SUSTAINABLE AGRICULTURAL DEVELOPMENT FOR MARGINAL DRY AREAS

KHANASSER VALLEY INTEGRATED RESEARCH SITE

ICARDA

International Center for Agricultural Research in the Dry Areas (ICARDA)

in cooperation with

AECS

Atomic Energy Commission of Syria (AECS)

universitätbonn
Bonn University

Bonn University, Germany

With the participation of farmer communities of the Khanasser Valley

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KHANASSER VALLEY INTEGRATED RESEARCH SITE

KHANASSER VALLEY: A BENCHMARK SITE FOR MARGINAL DRY AREAS

The Khanasser Valley was selected by ICARDA's Natural Resource Management Program as an integrated research site to address problems that are characteristic for the marginal dryland environments of CWANA. The diversity and dynamics of livelihoods, the occurrence of natural resources degradation, the prevailing poverty and the relatively easy accessibility were the main factors in the choice of Khanasser Valley as a benchmark site.

Khanasser Valley is located approximately 80 km southeast of Aleppo city. The study area covers 453 km^2. The total resident population is about 27,300 (or 2900 households). The agricultural area and the natural rangelands of the steppe meet in the valley. An average annual rainfall of 200 mm/year is considered the boundary between the two areas. Based on annual rainfall, the valley is located in Syria's agricultural stabilization zone 4.

The project "An Integrated Approach to Sustainable Land Management in Dry Areas" started in January 2001 and will conclude in June 2005. The main collaborators are: the International Center for Agricultural Research in the Dry Areas (ICARDA), Atomic Energy Commission of Syria (AECS), and Bonn University (Germany). The main sponsor is the German Federal Ministry for Economic Cooperation and Development (BMZ), with matching funds from ICARDA and AECS.

OBJECTIVES OF THE KHANASSER VALLEY INTEGRATED RESEARCH SITE (KVIRS)

Goal of KVIRS

Livelihood improvement of land users and sustainable management of natural resources in the marginal dry areas.

Purpose of KVIRS

1. To develop environment-friendly "adoptable" agricultural technologies and approaches for Khanasser Valley. This could be either improvement of existing technologies or development of new options.
   Indicator: Farmers start to adopt and/or adapt technologies without any form of subsidy.
2. To develop an integrated and transferable natural resource management approach that can be applied beyond Khanasser Valley in a spectrum of dry area environments. This approach includes:
   1. Analysis of natural resource dynamics (degradation and rehabilitation).
   2. Approach for developing potential resource management options.

3. Operationalization of the integrated natural resources management (INRM) framework in dry areas.

Indicator: Methods and tools available by the end of the project.

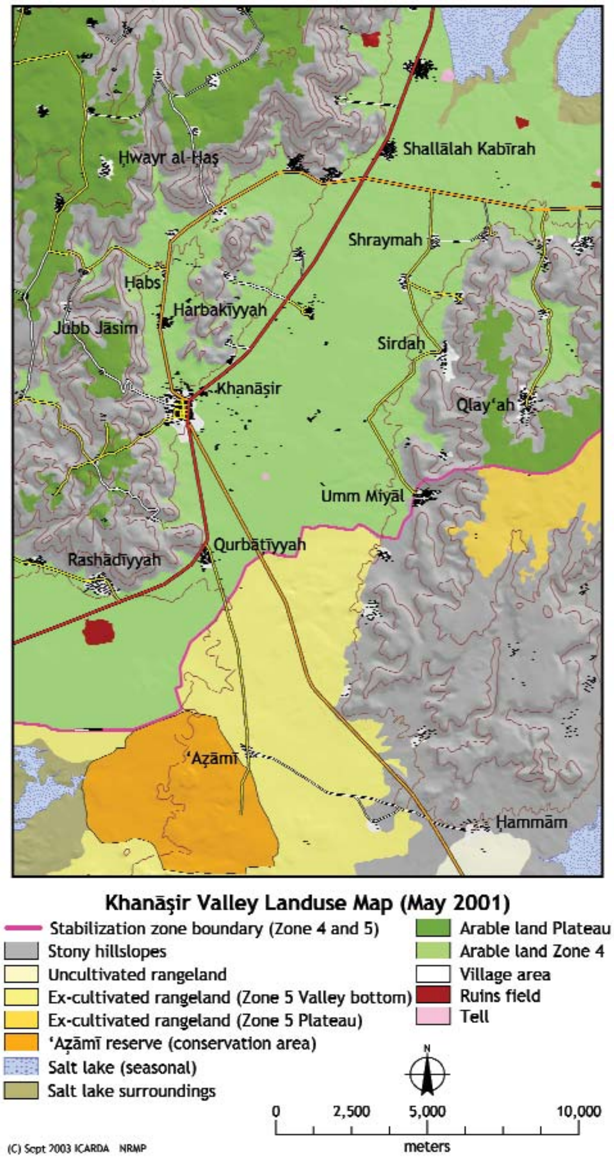


Figure 1: Land-use in Khanasser Valley.

POTENTIAL OUTSCALING AREAS

The technological options for resource-stressed farmers and communities developed in Khanasser Valley have application possibilities in the dry areas far beyond Khanasser, as described below.

Zone 4 in Syria

Syria has been divided into five agricultural stabilization zones according to the probability of annual rainfall, which determines rainfed crop production. Zone 4:

- Receives an average annual rainfall between 200-250 mm and not less than 200 mm in 50% of the monitored years.
- Represents a marginal zone between the more favorable agricultural production zones (Zones 1 through 3) and the steppe (Zone 5).
- Covers about 20,600 km² or about 11% of Syria's geographical area.
- Houses about 2 million people, or approximately 14.4% of Syria's population (1994).

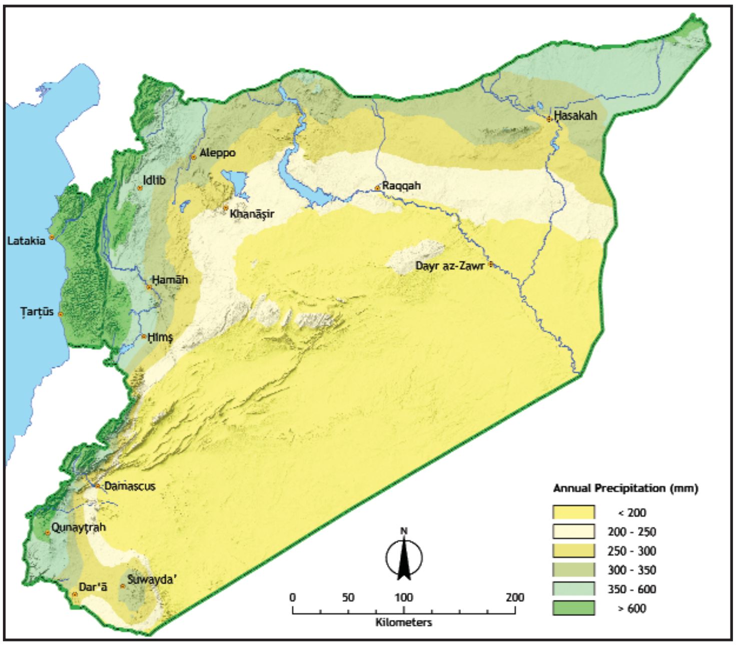


Figure 2: Average annual rainfall and location of Khanasser Valley in Syria.

Central Asia, West Asia and North Africa (CWANA)

Agro-ecological similarities were mapped to assess where in CWANA the technological options, developed in Khanasser Valley, have potential relevance. The following parameters were considered: temperature, precipitation and land use/land cover.

Areas with high similarity in climatic conditions within the three land use/land cover patterns (Fig. 3) are situated within a narrow latitudinal range (28ºN-40ºN), characterized by precipitation during the colder part of the year. Environments similar to the one in Khanasser Valley can mainly be found in: Syria, Jordan, Maghreb countries and Iran.

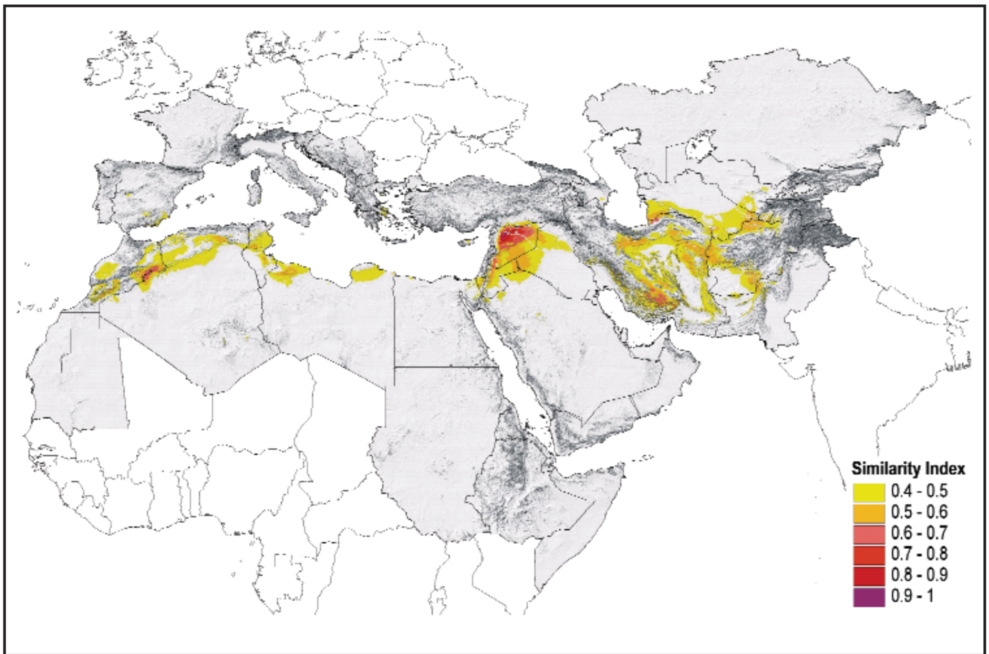


Figure 3: Areas with highly similar climates and land use/land cover patterns.

INTEGRATED NATURAL RESOURCES MANAGEMENT (INRM)

Problem

Traditional single-disciplinary and single-scale approaches for agriculture and natural resources management (NRM):

- often resulted in great technologies,
- but with poor impact,
- especially in dry marginal areas, where agricultural problems are usually complex, interrelated and multi-scale in nature.

This realization induced rethinking of the prevailing research strategies for NRM.

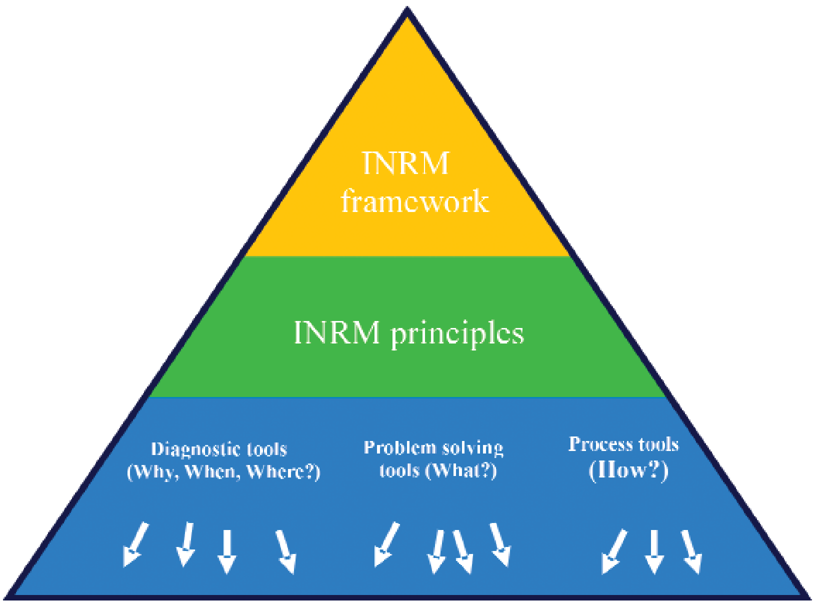
Approach

1. Based on lessons learned, NRM practitioners came up with a new framework:

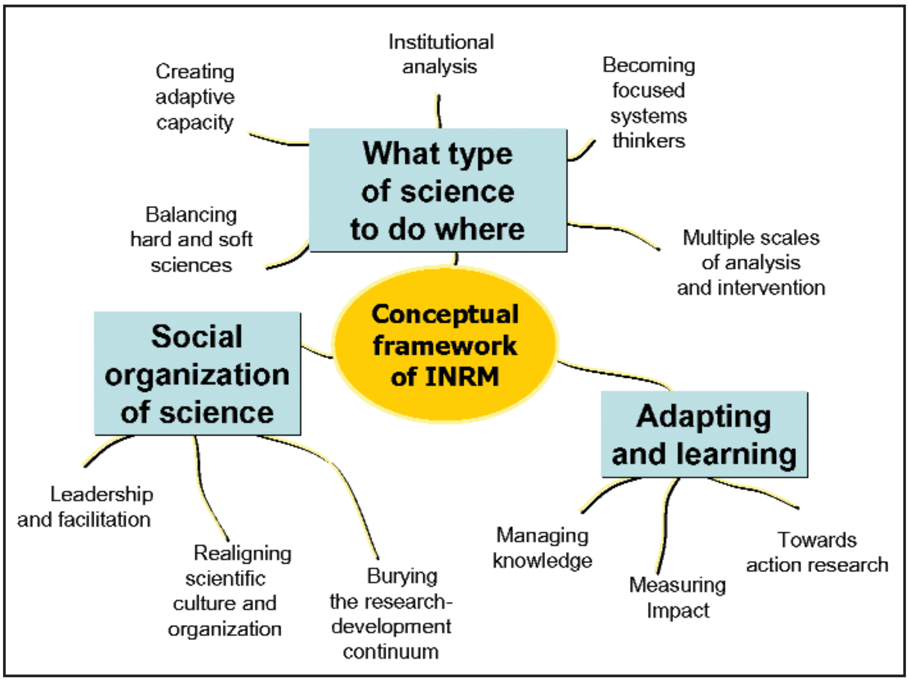
"Integrated Natural Resources Management (INRM) is an approach that:

- integrates research of different types of natural resources,
- into stakeholder-driven processes of adaptive management and innovation,
- to improve livelihoods, agro-ecosystem resilience, agricultural productivity and environmental services,
- at community, ecoregional and global scales of intervention and impact."

This framework can be translated into a number of principles and tools.



2. INRM principles:
- Balancing hard and soft sciences.
- Merging research and development.
- Setting up a system for adapting and learning.
- Focusing the right type of science at the right level.
- Changing scientific culture and organization.



3. To operationalize INRM, practical INRM tools were identified:

Diagnostic tools	*Tools for problem-solving and capitalizing on opportunities*	*Process tools*
1. Integrated research sites. 2. Multi-level framework for diagnosis. 3. Livelihood, gender and community organization analysis. 4. Analysis of policy, institutional and market environment. 5. Analysis of natural resources status and dynamics. 6. Holistic system analysis.	*7. Multi-level framework for problem-solving. 8. 'Plausible options' or 'best bets'. 9. Decision and negotiation support tools. 10. Scaling-out and scaling-up.*	*11. Cross-disciplinary approach. 12. Envisioning. 13. Participatory action research (PAR). 14. Multi-stakeholder cooperation: Trust, Ownership and Commitment (TOC). 15. Capacity building of different stakeholders (INRM, organizational and technical). 16. Effective communication, coordination and facilitation strategy. 17. Monitoring, evaluation and impact assessment. 18. Knowledge management.*

An example of the application of Tool No.7, a "multi-level framework for improving olive cultivation in marginal dry areas" is presented below:

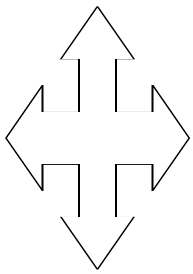
SPATIAL LEVELS

Marginal drylands (Zone 4)
- Selection of adapted varieties.

Khanasser Valley
- Selection of appropriate areas.

(Sub)-catchments
- More efficient use of runoff water.

Field
- Soil and water management: Water harvesting, irrigation, tillage, soil erosion control.
- Tree husbandry: Pruning, disease control, soil fertility management.



STAKEHOLDER LEVELS

Policy and institutions
- Policy and institutional recommendations for enabling environment

Marketing
- Develop local market.

Communities
- Social fencing: Communal-agreed arrangements.
- Equitable use of runoff water.

Household livelihood strategies
- Targeting research to (potential) olive growers and to the relevant gender groups.
- Participatory research awareness and training about improved husbandry.
- Viable alternatives for olives?

NATURAL RESOURCES OF KHANASSER VALLEY

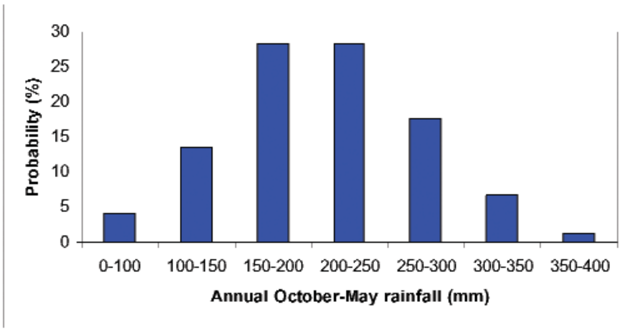
Khanasser Valley lies between the basalt-covered hill ranges of the Jabal al-Hoss in the east and the Jabal Shbayth in the west. The northern part of the valley drains towards the Jabbul Salt Lake, while the southern part drains towards the steppe.

Climate

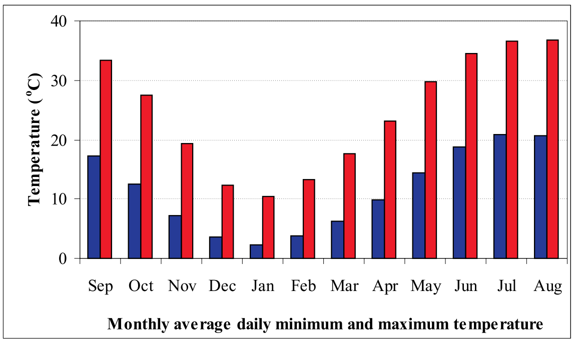
The long-term average annual rainfall during the rainy season (October-May) is 210 mm. The variability of the rainfall within a year and between years is high. During the period 1929-2004, more than half of the years (53%) had rain above 200 mm, and 25% of the years received more than 250 mm.

Rain occurs sometimes in large storms or with high intensities, causing surface runoff and flooding. Days that receive 20 mm rain or more occur on average once a year. During the period September 1998 and August 2004, the maximum amount of rain that fell during a 30-minute period was 23 mm.

The total reference evapotranspiration during the October-May cropping season is about 700 mm.



Monthly average daily maximum temperatures reach almost 37°C in July and August. Average minimum daily temperatures are lowest in January (2.3°C). Below-zero temperatures occur at night during the months November to March, and rarely in April. Temperatures hardly ever remain below zero for the day.



Water Resources

The upper groundwater system in Khanasser Valley consists of alluvial, proluvial, and lacustrine Quaternary deposits and chalky limestone formations of the Paleogene.

Groundwater in the center of the valley is brackish to saline, limiting its use for agriculture and domestic purposes. The salinity is mainly of geologic origin.

Groundwater flow in the chalky limestone formations is slow, limiting the amount of water that can be pumped each day. Locally, fractures improve the flow.

Recharge of the upper aquifer system comes from the parts of Jabal Al Hoss and Jabal Shbayth that drain towards the valley. This recharge is estimated as 4-10% of the annual rainfall, resulting in 0.85 to 2.15 million m^3 per year. In the valley bottom, groundwater recharge is limited because of the predominantly thick,

clay-loam soils. Furthermore, the poor quality of the underlying groundwater limits the use of this water.

The deeper groundwater system (below 300 m) is a Cretaceous limestone formation. The water is sulfuric and saline and not suitable for use.

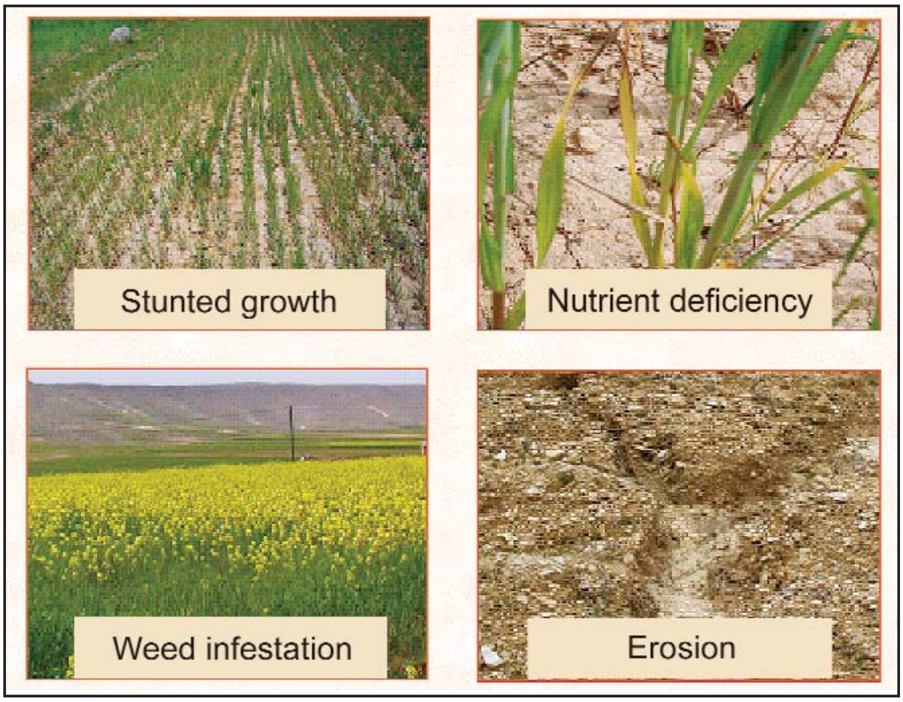
Most water for household use is brought in by truck or tractor-pulled tankers from the government pipeline in the north of the valley. The wells in the Harbakieh side-valley provide another source.
Observations have not shown alarming changes in the quantity and quality of the groundwater during the last five years.

Soils and fertility

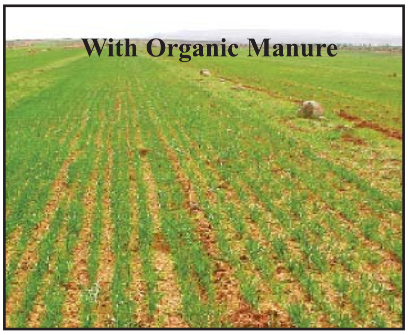
The soils of Khanasser Valley include Calcisols, Gypsisols, Leptisols, and Cambisols. They are well-drained and are fine to moderately textured.

The soils are predominantly derived of calcareous parent material with high pH (8.3), low organic matter (0.6%) and multi-nutrient deficiencies (especially P and Zn). The soil fertility status of the agricultural land is in general low and the situation is further aggravated by poor management strategies. The soil fertility status is declining, due to the following reasons:

- Exhausting the soil by continuous cropping. The traditional fallow has been abandoned due to land partitioning and mechanization.
- Absence of crop rotations (e.g. no inclusion of leguminous crops to improve soil N status).



- Nutrient mining: Little or no nutrient inputs to the soil; farmers cannot afford to invest in high inputs because of financial constraints. Moreover, animal manure is being sold to the irrigated areas as a means of generating income.
- Water erosion: Plowing up and down the slope implies less chance for rainwater to infiltrate and accelerates erosion.
- Wind erosion: Clean grazing at the beginning of the dry season gives the wind free play to blow away nutrient-rich particles.
- Lack of incentives to conserve soil resources (e.g. insecure tenure systems and other policies).
- Low level of knowledge about proper soil fertility management.



Many farmers realize the negative consequences of their practices, however, they are usually driven by their immediate problems and short-term objectives. They are reluctant to use high levels of inputs and tend to adopt risk aversion strategies rather than maximization of production.

The plant vegetation

A plant species survey of the Khanasser Valley area, including the al-Hoss and Shbayth hill ranges, identified about 240 species, belonging to 41 families and 165 genera. The climax vegetation of the region was most probably dry steppe-forest. The dominant species of the first and tallest layer of climax vegetation was *Crataegus aronia* including other arboreal species such as *Pistacia* and *Prunus.* Tall grasses including *Stipa*, *Avena*, *Lolium*, *Phlomis* and others form the second lower layer, while short grasses and herbs, such as *Hordeum*, *Bromus*, *Linum*, *Dianthus* and others form the third and lowest layer. Destruction of the climax vegetation by cutting, plowing and heavy grazing led to degradation of the vegetation to lower successional stages, where the tree layer was removed and the valuable semi-shrub fodder plants were replaced by less palatable or spiny species. In many sites around settlements, the vegetation was reduced through overgrazing and cutting to extremely poor forage, mostly the *Peganum harmala* - *Carex stenophylla* plant association, with nearly no ability to sustain livestock.

The main associations currently present in the area are:

- *Crataegus aronia* - Tall grasses association.
- *Crataegus aronia* - *Noaea mucronata* association.
- *Anagyris foetida* - *Avena barbata* association.
- *Noaea mucronata* - *Carex stenophylla* association.
- *Noaea mucronata* - *Capparis spinosa* association.
- *Peganum harmala* - *Carex stenophylla* association.

After short-term protection and establishment of simple water furrows and micro-catchments, the standing crop biomass of the vegetation was measured at 1352 and 2710 kg/ha dry weight in dry and rainy years, respectively. This demonstrates the high biomass potential of the land.

Many plant species of high economical value are found in the area:

- Medicinal: *Thymus syriacus*, *Saturija pallaryi*, *Teucrium polium*, *Gluacium aleppicum*, *Anethum graveolins* and others.
- Ornamental: *Tulipa systola*, *Iris sindjarensis*, *Ixioliron tataricum* and others.
- Cash: *Capparis spinosa*, for medical and industrial purposes.
- Fuel: *Ziziphus lotus*.

Grazing resources

The flocks of the Khanasser Valley have access to different land types for grazing. Hill-slope rangeland: The vegetation near the settlements is usually overgrazed and degraded, dominated by annual grasses, non-palatable broad-leaf forbs and spiny shrubs. Most of the hill-slope grazing is not private but village land grazed in common from January to June.

Cropland stubble in the valley floor: During June, the flocks move to the fields to graze the crop stubble (especially barley). After this period, the flocks move northwards off of their community land towards Zone 3 to rent grazing on the stubble of wheat, lentil, cotton and other crops.

The steppe rangeland: Flocks move from the settlements to the communal rangeland of the badia (Zone 5) during winter and spring depending upon rainfall. During high rainfall years they may stay on this common rangeland as long as 8 months but less than 2 months during dry years. This forage resource is free for the taking but overstocking reduces the amount of forage available and has degraded much of the steppe vegetation to less palatable species.

Rotational grazing could improve the productivity and sustainability of the badia, but herder cooperation is required. Efforts are being made by the government and various international organizations to improve this rangeland by shrub plantation and yearlong rest.

LIVELIHOOD STRATEGIES AND DEVELOPMENT PROBLEMS IN KHANASSER VALLEY

Major income sources

People's livelihoods in Khanasser Valley are similar to those of people living in many other marginal dry areas of CWANA, in terms of ecological conditions, market marginality, and migration.

In Khanasser Valley, small ruminant production (mainly fattening) and off-farm labor are the major breadwinners of local households, generating on average 48% and 42% of total cash earnings, respectively. Earnings from sale of crops constitute about 10-30% of total household income. Yet crops are fundamental inputs in the mixed crop-livestock system.

Diverse livelihood strategies

Livelihood strategies at Khanasser Valley cannot be simply generalized. There is a wide diversity of strategies. The major categories are:

- *Agriculturalists*: They integrate crops, fattening and waged labor, with a per capita income of 1.3-2$/day.
- *Pastoralists, or extensive herders*: They migrate for wages or move to fattening; with a per capita income of 1-1.5$/day.
- *Land-poor laborers*: They rely on off-farm earnings and have a per capita income lower than 1$/day.

In the Khanasser Valley area, 40% of the families are *agriculturalists,* 10% *pastoralists*, and 50% are *land-poor laborers*. The *pastoralists* have no land. Half of the *land-poor laborer* families have little land (on average 3.5 ha), the other half have on average 7 ha land.

Identification and definition of household typologies enable to better target the poor and enhance impact. Local farmers associate being poor with having few or no sheep and little or no land, family members without work, as well as debts and chronic cash shortage.

Livelihood challenges

Households living in marginal dry areas face challenges from different fronts:

- Bio-physical challenges:
  - Water scarcity: Low and unreliable rainfall, drought, declining groundwater and drying up of wells.
  - Land degradation: Soil fertility depletion, salinization, and water and wind erosion.
  - Rangeland degradation and bio-diversity loss affects flock size and results in migration.
- Social challenges:
  - Population growth and mechanization of farming causes declining employ ment opportunities in rural areas.
  - Climatic variability results in a high fluctuation of income and employment certainty.
  - Land fragmentation has a strong effect on marginal areas, as the productivity per unit area is much lower and smaller plots will not sustain households.
  - Out-migration of particularly the male family members due to increased work opportunities in cities and abroad, often resulting in de-facto woman-headed households.
  - Lower elementary school enrolment, particularly for girls of households that keep moving from one location to another for temporary employment.
  - Feminization of agricultural labor.
  - Higher child malnutrition than in the more favorable agricultural zones and irrigated areas.
  - Education and health services are under-developed.

- Economic and financial challenges:
  - The farmers and livestock keepers of Zone 4 heavily rely on a network of traders for marketing their products, purchasing inputs and getting loans. In this complex relationship, traders are often in a stronger negotiating position than farmers. The interest rates charged by traders are estimated at more than 50%.
  - Decreased real per capita incomes due to growing families.
  - Household earnings are firstly spent to cover health costs, recurrent living costs, and - only when these are met - farming costs in general:
    - the *agriculturists* primarily spend money to rent equipment or hire laborers.
    - the *pastoralists* spend money to transport the animals, buy water, and hire labor. As such, net disposable incomes for agriculture is limited. Only the *agriculturists* and '*pastoralist-laborers*' have such a surplus.
  - Lack of cash and erosion of savings due to increasing living and farming costs. Rural households increasingly seek credit to overcome cash problems. Yet this is not matched by sufficient availability of credit at accessible rates.

Coping strategies

Rural households in Zone 4 suffer from both income poverty and high uncertainty and vulnerability. Strategies of local households to cope with the challenges of living in marginal areas include:

1. Diversification of livelihood strategies.
2. Specialization in few and defined options, such as lamb fattening.
3. Migration for off-farm wages.
4. Permanent exit from agriculture.

The latter two are often the case of households less endowed in land and natural resources, and with livelihoods only marginally based on farming.

Exiting from agriculture is the extreme case when farmers cannot diversify and compete in their business anymore. This is often the case of the poorer, landless, more remotely located people in marginal areas, for whom there seems to be no obvious farming options anymore.

GOVERNMENT POLICY AND STRATEGY FOR ZONE 4

The system of agricultural stabilization zoning was introduced in 1975. It is part of the overall effort by the government to better regulate agricultural production through medium and long-term agricultural sector planning. This central planning effort involves a detailed annual agricultural plan specifying the crops that farmers should grow and the area allocated to each crop in each of the agricultural stabilization zones and administrative units. This has resulted in zone-specific policies that affect farmers' crop choice, and access to inputs, credit and government subsidies. The agricultural policies in general and more recent policy changes that affected rural livelihoods in Zone 4 are as follows :

- Formal credit is not available to crop production because cropping is considered risky.
- Fertilizer is not allocated to rainfed crops because it is considered unnecessary in this marginal zone.
- Because it is a marginal production zone, farmers do not participate in the government production plan and hence do not have crop production licenses that allow them to access subsidized inputs.
- Groundwater pumping for irrigating summer crops is banned.

However, the government of Syria is aware of the development needs of Zone 4. The Jabal al-Hoss Rural Development Project is an example of the government’s support for the development of Zone 4.

AGRICULTURAL DEVELOPMENT OPTIONS FOR KHANASSER VALLEY AND ZONE 4 IN GENERAL

Given the uncertain climatic conditions, the marginality of the natural resources and the challenges in rural livelihoods, the major strategies that will strengthen livelihood resilience in a sustainable way are strengthening the barley-sheep system, diversification, careful specialization, measures for efficient and sustainable resource use, and community organization:

1. Strengthening the barley-sheep system: The core agricultural system in Khanasser Valley is the barley-sheep raising system. This system will likely continue to play an important role, as it has proven its suitability to this harsh environment. Measures to improve this system include: drought-tolerant barley varieties, vetch-barley rotations, atriplex and priming of barley seeds.
2. Diversification: This can include subsistence and cash generating activities:
   - Cash-generating activities are highly desired by the cash-strapped farmers of Khanasser Valley (e.g. wheat, cumin).
   - Agricultural products for subsistence use are also generating interest as they reduce household cash expenses and reduce livelihood vulnerability (e.g.olives, home gardens).
3. Specialization: This usually involves cash-generating activities, with relatively high initial investments (e.g. lamb fattening).
4. Efficient and sustainable resource use (e.g. water harvesting, efficient irrigation, manure use, phospho-gypsum).
5. Community organization: Local institutions for better marketing (e.g. *jabban*), provision of loans (*sanadiq*) and community based natural resources management (e.g. sustainable rangeland management).

Most of the mentioned options of technologies have been tested in close collaboration with Khanasser farmers. Descriptions of these technologies are provided in the next sections.

Many of the challenges faced by Zone 4 farmers are beyond their control. On the other hand, government investments in marginal areas such as Zone 4 are often low, because it is not easy to increase productivity in these areas. The higher poverty incidence associated with low resource endowments should justify greater human development programs in this region. Rural development in this region will need structural support, through policy and institutional measures, such as:

- Farmer training and dissemination of extension information.
- Equal opportunities to access input supplies (compared to other zones).
- Effective and sustainable micro-credit systems.
- Improved flow of market information.
- Establishment of local markets.
- Improved small-scale village post-harvest facilities (e.g. for handling and processing quality dairy products).
- More investment in rural services and infrastructure (health, education, water and sewage systems, electricity, (mobile) telephone network).

AGRICULTURAL DEVELOPMENT OPTIONS

PARTICIPATORY BARLEY BREEDING

1. Description

In a conventional breeding program, the most promising lines are released as varieties, their seed is produced under controlled conditions and only then farmers decide on adoption. The process often results in many varieties being released, and only a few being adopted.

The objective of Decentralized-Participatory Plant Breeding (D-PPB) is to develop an alternative way of conducting plant breeding that is more efficient in bringing new varieties to farmers regardless of their farm size, location, wealth, education, etc. These varieties are adapted to the physical and socioeconomic environment. The major consequence of D-PPB concepts is that the process turns the delivery phase of a plant-breeding program upside down. The program is based on the following concepts:

1. The traditional linear sequence scientist-extension-farmers is replaced by a team approach with scientists, extension staff and farmers participating in variety development.
2. Selection is conducted in farmers' fields using agronomic practices decided by them.
3. Farmers are the key decision makers.

The general scheme starts with planning meetings driven by farmers, a research agenda formulated in partnership with them, and implemented at the community level.

Under D-PPB, it is the initial farmers' adoption that drives the decision of which variety to release. Hence, adoption rates are higher, and risks minimized, as intimate knowledge of varietal performance is gained as part of the process. The investment in seed production is nearly always paid off by farmers' adoption.

2. Strengths and weaknesse

Strengths	Weaknesses
• Improved varieties are released quicker and adoption rates are higher. • Different varieties are being selected in different areas in Syria, in direct response to different ecological constraints. • Farmers spontaneously tested new varieties as early as three years after starting the program. Thousand of hectares are planted with 2 newly released varieties and about 30 varieties are under large scale testing. • In advanced yield trials in the valley, several lines out yielded the local varieties; yield gains were modest in Mugherat (10-11%), higher in Khanasser (22-28%)	• The difficulty for some National Program scientists to deal with farmers as partners. • Changes within the national agricultural research and extension systems are slow. • Rigidity of variety release systems.

Farmers in both Mugherat and Khanasser selected for tall varieties and for varieties growing faster in winter. The visual selection of farmers in Mugherat was much more closely correlated with grain yield (r = 0.503) than that of farmers in Khanasser (r = 0.059).

3. Target group

The *agriculturalists* but also the *land-poor laborers* are benefiting from the quicker access to improved barley varieties as a result of D-PPB. Indirectly, the *pastoralists* and their sheep also benefit from better barley.

4. Actual and potential side effects

The cyclic nature of D-PPB programs has enriched farmers' knowledge and improved their negotiation capability, thus, empowering farming communities.

5. Institutional and policy implications

- In several countries, D-PPB generated changes in the attitude of policy makers and scientists towards the benefits of participatory research.
- Extension services need to take on new tasks. The role of extension in D-PPB is both in participating, together with farmers and researchers, in technology development, and in involving additional farmers in the process, rather than transferring research results from researchers to farmers.

VETCH

1. Description

- Vetch, an annual forage legume, is planted in rotation with barley in winter.
- Vetch is either grazed or cut for hay making in early spring.
- Vetch is harvested for seed and straw in late spring.
- Hay, seed and straw are used as protein supplements to cereals straw (e.g. barley).

2. Strengths and weaknesses

Strengths	Weaknesses
• Yields of barley straw and grain increase by 25-40% when grown in rotation with vetch, as compared with continuous barley cropping. • Feeding vetch hay or grain as supplement to low-quality cereal straw improves lamb growth by 20-30%. • Lambs grazing vetch in early spring gain as much as 100-150 g per day. • Soil nitrogen and phosphorus levels increase by 10-15% when barley is planted in rotation with vetch. • Sale of vetch seed and straw provide additional income to farmers. • The production and marketing risks of vetch to be lower than cumin and wheat.	• Most farmers, especially in Khanasser have little experience with growing vetch in rotation with barley. • Good-quality seeds of high-yielding varieties are expensive and not readily available to farmers. • Farmers do not have access to information on growing vetch - seeding rates and dates, weed control, fertilizer needs, and harvesting methods. • Farmers have limited information on the storage and use of vetch (hay, straw and grains) as animal feed and grazing of vetch in spring for lamb fattening.

3. Target group

- Poor livestock farmers in rural and urban communities.
- Dry areas with annual rainfall ranging from 200-400 mm.

4. Actual and potential side effects

- Crop and livestock outputs increase by 20-30%.
- Soil organic carbon and nitrogen status increase by 10-15%.
- Household income increased from sale of excess crop and livestock outputs.

5. Institutional and policy implications

- Empowering farmers to use the technology.
- Support for viable forage seed systems.
- Creation of market opportunities for fodder and forage seed.

ALLEY-CROPPING WITH SALTBUSH AND BARLEY

1. Description

- Saltbush (*Atriplex*) is a perennial shrub planted in barley fields to provide fodder in the dry season.
- Saltbush is planted in rows of 10 m apart, with 2 m between shrubs within each row. They can reduce wind erosion if planted perpendicular to the prevailing wind direction.
- Barley or other crops are grown between the rows of saltbush.
- Saltbush is protected from grazing during the first season.
- After harvesting barley, sheep graze the stubble and the saltbush.

2. Strengths and weaknesses

Strengths	Weaknesses
• The shrubs provide additional forage, but do not reduce barley yields. • Saltbush provides green feed when no other forage is available. • Compared to stubble alone, stubble plus saltbush provide a longer grazing period. • Sheep gain more weight by grazing stubble with saltbush, compared to stubble alone. • Low quality stubble diet is supplemented by the higher protein content of the saltbush. • Shrubs can survive in harsh environments for many years, and can be a source of fire wood.	• Sheep require more water because of the high salt content. • Rodents may increase. • The technology has high establishment costs.

3. Target group

This technology is most suitable for *agriculturalists* in the drier areas (Zone 4) who have an integrated rainfed crop-livestock farm.

4. Actual and potential side effects

- Although the crop land is private, planted shrubs might be a temptation to trespassing animals. This might result in conflict between herders and farmers.
- Saltbush can protect the barley crop against desiccating wind and the topsoil against wind erosion.

5. Institutional and policy implications

- Although spontaneous adoption doesn't seem to take place, farmers are willing to accept the technology if assistance is provided.
- The government could test the acceptability of this technology with farmers throughout Zone 4.
- As intercropping can provide a public service by reducing erosion, government assistance for planting shrubs may be justified.

SEED PRIMING WITH NUTRIENT SOLUTIONS

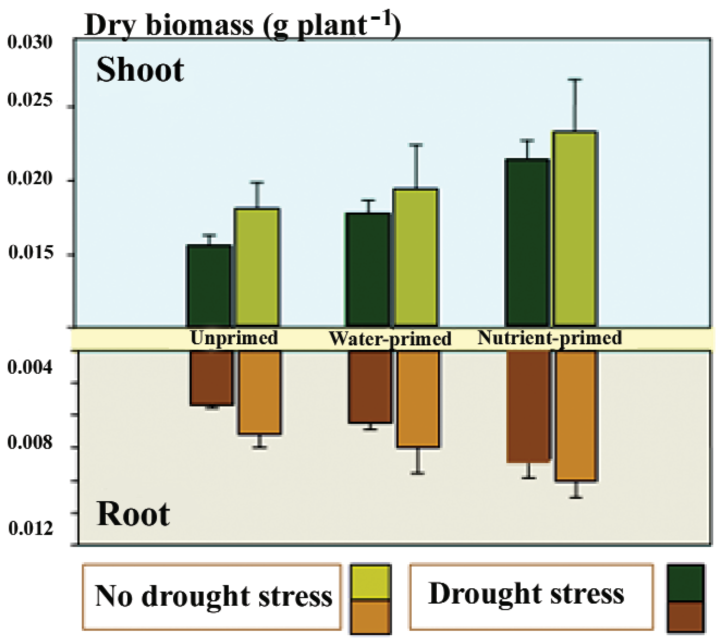
1. Description

Low input production of barley in Khanasser Valley is affected by drought and low availability of nutrients such as phosphorus and zinc. Farmers usually do not apply these nutrients to their barley fields. Seed priming is the soaking of seeds with site-specific deficient nutrient solutions and then drying back to original seed moisture. Seed priming increases the nutrient content of seed and stimulates early growth.

In Khanasser Valley, barley seeds were soaked in a phosphorus and zinc solution:

- 20 kg barley seeds
- 40 L water
- 320 g Potassium phosphate
- 120 g Zinc sulfate

The seeds are soaked overnight (12 hrs) and dried for a day (24 hrs) before planting. Seed priming can be done within three months before sowing. This provides a wider window for farmers to prime seeds when there are less agricultural activities.



2. Strengths and weaknesses

Strengths	Weaknesses
• Superior seed establishment. • Improve the competitive ability of the barley seedling. • Enhance further nutrient uptake. • Bad seeds and straw float to the water surface during soaking and can be easily removed. • Low-cost technology.	• Additional work for soaking and drying.

3. Target group

Seed priming can be practiced irrespective of socioeconomic status of farmers. However, it best suits the *agriculturalists* and the *land-poor laborers*.

4. Actual and potential side effects

No negative environmental and socioeconomic side effects are foreseen.

5. Institutional and policyimplications

If this technology generates interest by farmers, then extension can play an important role in:

- Training farmers in seed priming.
- Making phosphorus and zinc nutrients easily available.

CUMIN

1. Description

Cumin is a cash crop with a short growing cycle, which demands little moisture and nutrient inputs.

Proper agronomic management reduces the risk for farmers:

- Planting in mid-January.
- Mixing seeds and fertilizer, and planting them together (using cereal drill).
- Seed rate of 30 kg/ha.
- Fertilizer rate: If spring rains are adequate, 50 kg of ammonium nitrate (33%) can be top-dressed.
- Weed control:
  - Hand weeding at early stages of cumin growth.
  - Herbicide application of Treflan 15 days before planting and Afalon or Gesagard early after emergence would provide proper weed control.
  - At planting: 50 kg/ha of Triple Super Phosphate (TSP) and 50 kg/ha of urea.

2. Strengths and weaknesses

Strengths	Weaknesses
• At present, cumin is the only rainfed cash crop available for Khanasser farmers (and an alternative to barley mono-cropping). • Yield of barley after cumin is more sustainable compared with barley mono-cropping. • Manual weeding and harvesting generate local job opportunities. • Inclusion of cumin contributes to diversification of the cropping system and farm income.	• High cost for inputs. • Good management knowledge is needed to obtain good returns and reduce risks of failure. • Cumin planted in succession contributes to the diffusion of wilt disease in cumin (but it does not affect the following barley crop). • Fluctuations in cumin prices make cumin a risky business; yet prices always remained above thresholds for profitability gains, and have recently improved again.

3. Target group

Cumin is suitable for households with even small amounts of agricultural land. However, they will need to have enough family labor.

4. Actual and potential side effects

- Cumin leaves residual water for the following barley crop.
- When grown under supplemental irrigation, cumin requires less water than wheat.

5. Institutional and policy implications

- Cumin prices remain competitive even in marginal areas, although they depend on international trade and need to be monitored closely.
- Farmers need to have better access to early market and price information. They need this information before they make planting and/or marketing decisions.
- Management recommendations that reduce production risks should be transferred to farmers through local extension services and farmer interest groups.

OLIVES

1. Description

As olive trees are traditionally not grown in the Khanasser Valley, farmer experience in tree growing is limited. Rainfall in Zone 4 is too low to ensure good olive growth and production. Therefore, the following measures are recommended:

- Planting of drought-tolerant cultivars ('Qaisi,' 'Sorani,' and 'Nabali muhassan').
- Construction of earthen bunds just down-slope from the tree to capture surface runoff during the rainy season (water harvesting).
- Water-saving measures such as stone mulch.
- Vertical pipes in stone pockets in the soil can be used for subsurface irrigation.
- Supplemental irrigation in summer.
- Composted sheep manure amendment to improve soil water-holding capacity and provide nutrients to the trees.

2. Strengths and weaknesses

Strengths	Weaknesses
• Home production of olives and olive oil cuts household costs. • Growing trees increases land value. • Trees do no compete with annual crops (barley) for labor with management operations occurring at different times of the year. • Pruning residues can be fed to sheep. • Grove establishment costs can be recovered after 11-12 years of planting. • Water harvesting could save up to 10% of irrigation costs.	• Commercial production is difficult for households without own well for irrigation. • Farmers need to protect their groves against sheep grazing. • Labor is needed for planting, pruning, olive picking, and water harvesting.

3. Target group

This technology addresses mainly *agriculturalists* who want to diversify their production system. Requirements are: sufficient own land, enough labor, and preferably a well.

Olives in the Khanasser Valley are grown under two conditions:

- Valley floor: Easy accessibility for management operations, but competition with annual crops.
- Foot slopes: Difficult accessibility for management operations, but potential for water harvesting. The sloping land is less valuable for annual crops, but is commonly used for grazing.

4. Actual and potential side effects

Environmental side effects:

- Productive use of water on the slopes.
- Reduced water erosion and sedimentation, if combined with water harvesting.
- Increased need of irrigation water in summer to improve the productivity of the orchards.

Side effects at community level:

- The greenness, shade, and microclimate provided by the tree canopy improve the living conditions in the villages.
- The intensive labor needed for pruning and picking provides job opportunities.
- Expansion of olive orchards on natural grazing lands may cause conflicts between herders and olive growers.

5. Institutional and policy implications

- Olive seedlings and extension information should be easily available for interested farmers.
- A governmental policy that supports the planting and sustainable management of fruit trees by farmers on degraded, state-owned hill slopes in Zone 4 would improve farmer income and environmental conditions of marginal lands.

Other tree crops for dry areas

Other suitable drought-tolerant tree crops are: almond, fig, and pistachio. Industrial high value-added perennial woody shrubs such as jojoba can also be considered.

AWASSI LAMB FATTENING

1. Description

Lamb fattening starts with the purchase of around 3-5 month old lambs. The lambs are fed and hold in a confined area. After 2-3 months the lambs are sold for meat. Successful fattening requires:

- Development of low-cost diets using conventional and unconventional feeds that are easily manageable by farmers.These include the use of local low-cost agricultural by-products, as for example:
  - Molasses (with high energy content),
  - Treatment of under-utilized wheat straw with urea (as a source of protein).
- Improved production and management methods to better target market sales.

2. Strengths and weaknesses

Strengths	Weaknesses
• Income generation option for marginal areas. • Fattening of lambs may generate an added value besides milk production from sheep flocks. Thus, generating a steady cash flow during the year and income improvement. • Job opportunities for women and family members. • The production system structure and short duration of the fattening periods allow fatteners to engage in alternative work that compliments the income from fattening.	• High feeding costs. • High cost of tackling health problems in lambs. • Capital is needed to initiate a fattening enterprise. • Poor accessibility to livestock markets, and strongly fluctuating prices. • Credit schemes may be considered a risk if selling of a group of fattened lambs does not make the expected return, putting the farmer in risk of personal debt.

3. Target group

Sheep fattening is currently an option for the relatively better-off and market-connected *agriculturalists* (about 15% of the households in Khanasser Valley). They derive about 50% of their incomes from fattening.

4. Actual and potential side effects

Environmental side effects:

- Reduction of the pressure of grazing animals around the village and on the rangelands.
- Smell nuisances due to many lambs being kept in closed inten-sive feedlot systems.
- Topsoil loss and dust nuisances due to animal trampling, especially in the dry months.
- Potential for pollution of surface water and groundwater due to localized high liquid emissions and inadequate collection and storage of manure.

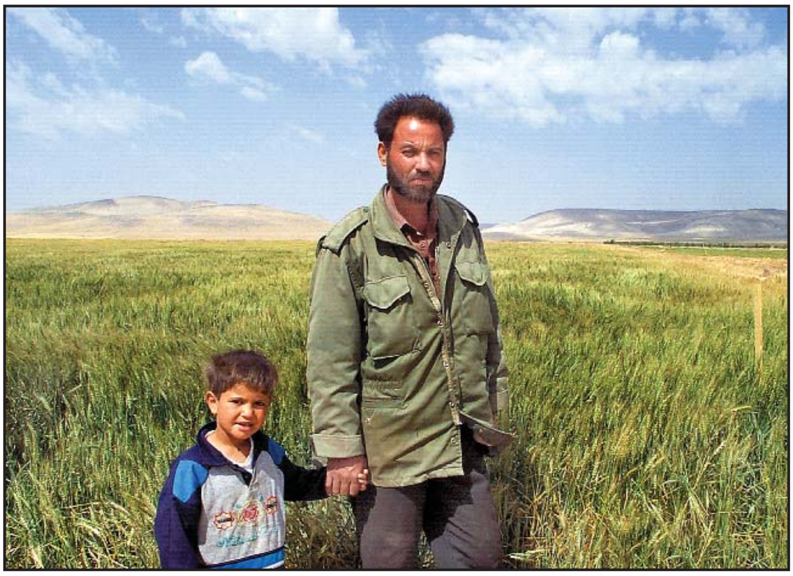
Side effects at community level:

- In villages that are specializing in lamb fattening, farmers are learning from each other.
- Potential for development of cooperatives to organize loans, bulk feed purchase, veterinarian services, etc.

5. Institutional and policy implications

- Extension services for lamb fattening enterprises are generally poorly developed, and thus need more support.
- Sheep fattening faces a range of trade challenges related to fluctuating prices, veterinarian restrictions and policies that at times restrict the export of fattened lambs.
- Large dependence on purchased feedstuffs generates concern about the expansion possibilities of lamb fattening enterprises with regards to country self-sufficiency in providing feeds for fattening.
- Policies generally support the already better-off, as support depends on flock size. However, fattening could also become an option for knowledgeable-poor farmers (primarily laborers and *pastoralists*) if:
  - Better forms of credit are identified, allowing them to progressively invest in economically-viable flocks.
  - Investors are involved.
  - Access and availability of market and trade information are improved.
  - Low-cost feed technologies are disseminated.

GROUNDWATER USE



1. Description

- The use of groundwater depends on the available resources and the quality of the water.
- To prevent wells from drying up, pumping should not exceed the amount added to the groundwater system by rainfall (recharge or renewable amount).
- In Khanasser Valley, the renewable amount is estimated as 0.85-2.15 million m^3 per year. This is equal to 85-215 liter per person per day.
- Thus, if no extra water is brought in for household use, little water can be used for irrigation:
  - Supplemental irrigation of wheat (2000 m^3/ha).
  - Supplemental irrigation of barley for early grazing in fall (1000 m^3/ha).
  - Supplemental irrigation of olives in summer (200 m^3/ha).
  - Irrigation of vegetable home gardens in summer (6000 m^3/ha).

2. Strengths and weaknesses

Strengths	Weaknesses
• The use of groundwater resources for crop production can improve livelihoods in the dry areas. • Supplemental irrigation of wheat can prevent crop failure and double crop yields. • Early irrigation of barley provides grazing when there are no other grazing resources. • Supplemental irrigation of olives in summer improves growth and production of olives. • Irrigation of small vegetable plots provides food and some income during the dry summer months.	• Low rainfall and high evaporation rates results in little water coming into the groundwater system. • Irrigation with saline groundwater leaves the salts behind in the soil, and thus, reduces crop yields in the long term. • Sprinkler irrigation with saline water affects sensitive crop surfaces and decreases the yields.

3. Target group

- Less than 10% of the households in Khanasser Valley have an irrigation well.
- Groundwater along the foot of the hill ranges of the Jabal al-Hoss and to a lesser extent the Jabal Shbayth is suitable for drinking and irrigation.

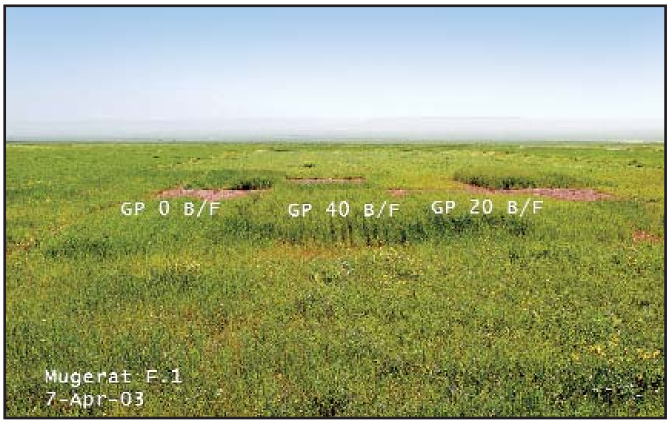
4. Actual and potential side effects

- Pumping affects the groundwater system, therefore, the long-term availability of the resource is difficult to estimate.
- Groundwater is a common resource, managed and used by a large number of people.
- Over-exploitation of groundwater resources results in dropping water tables, the drying up of wells, and reduced quality of the water.

5. Institutional and policy implications

- Irrigation wells should be registered and metered.
- Groundwater levels and water quality should be monitored annually and maximum pumping volumes should be defined each year, considering the sustainable use of the resource.
- The long-term need for drinking and household use in the area is the first priority when determining groundwater use volumes.
- To improve the productive use of the resource, technical assistance and financial support (credit) for precision irrigation systems need to be provided.
- Irrigation scheduling advice should be provided during the cropping season.

PHOSPHO-GYPSUM FOR BARLEY CULTIVATION



1. Description

Phospho-gypsum (PG) is a residual of the phosphate fertilizer industry, available in large quantities in Syria. PG can be used as a soil conditioner to improve the physical and chemical characteristics of soils. It has physical properties similar to natural gypsum, which makes it good for improving the poorer soils. It is rich in phosphate and other elements, such as sulfur. PG also improves the soil structure during the dry season, hence conserving soil moisture.

The effects of a PG application of 20 and 40 ton/ha on soil and crop parameters are being monitored in Khanasser Valley.

2. Strengths and weaknesses

Strengths	Weaknesses
• PG increases barley production, both grain and total biomass. • Average grain yield increase during 3 years: - 20 ton PG per ha: 23-47% - 40 ton PG per ha: 31-66% - 50 kg P_2O_5 per ha*: 24-37% • PG improves soil fertility and soil physical properties and makes more moisture available to plants. • PG has a similar effect as manure application.	• Required PG applications are bulky. • Extra labor is needed for application. • Transportation costs are high. • Because of potential side effects by over-use, PG distribution and application need to be controlled.

*: P-fertilizer is applied every year but PG is applied once only at the first planting season.

3. Target group

- PG application is an option for *agriculturalists*.
- PG can only be applied in easy accessible areas.
- The benefits of PG are higher on soils with poor soil fertility.

4. Actual and potential side effects

- Phospho-gypsum emits low levels of radiation.
- Measurement of soil radioactivity after the addition of PG was much lower than the permissible limits in Khanasser Valley.
- There was no radiation effect below 15 cm soil depth.
- The radioactivity of barley straw and grain was below the detection limit.

5. Institutional and policy implications

- Currently, PG is not freely available.
- Distribution and use of PG needs to be controlled by the government.
- The transportation of the required large amounts of PG from the Phosphate factory to farmer fields will add to the costs of this input. A transport subsidy will probably be necessary to make this a profitable technology.

JABBAN: A LOCAL DAIRY INSTITUTION

1. Description

Milk and dairy products, particularly cheese, are an integral part of the diet of people in many dry areas. In the Khanasser Valley, many poor farm households and landless households produce milk. The type of dairy products produced depends on the source of milk:

- Cheese is produced mainly from sheep milk, especially from large producers.
- Small producers rely on sheep milk mixed with small quantities of goat milk to make cheese.
- Yogurt is made from both sources.

The high demand for these dairy products, especially in village markets, represents an important livelihood source for the poor. Small-scale milk and dairy producers can tap into these markets to improve their income and quality of life. Small producers sell their milk to external cheese makers and traders (*jabbans*), composed of women and men of a single family. Milk producers are then paid for their milk on the basis of cheese prices at the market.

2. Strengths and weaknesses

Strengths	Weaknesses
• *Jabbans* process milk and market the cheese entrusted by producers. • *Jabbans* provide important services to the poor, such as "interest free" loans and handling small volumes of milk (which cannot be marketed otherwise, especially in the absence of a formal infrastructure). • *Jabbans* serve poor farmers where such services are not easily available.	• Marketing information is held by the *jabbans*. • Marketing risk is borne by the milk producers. • The unequal institutional arrangements may perpetuate poverty.

3. Target group

- *Jabbans* settle down in villages where milk production is important, where sheep are temporarily raised in significant numbers, or where flocks from the steppe settle for grazing during the spring season.
- Sheep dairy production is highly gender specific. Dairy production and processing mainly involve the women, whereas the men handle marketing and loan provisions.

4. Actual and potential side effects

Local dairy marketing networks are well organized and trusted by the communities, which cooperate with them successfully and respect the traditional environment. However, the *jabban* does not settle in the smaller villages, thus, not all the poor may be served.

5. Institutional and policy implications

- Development and research programs should improve their understanding of the role of traditional *jabbans* to improve these services for all.
- Improved access to marketing information, micro-credit such as *sanadiq*, and technology to preserve dairy product quality could reduce losses and increase farmers' bargaining power vis a vis local traders.
- Technology development and dissemination in the dairy sheep sector should be more gender specific to have an impact on the well-being of women.

SANADIQ: VILLAGE SAVING AND CREDIT ASSOCIATIONS

1. Description

The credit situation in the Jabal al-Hoss area, which covers the eastern part of Khanasser Valley, is as follows:

- Formal institutions have low, subsidized interest rates, but do not reach marginal regions and the poorest.
- Informal credit providers lend money, albeit at high interest rates. Informal sources provide 73% of credit with average 77% annual interest rates.
- Households in the region obtain on average nearly 2 credits per year.
- Average outstanding loan per household in 2003 is 28,100 SL (=540$US), 84% of this amount is from informal sources.

Sanduq (plural: *sanadiq*) has several meanings. Here the term *sanduq* refers to an autonomous microfinance institution, owned and managed by its members. The development of *sanadiq* in the Jabal al-Hoss area was undertaken by the Rural Community Development Project (RCDP) of the UNDP and the Syrian Ministry of Agriculture and Agrarian Reform. Up to the end of 2004, 30 *sanadiq* have been established in the following way:

- A minimum of 50 people from a village put together at least 1000 SP per person.
- A village *sanduq* committee consisting of 3 people from the village, with at least 1 woman, is elected.
- The *sanduq* starts with an experimental stage of 3 months without any external financial support.
- If the experimental stage is successful the RCDP will put additional money in the *sanduq* to allow them to give loans to more members.
- The *sanduq* committee under supervision of the RCDP agrees on loans for income generating activities at either 1% (monthly payback) or 1.5% per

month (payback at the end of the loan period).
- Taking in consideration Islamic banking principles, a profit sharing system (*murabaha*) is applied. This means that the borrower receives the goods or animals purchased with the loan instead of money. He has to repay the purchase price of the goods plus a service charge equal to a certain percentage of that price, instead of interest.

2. Strengths and weaknesses

Strengths	Weaknesses
• *Sanadiq* present a much cheaper source of credit than informal sources. • Seasonal cash shortages in agriculture can be overcome. • Start-up money for new enterprises and adoption of new technologies can be provided. • *Sanadiq* also provide a money saving opportunity.	• Investments are not always successful because of the high risk of rainfed agriculture in these marginal areas. • Credit demand is higher than the availability of money in the region. • Costs for the control of the credits are generally high.

3. Target group

- Getting credit from a *sanduq* can be interesting for *agriculturalists* to finance the production input as fertilizer and seed, for *pastoralists* that invest in lamb fatting to buy feed or young lambs or for *land-poor laborers* to invest in any income generating activity. The only limitation is for the migrating households as it is not possible for the *sanduq* to follow up with the outstanding money.

4. Actual and potential side effects

- The impact of a *sanduq* on a village is perceived as either positive or substantially positive by 90% of the population.
- The *sanduq* system provides financial services to the rural poor.
- As *sanadiq* are managed by people from the village, it empowers local people.

5. Institutional and policy implications

- There are no clear regulations for microfinance institutions on national level.
- Before the *sanduq* system can be recommended for other regions in Syria, a nation-wide law for microfinance has to be established. This is especially pressing as the *sanadiq* also engage in mobilizing poor people's savings.
- *Sanadiq* require a mechanism for communicating and clarifying the internal regulations of the *sanadiq* to the rural people.