolving fund to help the local community to implement small agricultural projects with a focus on Permaculture. The revolving fund has had a great impact in helping the local community to implement and sustain Permaculture practices in their household gardens. The project donates 140 revolving loans for local community members (male and female) to implement agricultural and commercial small businesses and 100 loans used for agricultural and Permaculture projects.

Now that the project has been in operation for three years, the farm has abundant green cover and Permaculture ecosystems are well established on the farm. The farm is cultivated now with different productive crops which are used to generate income for the local community. At the household level, different crops are also cultivated to provide supplemental food for the families. Families have stopped using chemicals for plant protection or fertilizers for soil improvement and now they depend on safe methods and materials for plant protection and organic manure, and compost and plant residue for soil improvements.

#### 5. LIMITATIONS ON THE USE OF ECOSYSTEMS IN THIS PARTICULAR HAZARD

The only limitations are the need for a thorough education of the people involved in establishing a demonstration site as a living example that proves the system works. Educational courses need to be an on going process for local people to understand how to transition to sustainable land use systems.

#### 6. IMPLEMENTATION COSTS

In most cases implementation and input costs are no higher than the present agricultural practices that are causing the damage and degrading the landscape, and over time they are less and production volumes and quality increase.

## 7. CARBON BENEFITS

The carbon benefits are difficult to measure, but potentially enormous in the increased biomass above and below the soil. Incorporating tree cover with water harvesting earth works greatly increases soil biomass where very large amounts of carbon are locked up.

## 8. CONCLUSIONS AND LESSONS LEARNED

The results show that the application of Permaculture methods and introducing Permaculture techniques like swales, natural mulching, rainfall harvesting, legume cultivation, have a clear role in improving soil properties, increasing soil organic matter content and reducing soil salinity. In particular;

- ★ The pilot farm produced fruits and vegetables free of chemicals that are safe for human consumption.
- ★ The farm represents a pilot model for sustainable management of natural resources especially soil, water and plants under extreme drought and salinity conditions. The local community has adopted the project and implemented Permaculture practices in their household gardens.
- ★ There is greater awareness among the community members of the importance of local natural resources like native plants, local plant varieties, agricultural wastes, recycling and local community experience to deal with farm problems and implement the Permaculture practices.
- ★ The local community played a crucial role in the success of the project. They learned and adopted new practices for water, soil and natural resources management as well as agricultural production.

## 9. ADDENDUM: SUBSEQUENT JORDAN VALLEY PERMACULTURE PROJECT

As of 2008, the Permaculture Research Institute has started another Permaculture project in the Jordan Valley. The project is a model of sustainable arid land development, demonstrating that all the basic needs for a healthy, meaningful, peaceful lifestyle can be affordable, understood and achieved by economically poor local people.

The project site is typical marginal arid land settled by poor people of the area. It will feature demonstrations of energy efficient appropriate housing with natural cooling systems and a plant nursery attachment, solar electricity, solar hot water, biological waste water treatment recycling, dry compost toilet, rain water harvesting earthworks, greening the desert diverse inter-active plant animal and tree systems for local food production and processing.

The demonstration house will function as a classroom, administration office for the project and the local community Permaculture group. Once fully established the project will serve as a model that can be replicated throughout Jordan and other counties in the region. The project is expected to be completed in 2011.

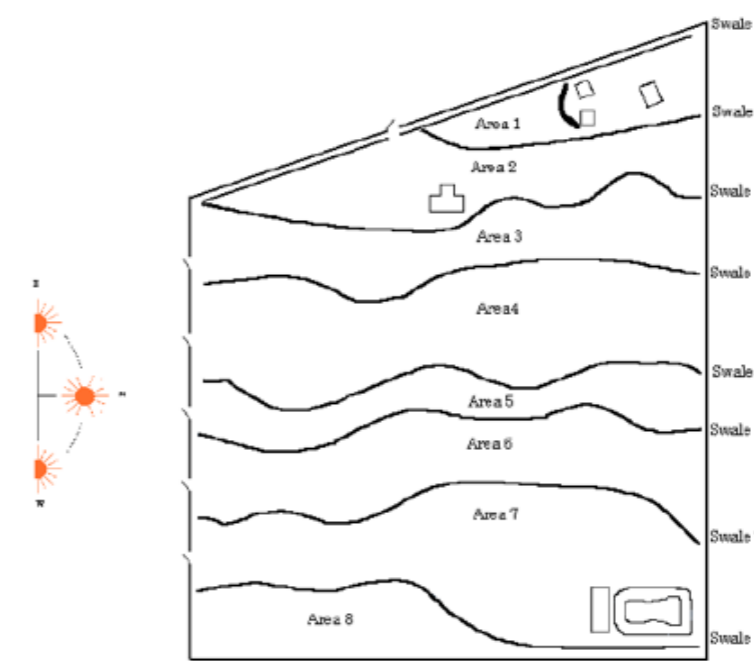


Figure 1: Site map



figure 2: Site photos; (a) before project; (b) 6 months ; (c) 3 years, 2003;

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## CONTACT DETAILS

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