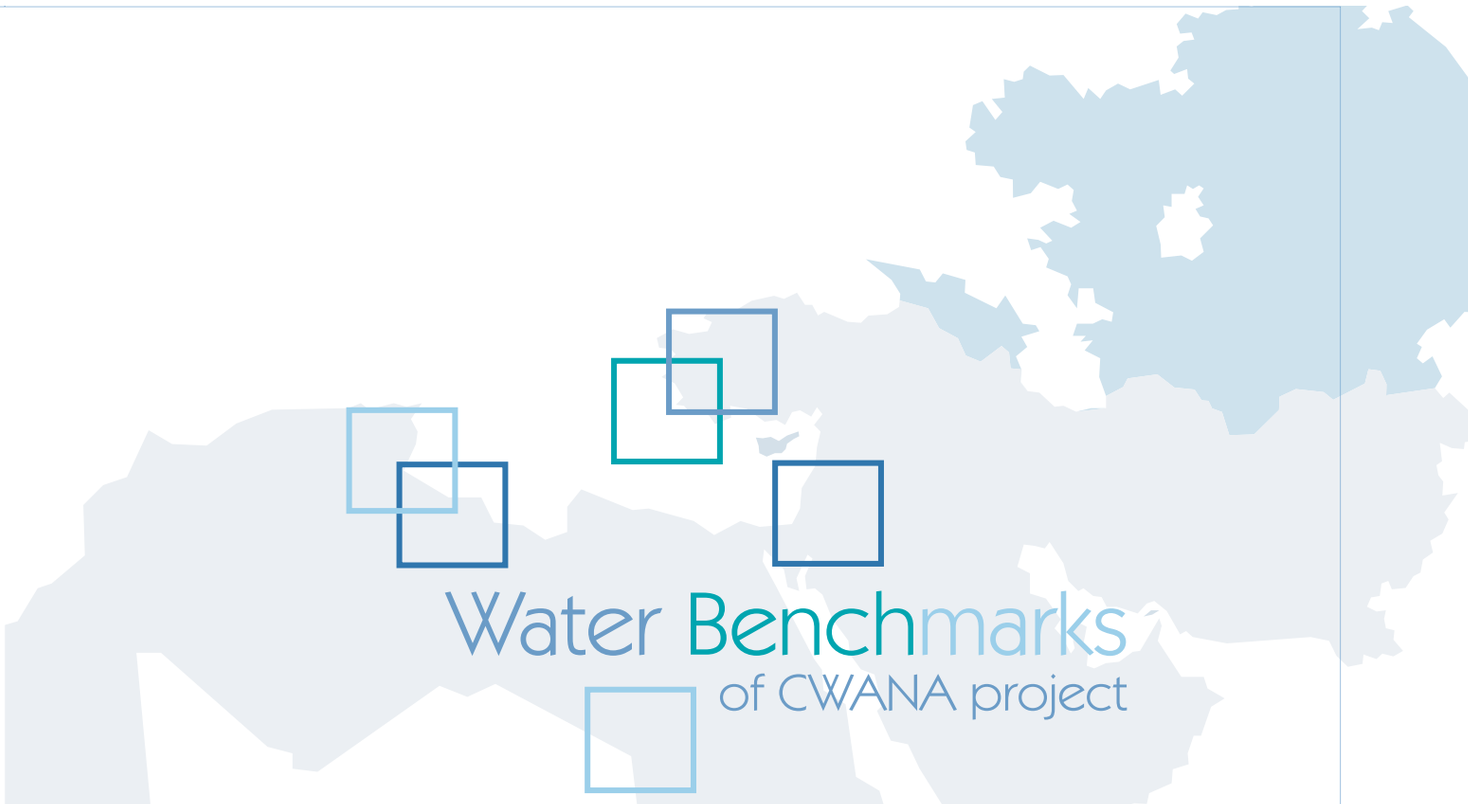

Water Benchmarks of CWANA project

Community-Based Optimization of the Management of Scarce Water Resources in Agriculture in West Asia and North Africa

6

Baseline Information and Livelihood Characterization of Badia Benchmark Water Harvesting in Jordan

Samia Akroush and Kamil Shideed

ICARDA International Center for Agricultural Research in the Dry Areas

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Executive Summary

Jordan is an arid to semi-arid country, with a land area of approximately 90,000 km^2. The population has increased dramatically over the past few decades; current annual population growth is about 2.8% due to natural and non-voluntary migration. Although population growth rates are declining, the expanding population will continue to place enormous pressure on water resources.

Jordan's water budget in 2000 was approximately 817 million cubic meters (Mm^3) or about 16% less than the peak year of 1993. In 2000, approximately 534 Mm^3 was used for agriculture, 239 Mm^3 was used for municipal purposes and 44 Mm^3 for livestock purposes – or about 65%, 29% and 5% of the water budget, respectively.

Per capita available water resources are falling as a result of increasing demand for water due to population growth and decreasing water supplies due to groundwater mining. Per capita supply is projected to decline from 160 $m^3\ yr^{-1}$ (all uses) at present to 91 $m^3\ yr^{-1}$ by 2025, placing Jordan in an 'absolute water shortage' category (Ministry Of Water and Irrigation, 2002).

As agriculture is characterized by increased water scarcity and growing demands for food (and thus for higher agricultural productivity), Jordan has no option but to improve the efficiency of water use in agriculture. This must include efficient management of rainwater through the utilization of effective water-harvesting techniques. Instead of allowing run-off to cause erosion, it must be harvested and efficiently utilized. Therefore, it is essential to develop and test, with the full participation of rural communities, water-management options that increase water productivity and that optimize water use that are economically viable, socially acceptable and environmentally sound.

A baseline survey was carried out to collect information on the biophysical and socioeconomic environment, context and conditions of the communities. Barley-livestock production systems are the dominant production systems in the areas studied. The major crops planted in the communities were barley, wheat and olives. Nearly 89% of farmers in the Muhareb community plant barley, with an average area of 30 ha, whereas the average area for planting barley in the Um Al Naám community is only 7.1 ha.

The project aims to improve the productivity of degraded rangelands through efficient utilization of limited rainfall. Nearly 48% of farmers in the Muhareb community own flocks, with an average flock size of about 159 head. About 52% of farmers in Um Al Naám own flocks, with an average of 125 head; about 63% of farmers in Muhareb community own a small flock (average 28 head), or a medium flock size (30%, average 293 head), or a large flock (7%, average 751 head. However, about 72% of farmers in Um Al Naám own a small flock, with an average flock size of 36 head. A medium-sized flock is owned by 26% of farmers, with an average flock size of 256 head. Only 1% of farmers own

large flocks, with an average flock size of 1540 head. Farmers who cultivate larger areas own larger flocks, although this only occurs on a small proportion of the farms (4.7%). Over 67% of farmers in the selected communities own small flocks, and 28% own medium sized flocks. There is a positive relationship between flock size and area cultivated.

The nomadic grazing system began to diminish due to trucking and the mobilization of feed and water. There is a shift in livestock production systems towards semi-intensive (77.5%); the nomadic production system is now not widespread (16%). The nomadic system is more dominant in the Muhareb community compared with the Um Al Naám community. The semi-intensive production system accounts for 91% of farming in the Um Al Naám community.

The survey considered five types of household assets: natural, social, human, physical and financial capital.

Natural capital: the average area owned was 6.8 ha^{1} for the whole sample and 7.7 ha for the Muhareb community. Nearly 90% of respondents have water sources, mainly collecting-wells and cisterns. Rainfall is the main source of irrigation in the surveyed communities: over 70% of farmers depend on rainfall for irrigating their crops. Community rangeland is degraded, as reported by 90% of farmers in the Um Al Naám community and 54% in the Muhareb community.

Social capital: Only 4% of farmers mentioned that they were members of a cooperative.

Human capital: the average experience in agriculture was about 27 years; average household size was about 9 individuals. The average number of family members who work in agriculture and livestock was about 3 persons/family in Muhareb and 2 persons/family for the whole sample. However, the average number of family members who work outside the farm was 2 per family in Muhareb and 3 pe family for the whole sample. The illiteracy rate was found to be high in the surveyed farmers: illiteracy was estimated at 28% for the whole sample.

Physical capital: more than 90% of farmers from the whole sample have a cement house. The semi-intensive production system is the dominant type of livestock production system, as indicated by 76% of respondents. Production equipment, such as machinery for plowing and seeding, are mainly rented; only a few farmers own such equipment. Financial capital can be in the form of cash, credit, savings or remittances. Nearly 38% of income is from off-farm sources and 62% is on-farm income. In the Muhareb community, 66% of on-farm income is from livestock production, 8% from crop and olive production. In the Um Al Naám community, 25% of on-farm income is from livestock production and 24% from crop and plant production. Thus, most households in Muhareb depend on livestock production. The cost of production was about 1000 and 900 fils ha^{-1} for barley and wheat, respectively. The net return was 800 fils ha^{-1} and 1.5 JD ha^{-1}, respectively. The average wage of laborers per day is 5 JD. Credit is obtained mainly from private banks and used mainly for livestock production.

Privately owned and *Meeri* land tenure were found in the surveyed communities. The overall average farm size for privately owned land is estimated at 12.2 ha, and is estimated at 8.2 ha for *Meeri* land. Almost all farmers (98%) have privately owned land tenure. *Meeri* land tenure is operated by only 2% of sample farms. One farmer indicated that his land tenure is of the 'Tribal' type, with an average area of 5 ha.

The native pastures can no longer satisfy livestock's feed needs, and supplemental feeding with barley grain, straw, bran and other crop by-products has become essential. Attempts to meet the widening 'feed gap' have resulted in an expansion of the area planted to barley. This is being achieved by cultivating previously uncultivated marginal land and by replacing the traditional barley/fallow rotations with continuous barley cropping.

Community rangeland is predominantly managed by livestock owners or shepherds, as indicated by 39% and 33% of the respondents, respectively. Only 5% of the respondents mentioned that tribal arrangements are applied in rangeland management, whereas 4% of the respondents indicated that rangeland is managed by cooperatives.

Rangeland rehabilitation is urgently needed to stop further degradation of range resources and to manage them for sustainable use. Farmers' perceptions are important entry points for any rangeland rehabilitation program. Farmers in the study area perceive water harvesting as the main intervention for improving rangeland, as indicated by 48% of sample farmers. Barley planting is a second option for farmers, as mentioned by 22% of the respondents. Thirteen percent of farmers indicated that shrub planting could be a third option for improved rangeland management.

Farmers face many constraints related to livestock production. The most dominant two constraints are feed shortages and the high prices of feed sources, as indicated by 28% and 26% of respondent farmers, respectively. Nearly 39% of sample farmers indicated that Enterotoxaemia is the most common disease that infects their animals. However, more than 11% of farmers mentioned that diarrhea and sheep pox infect their herds.

Water harvesting is considered to be a management technique for collecting, storing and distributing rainwater for any productive use. In general, water harvesting can make water available in regionswhere other sources may be distant and costly, such as the target communities of the project. However, water-harvesting techniques are not implemented on a large scale due to capital shortage, as indicated by 40% of the respondents, and are not considered to be efficient techniques, as indicated by 30% of farmers. The constraints for wider adoption of water-harvesting techniques are mainly due to lack of knowledge about water-harvesting techniques, low income of farmers and shortage of capital, as suggested by 26%, 20% and 19% of respondents, respectively.

[1]1 ha = 10 du (Jordanian); hectare (ha) and Durum (du) are used interchangeably

1. Introduction

Jordan is an arid to semi-arid country, with a land area of approximately 90,000 km^2. Its topographic features are variable. A mountain range runs from the north to the south of the country; land slopes gently to the east of this range to form the eastern deserts, but to the west the ground slopes steeply towards the Rift Valley, which extends from Lake Tiberias in the north, at an elevation of -220 m below sea level, to the Red Sea at Aqaba.

The population in Jordan has increased dramatically over the past few decades. The annual population growth rate stands today at about 2.8% due to natural and non-voluntary migration. Although population growth rates are declining, the expanding population will continue to place enormous pressure on water resources.

Jordan's water budget in 2000 was approximately 817 Mm^3 or about 16% less than the peak year of 1993. In 2000, approximately 534 Mm^3 was used for agriculture, 239 Mm^3 was used for municipal purposes and 44 Mm^3 for livestock purposes – or about 65%, 29% and 5% of the water budget, respectively. From 1993 to 1997, the water budget has remained relatively constant at approximately 880 Mm^3, with the relative percentages of water use by the three primary water sectors as stated previously, and then it was decreased to reach 817 Mm^3 by 2000. Again, this reflects more a limitation of the water supply than the actual demand. In general, water used by the domestic sector has increased from 20% to 27% of the annual water budget in the 1990s. During the same period, water use by the agricultural sector has decreased from 75% to 68% (Ministry of Water and Irrigation, 2002).

The per capita available water resources are falling in Jordan as a result of increasing demand for water due to population growth and decreasing water supplies due to groundwater mining. Per capita water supplies are projected to decline from 160 $m^3\ yr^{-1}$ (all uses) at present to only 91 $m^3\ yr^{-1}$ by 2025, placing Jordan in an 'absolute water shortage' category (Ministry of Water and Irrigation, 2002).

Water resources consist primarily of surface and groundwater resources, with treated wastewater being used on an increasing scale for irrigation, mostly in the Jordan Valley. Renewable freshwater resources are estimated at about 850 Mm^3 per year. About 125 Mm^3 of freshwater resources per year are available from fossil aquifers and through desalination that occurred in 2005, making the annual freshwater budget about 975 Mm^3 per year (Ministry of Water and Irrigation, 2002).

As agriculture is characterized by increased water scarcity and growing demands for food (and thus for higher agricultural productivity), Jordan has no option but to improve the efficiency of water use in agriculture. This must include the efficient management of rainwater through utilization of effective water-harvesting techniques. Instead of allowing run-off to cause erosion, it must be harvested and utilized. In areas with limited water resources such – as Jordan, where

water is the greatest limitation to production – water use efficiency (WUE) is the main criterion for evaluating the performance of agricultural production systems. Productivity per unit area is no longer the main objective, as land (unlike water) is not the limiting factor to production. The average WUE of rain in producing wheat in the dry areas of Jordan is about 0.35 kg grain/m^3, although with good management and favorable rainfall (amount and distribution), this can be increased to 1 kg grain/m^3.

The project 'Community-Based Optimization of the Management of Scarce Water Resources in Agriculture' is funded by IFAD (International Fund for Agricultural Development) and AFESD (Arab Fund for Economic and Social Development). The long-term development goal of the project is improvement of rural livelihoods in the dry areas of West Asia and North Africa (WANA) by enhancing the productivity of agriculture based on the efficient and sustainable management of the scarce water resources from rainfall, groundwater and surface sources. The immediate purpose of the project is to develop and test, with the full participation of rural communities, water-management options that increase water productivity, optimize water use and that are economically viable, socially acceptable and environmentally sound.

The project will examine a wide range of technologies (supplementary irrigation, water harvesting, increased WUE in three agro-ecological zones (rainfed, Badia and irrigated areas)) to identify the constraints to and opportunities for the application of these technologies under various production systems.

At the outset of the project, this baseline survey was carried out to generate the necessary information on the biophysical and socioeconomic environment, context and conditions of the communities. The initial data set builds the bases of subsequent monitoring and evaluation activities. Potential change in economic, ecological and social systems is monitored using the baseline data set. Therefore, this baseline survey is a precondition in assessing the project impact and effectiveness.

The baseline survey is the starting and reference point (counterfactual) on which achievements are judged at any stage of the project process. Baseline surveys are the scientific basis used to assess and measure progress and to assure the availability of qualitative and quantitative data. Baseline data therefore facilitate and assist management tasks, including research process policy and planning decisions. This gives a first insight into the overall biophysical and economic situation of the community or watershed.

In this baseline survey, quantitative data were collected, including socioeconomic data on production, yields, and education. The collected information allows those involved in the project to understand the initial livelihood conditions of the people, and what needs to be done to reach the goal of improving the livelihoods of the poor. This report serves as a reference against which the successes of the project can be measured in the future.

1.1. About Jordan's Badia

The Badia of Jordan was selected as the Benchmark site for the project for water harvesting. In Jordan, 'Badia' refers to those areas receiving less than 200 mm of annual precipitation - areas that are located in the eastern and southern parts of the country. The Badia encompasses a large proportion of Jordan and covers an area of 72,600 km^2, which constitutes 81% of the total area. The Badia region is dominated by a dry climate, the average annual rainfall being less than 200 mm. In most cases, the rainfall season starts in November and ends by March. Rainfall distribution is highly variable from one season to another, and occurs as short, but intense thunderstorms, causing intensive run-off for a short period of time.

The total population of the Badia represents 5% of the whole population of the country. Only 5% of the Badia population is still nomadic and the rest are now settled. The majority of the Badia population is involved in agriculture, livestock production, the civil service, commerce, the armed forces, mining and prospecting industries. More than 85% of the Badia population is accommodated within a well-established basic infrastructure of roads, electricity and telephones. Roads serve more than 88% of the Badia communities, whereas more than 72% have post-offices that are equipped with telecommunication systems. Nesheiwat (1995) has identified a total of 170 communities in the Badia: 71 in the north, 48 in the center and 51 in the south of Jordan.

Rangelands are the main resource of agriculture in the Badia and are characterized by poor vegetation cover and accelerated soil erosion. Barley is the main field crop in dry farming. Forage, vegetables, fruit orchards and wheat are under irrigation at the best sites that have deep and fertile soils. Most farm animals in the country (61%) are located in the Badia. Livestock production includes sheep, goats, cattle and camels. Poultry production includes broiler and egg-laying hen farms. Around 70% of Jordan's animal products are produced in the Badia (Al-Karablieh et al., 2002).

In an attempt to understand the socioeconomic conditions and trends in the Jordanian Badia, the socio-economic survey of rangeland users (IFAD, 1995) was produced. Although this was one of the most comprehensive surveys of this type to date, it excluded flocks of less than 30, and attempted mainly to interview owners with at least 50 animals. The justification for this is that smaller numbers have less impact on the rangelands and that the family income is not generally dependent on livestock. The findings have to be seen in this light. The main results of the socio-economic survey were:

- There has been a major breakdown in traditional migration patterns in favor of the opportunistic search for pasture.
- The traditional land tenure system has broken down and, in practice, rangeland is available to those who can exploit it.
- The monetization of sheep production is leading to a stratification of herd ownership. Large-scale herd

owners (with herds of more than 1000 animals) can take advantage of the economies of scale and thus survive the removal of feed subsidies, whereas medium-scale herd owners do not have the resources to manage their herds without getting into debt.

- The very large herds in the Badia no longer use the rangeland as a source of feed but treat it as a space to raise animals. The economic motivation to conserve the rangelands is minimal, as feed is trucked in for all but 2 months of the year when the natural vegetation can sustain the flock.
- The users do not feel responsible for the condition of the range. The rangeland problems are largely attributed to poor rainfall or encroachment of agriculture.
- Radical re-stocking is not seen to be a solution. An alternative would be to encourage herd owners to switch to year-round feeding. This would have to be accompanied with a change in ruminant nutrition to compensate for the loss of roughage and minerals obtained from the range.

There is a strong correlation between poverty and environmental degradation. The poorer herders cannot afford to pay the high costs of imported feed and therefore aim to find as much forage from the rangeland as possible. Poverty seems to be an effect as well as a cause of rangeland degradation, because as the availability of natural forage decreases each year, the farmer is forced to buy an increasing amount of feed concentrates per head. This, in turn, requires the farmer to sell some of his flock and/or plant barley on degraded land in the hope of sufficient rainfall to harvest a crop. Although the chance of a good barley harvest is low in most rangeland areas, many farmers prefer to take the risk in the hope of reducing expenditure on imported feed. The 'worst case' and, unfortunately, the most probable outcome, is increased debt for the farmer due to the investment costs of planting, and further degradation of the rangeland.

2. Objectives of Community Characterization

An important component of research implemented under this project is documenting the impact of the demonstrated options on the rural communities. This requires, in the first place, clear characterization of targeted areas because such detailed information about the project site in the Jordanian Badia and beneficiaries are not available.

The objectives of community characterization are to:

- Describe the basic economic characteristics of the selected communities, including population characteristics, source of income, resource property rights, land fragmentation, agricultural production system and rangeland utilization.
- Identify the problems of community participation and obstacles facing them in order to improve the performance of the watershed management system.
- Collect preliminary information on the status of using alternative water-

harvesting techniques, and identify major constraints that hinder their wide adoption.
- Characterize the livelihoods of rural communities in the Badia area of Jordan with respect to household capital, financial, physical, natural, human and social assets.
- Establish baseline information for economic, environmental and social indicators, as related to the project interventions to be used for assessing the adoption and impact of the project.

3. Collection of Information

3.1 Community selection and characterization

During the early stages of the project, it has been emphasized that the project approach is a multi-disciplinary approach that includes: technology, management, institutions and research development. It has also been agreed that the final selection of the potential watershed sites should match the following criteria, which are subdivided into three major groups:

First group: target area criteria:
- Annual rainfall: 100-250 mm.
- Rangeland (barely livestock-based system), with other land use existing.
- Livestock is the main farming enterprise.
- Land is degraded (declining vegetation, soil erosion and low organic matter).
- Shortage of feed.
  Low adoption of improved technologies.
- Low public and private investment.

Second group: watershed criteria:
- Representative of major physical and social characteristics of the Badia.
- Communities in upper-mid and lower part of the watershed.
- Potential for water harvesting.
- Rangeland-based system dominates.
- Potential for halting/reducing land degradation at relatively low cost.
- Multiple rangeland uses.
- Area: 30-150 km^2.
- Both private and communal natural resources.
- Land ownership: private and government land, claimed by tribes.
- Rangeland use: open access.
- Exposed to other projects.
- Potential for achieving noticeable impact.
- Easily accessible.
- Availability of basic data and previous studies.

Third group: community criteria:
- Poor community.
- Commitment to participate.
- Existence of institutions (informal and/or formal).
- Trans-human to sedentary systems.
- Agriculture plays a significant role in households' income.
- Access to government/development projects.

These criteria were suggested by a team that includes all relevant specialties. It is obvious that although these criteria are important for the success of the project, the selection of a watershed(s) that satisfies all these criteria is not an easy task - particularly because the selection process should be reproducible in other similar areas as far as

the project is concerned. Accordingly, the site selection proceeded by subdividing the process into the following sub-components:

1. Scoring and weighing the selection criteria.
2. Potential watershed(s) selection (three stages).
3. Rapid Rural Appraisal (RRA) for the selected potential watershed(s).
4. Rapid hydrological assessment.
5. Rapid environmental assessment.
6. Data management and manipulation.
7. Integration of sub-components 2-5 for the final selection.

An integral part of the above sub-components is the continuous field visits and verification by an inter-disciplinary team. The purpose of the field visits was to verify the information and to check the relevancy with the situation on the ground. The rest of this report is devoted to detailed community characterization.

The multidisciplinary team for site selection worked together to rank the watershed criteria (14) and the community criteria (6) according to their importance to propose the most conducive and potential watershed sites for the project (RRA report of Benchmark Project). The results of the RRA show that Muhareb + Falej, and Um Al Naám El-Shargieh, are the most likely potential sites for conducting the project activities in terms of socioeconomic factors, such as community characteristics, source of income, poverty and willingness to cooperate, as well as previous exposure to water-harvesting techniques.

The cycle of planning, monitoring and evaluation begins with a needs assessment and the collection of information relevant to project goals and indicators to be measured.

As mentioned above, the communities were selected according to criteria put forward by the site selection group and according to the results of RRA; therefore, a socioeconomic questionnaire for the characterization of the watershed and communities was used to collect the information needed. The questionnaire was prepared by the socioeconomic team members of the project to satisfy the objectives of this component and was modified and discussed with all team members of the Badia Project. A socioeconomics team was trained to collect the required data from the field; several meetings were held for the team and the questionnaire was discussed with them in detail. Pre-testing was carried out in the targeted communities to test the questionnaire's validity with regard to farmers' situations; slight modifications were made through feedback from farmers' interviews and with participation of all team members.

Given the fact that each community represents a single agro-ecology and that there is a high degree of homogeneity among community members (as was evident from RRA and field visits), a simple random sampling approach was used to select a representative sample.

From the selected communities, 143 households in the two selected communities of the project were interviewed (55 from Muhareb + Falej, and

79 from Um Al Naám El-Shargieh); they were selected randomly and personally interviewed. The data were collected from all households represented from the Muhareb community. The rationale for using a comprehensive survey method in the Muhareb area is as follows: (a) All the households are located in one area and the researchers were able to reach all of them; (b) It is always recommended to collect data from the whole community, wherever possible, rather than a sample in order to collect sufficient information to be used in the analysis; and (c) A list of household members located in the Muhareb area was obtained from the General Statistics Department, 2003, which was used to survey the whole community.

4. Results of the Survey

The following section presents the results of the community characterization after implementing the socioeconomic survey in the selected communities. The community characterization questionnaire applied in this study was used to collect data on communities, agricultural production, land tenure, livestock, water resources and its utilization, farming practices and other socio-economic aspects. The following are the main components of the community characterization:

- Production systems (crops, enterprise budget, assets).
- Livestock production (flock size, livestock production system, income, marketing of livestock products, labor of livestock activities).
- Household assets (natural assets, human capital, financial capital, social capital, physical capital).
- Socioeconomic aspects (land tenure, land management and use, income sources, household size, education).
- Natural resources (rangeland management, grazing management, ownership, status, migration, access).
- Constraints (general constraints, constraints related to water harvesting, exposure to water harvesting).
- Opportunities (sources of irrigation, awareness of water-harvesting techniques, farmers' willingness to cooperate in project activities, land-improvement practices in farmers' fields).
- Livestock watering (source, quantity, cost, share of each source).
- Feed resources (cost, sources).
- Baseline indicators (yield, net return, feeding costs, water productivity).

4.1. Community Characterization

4.1.1 Production systems

Selected communities are located in the Badia area, where the average annual rainfall is 100-200 mm. The dominant production system is an integral part of implementing project activities. In the communities' area, barley-livestock production systems, in addition to areas planted with wheat and olives, were dominant. The following represents a description of the main crops planted in the communities' area, as well as enterprise budget, profit and machinery ownership.

4.1.2. Crops

Major crops planted in the communities' area were barley, wheat and olives. The average area planted was 16.5, 2.3 and 1.4 ha, respectively (Table 1).

Table 1: Crops planted in all the selected communities.

Crop	Average area (ha)	No. of farmers	% of farmers from total sample
Barley	16.5	119	88.8
Wheat	2.3	15	11.2
Olives	1.4	30	22.4

Most of the crop land is allocated for barley plantation and most of the farmers plant barley (88.8%) as a source of livestock feeding; about 11% of farmers plant wheat and 22% of them plant olives. Nearly 89% of farmers in the Muhareb community plant barley, with an average area of almost 30 ha, whereas the average area for planting barley in the Um Al Naám community is only 7.1 ha (Table 1.1).

4.1.3. Enterprise budget for barley production in the selected communities

The main characteristics of the farming systems in the Badia area are low productivity (barley, forage and red meat), a fragile system of integration between cropping and animal production, and irregular rainfall; therefore, farmers are always worried about unexpected weather. They try to select crops and practices that will produce even the minimum yield under these conditions instead of applying new methods or technology that could increase their production.

Enterprise budgets record income or revenue, expenses and returns for crops. They were calculated for wheat and barley at the whole sample and community levels.

The net return for barley enterprise is estimated at 8.25 JD du^{-1} (1 JD equals US$ 1.4) at the whole sample level; the total variable costs are estimated at 8.33 JD du^{-1}, with total fixed costs at 1.3 JD du^{-1}. The total cost of barley is estimated at 9.63 JD du^{-1}, and the total return is estimated at 17.88 JD du^{-1}.

The net return for barley enterprise is estimated at 8.77 JD du^{-1} in the Muhareb community; the total variable costs are estimated at 4.59 JD du^{-1}, with total fixed costs at 1.1 JD du^{-1}. The total cost of barley is estimated at 5.69 JD du^{-1}; the total return is estimated at 14.46 JD du^{-1}.

The net return for barley enterprise is estimated at 8 JD du^{-1} in the Um-Al-Naám community; the total variable costs are estimated at 8.9 JD du^{-1}, with total fixed costs at 2.1 JD du^{-1}. The total cost of barley is estimated at 11 JD du^{-1}, and the total return is estimated at 19 JD du^{-1}.

Table 1.1: Crops planted at a community level.

Crop	Muhareb community			Um-Al-Naám community		
	Av. area (ha)	No. of farmers	% of farmers from total sample	Av. area (ha)	No. of farmers	% of farmers from total sample
Barley	29.98	49	89.1	7.1	70	88.6
Wheat	3.0	2	3.6	2.2	13	16.5
Olives	1.1	10	18.2	1.586	20	25.3

Table 2: Average net return and cost of production of barley for the whole sample (du^{-1}).

Activity	Unit	Quantity	Price (JD)	Value (JD)	Total production cost of total area (JD)	% of total production cost
Total return	**JD**			**17.88**		
Grain	kg	73.15	0.109	7.97		
Straw	kg	139.6	0.071	9.91		
Total variable cost	**JD**			**8.33**	**1374.6**	**87**
Deep plowing	hr du^{-1}	0.23	1.02	0.23	38.0	2
Plough 2	hr du^{-1}	0.24	0.643	0.15	24.8	2
Seeding	hr du^{-1}	0.267	0.245	0.07	11.6	1
Seeds	kg du^{-1}	7.781	0.167	1.30	214.5	14
Harvesting	hr du^{-1}	0.197	6	1.18	194.7	12
Threshing	hr du^{-1}	1.79	2.4	4.30	709.5	45
Packaging	JD du^{-1}	1	1.1	1.1	181.5	11
Fixed cost				**1.3**	**214.5**	**14**
Land rent	JD du^{-1}	1	1.3	1.3	214.5	14
Total cost	**JD**			**9.63**	**1589.1**	**100**
Net return	**JD**			**8.25**		

Table 2.1: Average net return and cost of production of barley in Muhareb community (du^{-1}).

Activity	Unit	Quantity	Price (JD)	Value (JD)	Total production cost of total area (JD)	% of total production cost
Total return	**JD**			**14.462**		
Grain	kg	58.6	0.099	5.8		
Straw	kg	122	0.071	8.662		
Total variable cost	**JD**			**4.59**	**1377**	**81**
Deep plowing	hr du^{-1}	0.28	0.59	0.17	51	3
Plow 2	hr du^{-1}	0.26	0.54	0.14	42	2
Seeding	hr du^{-1}	0.27	0.2	0.05	15	1
Seeds	kg du^{-1}	6.3	0.133	0.84	252	15
Harvesting	hr du^{-1}	0.19	5	0.95	285	17
Threshing	hr du^{-1}	1.79	0.75	1.34	402	24
Packaging	JD du^{-1}	1	1.1	1.10	330	19
Fixed cost				**1.1**	**330**	**19**
Land rent	JD du^{-1}	1	1.1	1.1	330	19
Total cost	**JsD**			**5.69**	**1707**	**100.00**
Net return	**JD**			**8.77**		

Data in Tables 2, 2.1 and 2.2 provide important information on the contribution of different cost items to the total cost of barley production. Variable costs account for more than 80% of barley production costs, with fixed costs representing 14%, on average, of the total production costs. Threshing, seeds, harvesting and packaging are the major contributors to the variable cost, and thus to the total cost of barley production. On average, threshing accounts for 45% of the total production costs.

Table 2.2: Average net return and cost of production of barley in Um Al Naám community (du^{-1}).

Activity	Unit	Quantity	Price (JD)	Value (JD)	Total production cost of total area (JD)	% of total production cost
Total return	**JD**			**19**		
Grain	kg	79.8	0.11	8.78		
Straw	kg	146	0.07	10.22		
Total variable cost	**JD**			**8.9**	**631.9**	**81**
Deep plowing	hr du^{-1}	0.22	1.09	0.24	17.04	2
Plow 2	hr du^{-1}	0.22	0.74	0.16	11.36	1
Seeding	hr du^{-1}	0.27	0.267	0.07	4.97	1
Seeds	kg du^{-1}	8.8	0.19	1.67	118.57	15
Harvesting	hr du^{-1}	0.197	6	1.18	83.78	11
Threshing	hr du^{-1}	1.79	2.5	4.48	318.08	41
Packaging	JD du^{-1}	1	1.1	1.10	78.10	10
Fixed cost					**149.10**	**19**
Land rent	JD du-1	1	2.1	2.1	149.10	19
Total cost	**JD**			**11**	**781.00**	**100.00**
Net return	**JD**			**8**		

4.1.4. Enterprise budget for wheat production in the selected communities

The net return for wheat enterprise is estimated at 15.45 JD du^{-1} at the whole sample level; the total variable costs are estimated at 8.3 JD du^{-1}, with total fixed costs at 1.1 JD du^{-1}. The total cost of wheat is estimated at 9.4 JD du^{-1}, and the total return is estimated at 24.85 JD du^{-1}.

The net return for wheat enterprise is estimated at 0.96 JD du^{-1} in the Muhareb community; the total variable costs are estimated at 6.98 JD du^{-1}, with total fixed costs at 1 JD du^{-1}. The total cost of wheat is estimated at 7.98 JD du^{-1}, and the total return is estimated at 8.94 JD du^{-1}.

The net return for wheat enterprise is estimated at 15.47 JD du^{-1} in the Um-Al-Naám community; the total variable costs are estimated at 8.16 JD du^{-1}, with total fixed costs at 1 JD du^{-1}. The total cost of wheat is estimated at 9.16 JD du^{-1}, and the total return is estimated at 24.63 JD du^{-1}.

The study area is a rainfed area in which rainfall is less than 200 mm. These areas are not suitable for planting wheat, especially in the Muhareb community.

Data in Tables 3, 3.1 and 3.2 provide important information on the contribution of different cost items to the total cost of wheat production. Variable cost accounts for more than 80% of wheat production costs, whereas fixed cost represents 12%, on average, of the total production costs. Threshing, seeds, harvesting and packaging are the major contributors to the variable cost, and thus to the total cost of wheat production. On average, threshing accounts for 29% of total production costs. Farmers in these areas do not apply chemical fertilizers, pesticides and insecticides.

Table 3: Average net return and cost of production of wheat for the whole sample (du^{-1}).

Activity	Unit	Quantity	Price (JD)	Value (JD)	Total production cost of total area (JD)	% of total production cost
Total return	**JD**			**24.85**		
Grain	kg	91.11	0.181	16.5		
Straw	kg	134.8	0.062	8.35		
Total variable cost	**JD**			**8.3**	**191.1**	**88**
Deep plowing	hr du^{-1}	0.49	0.92	0.5	10.4	5
Plow 2	hr du^{-1}	0.18	0.69	0.1	2.9	1
Seeding	hr du^{-1}	0.28	0.34	0.1	2.2	1
Seeds	kg du^{-1}	8	0.26	2.1	47.8	22
Harvesting	hr du^{-1}	0.58	2.8	1.6	37.4	17
Threshing	hr du^{-1}	1.3	2.1	2.7	62.8	29
Packaging	JD du^{-1}	1	1.2	1.2	27.6	13
Fixed cost				**1.1**		**12**
Land rent	JD du^{-1}	1	1.1	1.1	25.3	12
Total cost	**JD**			**9.4**	**216.4**	**100**
Net return	**JD**			**15.45**		

Table 3.1: Average net return and cost of production of wheat in the Muhareb community (du^{-1}).

Activity	Unit	Quantity	Price (JD)	Value (JD)	Total production cost of total area (JD)	% of total production cost
Total return	**JD**			**8.94**		
Grain	kg	-	-			
Straw	kg	149	0.06	8.94		
Total variable cost	**JD**			**6.98**	**209.7**	**87**
Deep plowing	hr du^{-1}	0.49	0.92	0.45	13.5	6
Plow 2	hr du^{-1}	0.18	0.55	0.10	3	1
Seeding	hr du^{-1}	0.28	0.3	0.08	2.4	1
Seeds	kg du^{-1}	5	0.16	0.80	24	10
Harvesting	hr du^{-1}	0.58	2.8	1.62	48.6	20
Threshing	hr du^{-1}	1.3	2.1	2.73	81.9	34
Packaging	JD du^{-1}	1	1.2	1.20	36	15
Fixed cost				**1**	**30**	**13**
Land rent	JD du^{-1}	1	1	1	30	13
Total cost	**JD**			**7.98**	**239.4**	**100.00**
Net return	**JD**			**0.96**		

4.1.5. Machinery ownership

Information regarding machinery ownership showed that few farmers own plowing equipment and seed drills at the community level; most farmers rent machinery equipment as shown in Table 4: about 97%, 97% and 84% of farmers rent deep plowing, plow 2 and seed drilling equipment, respectively. It was noticed that farmers who own machinery cultivate land area less than farmers who rent machinery, as shown in Table 5.

Table 3.2: Average net return and cost of production of wheat in Um Al Naám community (du^{-1}).

Activity	Unit	Quantity	Price (JD)	Value (JD)	Total production cost of total area (JD)	% of total production cost
Total return	**JD**			**24.63**		
Grain	kg	91.1	0.18	16.39		
Straw	kg	133	0.062	8.24		
Total variable cost	**JD**			**8.16**	**179.56**	**89**
Deep plowing	hr du^{-1}	0.49	0.92	0.45	9.92	5
Plow 2	hr du^{-1}	0.18	0.74	0.13	2.93	1
Seeding	hr du^{-1}	0.27	0.34	0.09	2.02	1
Seeds	kg du^{-1}	8	0.27	2.16	47.52	24
Harvesting	hr du^{-1}	0.5	2.8	1.40	30.80	15
Threshing	hr du^{-1}	1.3	2.1	2.73	60.06	30
Packaging	JD du^{-1}	1	1.2	1.20	26.40	13
Fixed cost				**1**	**22**	**11**
Land rent	JD du^{-1}	1	1	1.00	22	11
Total cost	**JD**			**9.16**	**201.65**	**100.00**
Net return	**JD**			**15.47**		

Table 4: Machinery ownership.

Machinery	Whole sample				Muhareb community				Um Al Naám community			
	Owned		Rented		Owned		Rented		Owned		Rented	
Activity	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Deep plowing	2	3.4	55	96.6	-	-	8	100	2	4	48	96
Plow 2	2	2.6	75	97.4	1	2.6	38	97.4	1	2.6	37	97.4
Seed drill	14	15.6	74	84.1	-	-	31	100	14	24.6	43	75.4

Table 5: Machinery ownership in barley cultivation and total area cultivated.

Machinery ownership	Whole sample		Muhareb community		Um Al Naám community	
	Av. area (du)	No. of farmers	Av. area (du)	No. of farmers	Av. area (du)	No. of farmers
Deep plowing						
Owned	52.5	2	-	-	52	2
Rented	86.73	55	179.87	8	70.88	47
Total	**85.53**	**57**	**179.87**	**8**	**70.1**	**49**
Plow 2						
Owned	27.5	2	50	1	5	1
Rented	206.3	75	345.2	38	63.1	37
Total	**201.66**	**77**	**337.6**	**39**	**61.59**	**38**
Seed drill						
Owned	61.43	14	-	-	61.4	14
Rented	189.2	74	367.5	31	60.7	43
Total	**168.9**	**88**	**367.5**	**31**	**60.9**	**57**

Table 6: Seed sources for the whole sample and at the community level.

	Whole sample				Muhareb				Um Al Naám			
	Bought		Home storage		Bought		Home storage		Bought		Home storage	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Seed source	68	63.6	39	36.4	45	95.7	2	4.3	23	38.3	37	61.7

4.1.6. Sources of seed

Most farmers buy seeds from the local market (63.6%); while 36.4% store seeds from their own production to be used the next season. This percentage depends on the seasonal conditions and the amount of grain production. During drought seasons, farmers depend totally on market purchase. Sources of seeds vary by community and over 95% of farmers in Muhareb depend on the local market (Table 6). In Um Al Naám community, most farmers (62%) depend on their farm production as a major source for seeds.

Over 40% of farmers in the selected communities practice crop rotation (Table 7); while 48% plant barley continuously (Table 8). Over 57% of farmers practice fallow; more than 40% practice barley fallow rotation. Wheat and barley are planted in October before rainfall (AFEER); however, these dates depend on rainfall and seasonal conditions. Some farmers (18.7%) mentioned that they changed the planting dates.

About 54% of the farmers choose crop varieties based on grain yield and 26% choose according to straw yield. Drought tolerance is another criterion: 25% of farmers select a variety for its drought tolerance, and 14% choose varieties for palatability to animals. Crop residues in community areas are used mainly for grazing (91%); only 9% of farmers use residues as hay – the rental price of land for the purpose of grazing on crop residues is 2 JD du^{-1} (Table 9).

Table 7: Crop rotations and fallow.

Item	No.	(%)
Practicing fallow	34	57.6
Rotations	25	42.4
Total	**59**	**100**

Table 8: Crops planted in the rotations.

Crop rotations	No.	(%)
Continuous barley	31	48.4
Barley fallow	27	42.2
Barley forage crops	4	6.3
Wheat-barley fallow	1	1.6
Wheat-barley	1	1.6
Total	**64**	**100**

Table 9: Use of crop residues.

Crop residues	No. of farmers	(%)
Grazing	104	91
Hay	10	9
Total	**114**	**100**

4.1.7. Labor distribution for crop activities

Family members participate in all activities of crop production. About 49% of them participate in harvesting and 43% of them in the transport of produce (Table 10). Farmers also depend on hired labor for various activities, depending on on the area planted and the number of family members.

Table 10: Labor used in barley and wheat production.

Labor distribution	Familys labor		Hired labor	
	No.	%	No.	%
Monitoring the field	7	100		
Harvesting	35	49.3	36	50.7
Threshing	3	5.1	56	94.9
Packaging	26	19.4	24	48
Transport	22	43.1	29	56.9

4.1.8. Crop production and crop uses

Average ybarley grain yield is about 140 kg du^{-1} in good years, but only about 40.5 kg du^{-1} in drought years. During drought, large proportions of field are grazed and farmers do not produce any grain. For wheat, average yields are 149.6 kg du^{-1} and 15 kg du^{-1} in good and drought years respectively (Table 11). Wheat yield in Um Al Naám ranges from 137 to 14 kg du^{-1} in normal and drought years, respectively (Tables 11.1 and 11.2). Good, normal and drought years are classified according to the amount of rainfall. In the study area, annual rainfall is about 200 mm in a normal year.

Farmers mainly use their production of barley grain, barley straw and wheat bran for feeding livestock, with a proportion share from the total production of more than 50%. Wheat grain is sold and is also for home consumption. Selling price depends on seasonal conditions; prices in good, normal and drought seasons are presented in Tables 12, 12a and 12b. The quantity sold and consumed depends on the season's condition and the amount of production. The quantity consumed and sold increases in normal and good years, when production is high, and decreases during drought years (Tables 12.1 and 12.2).

Table 11: Average yield of crops (kg du 1).

Crop	Normal year		Good year		Drought year	
	Grain	Straw	Grain ˚t˚t˚t˚tStraw		Grain	Straw
Barley	73	140	140 ˚t˚t˚t˚t208.3		40.5	66.3
Olives	211	-	367.9 ˚t˚t˚t˚t˚t˚t-		65.1	-
Wheat	91.1	135	149.6 ˚t˚t˚t˚t150.6		15	24

Table 11.1: Average yield of crops in the Muhareb community (kg du^{-1}).

Crop	Normal year		Good year		Drought year	
	Grain	Straw	Grain ˚t˚t˚t˚tStraw		Grain	Straw
Barley	58.6	122	126.9 ˚t˚t˚t˚t130.4		39	47.5
Olives	307.8	-	618.7 ˚t˚t˚t˚t˚t˚t-		109.2	-
Wheat	-	-	200 ˚t˚t˚t˚t˚t75		16	24

Table 11.2: Average yield of crops in the Um Al Naám community (kg du^{-1}).

Crop	Normal year		Good year		Drought year	
	Grain	Straw	Grain ˚t˚t˚t˚tStraw		Grain	Straw
Barley	79.8	146	148.5 ˚t˚t˚t˚t˚t245		41	71
Olives	141	-	179.8 ˚t˚t˚t˚t˚t˚t-		49	-
Wheat	91	135	137 ˚t˚t˚t˚t˚t160		14	-

Table 12: Crop uses for the whole sample during normal years (kg).

Crop	Total farm production	Feeding livestock	% share from total prod.	Sold	% share from total prod.	Home consump-tion	% share from total prod.	Seed	% share from total prod.	Selling price JD kg^{-1}
Barley grain	9680.6	4064.3	41.98	3656.2	37.77	1500	15.49	460.1	4.75	0.125
Straw	19546.4	10695.9	54.72	6710.5	34.33	2140	10.95		0.00	0.073
Wheat grain	2207.6	0	0.00	1533.3	69.46	533.3	24.16	141	6.39	0.167
Wheat straw	4866.6	2450	50.34	1866.6	38.36	550	11.30		0.00	0.065
Olives	4981.14	0	0.00	4473	89.80	508.1	10.20		0.00	0.225

Table 12.a: Crop uses for the whole sample during good years (kg).

Crop	Total farm production	Feeding livestock	% share from total prod.	Sold	% share from total prod.	Home consump-tion	% share from total prod.	Seed	% share from total prod.	Selling price JD kg^{-1}
Barley grain	15516.1	7663	49.39	5915.9	38.13	1857.8	11.97	79.4	0.51	0.11
Straw	38340	9443.8	24.63	14971.2	39.05	13925	36.32	0	0.00	0.069
Wheat grain	2560	0	0.00	2000	78.13	408	15.94	155	6.05	0.21
Wheat straw	5695	3000	52.68	1200	21.07	1495	26.25	0	0.00	0.07
Olives	17000	0	0.00	14000	82.35	3000	17.65	0	0.00	0.22

Table 12.b: Crop uses for the whole sample during drought years (kg).

Crop	Total farm production	Feeding livestock	% share from total prod.	Sold	% share from total prod.	Home consump-tion	% share from total prod.	Seed	% share from total prod.	Selling price JD kg^{-1}
Barley grain	3090	1015	32.85	1570	50.81	0	0.00	505	16.34	0.133
Straw	17416.67	12416.67	71.29	5000	28.71	0	0.00	0	0.00	0.0766
Wheat grain	0	0		0	0.00	0	0.00	0	0.00	0.23
Wheat straw	40	0	0.00	40	100.00	0	0.00	0	0.00	
Olives	2275	0	0.00	0	0.00	2275	100.00	0	0.00	0.21

Table 12.1: Crop uses in the Muhareb community in normal years (kg).

Crop	Total farm production	Feeding livestock	% share from total prod.	Sold	% share from total prod.	Home consump-tion	% share from total prod.	Seed	% share from total prod.	Selling price JD kg^{-1}
Barley grain	10533.75	5500	52.21	3000	28.48	1500	14.24	533.8	5.07	0.08
Straw	2900	1800	62.07	0	0.00	1100	37.93	0	0.00	0.07
Wheat grain	0	0	0.00	0	0.00	0	0.00	0	0.00	
Wheat straw	0	0	0.00	0	0.00	0	0.00	0	0.00	
Olives	1671	1000	59.84	0	0.00	671	40.16	0	0.00	0.22

Table 12.2: Crop uses in the Um Al Naám community in normal years (kg).

Crop	Total farm production	Feeding livestock	% share from total prod.	Sold	% share from total prod.	Home consump-tion	% share from total prod.	Seed	% share from total prod.	Selling price JD kg^{-1}
Barley grain	9551.46	3913	40.97	3684.9	38.58	1500	15.70	453.6	4.75	0.113
Straw	20748	11204.2	54.00	6710.5	32.34	2833.3	13.66	0	0.00	0.077
Wheat grain	2257.8	0	0.00	1533.3	67.91	533.3	23.62	191.2	8.47	0.167
Wheat straw	4866.67	2450	50.34	1866.8	38.36	550	11.30	0	0.00	0.07
Olives	4911	0	0.00	4473	91.08	438	8.92	0	0.00	0.22

4.2. Livestock Production

4.2.1. Flock size

A livestock-rangeland-based system is the targeted system for implementing project activities. This is because the project aims to improve the productivity of degraded rangelands through efficient utilization of limited available rainfall. Table 13 shows the average flock size at community level: it was found that the Muhareb community has the larger average flock size (159 head) compared with the Um Al Naám community that has a flock size of 126 head; the average flock size for both communities of all kind of small ruminants is shown in Table 14.

Sample farms were categorized in terms of flock size on the following basis: small (less than 100 head); medium (100-500 head); and large flocks (more than 500 head). Table 15 shows

Table 13: Average flock size in the Muhareb and Um Al Naám communities.

Community	Av. flock (head)	Farmers number	Total flock (head)	% of total flock	% of total farmers
1. Muhareb	159	43	6824	54.1	48.3
2. Um Al Naám	126	46	5790	45.9	51.7
Total	**142**	**89**	**12614**	**100**	**100**

Table 14: Flock composition.

Kind	Muhareb community		Um Al Naám community		All communities	
	No. of farmers (head)	Av. flock size	No. of farmers	Av. flock size (head)	No. of farmers	Av. flock size (head)
Sheep	26	224	37	135	63	172
Goats	33	30	34	22	67	26
Cows			1	9	1	9

Table 15: Distribution of flock size for the whole sample.

Flock	Av. flock size(head)	No. of Farmers	% of farmers	% of total small ruminants
Small	32	60	67	13.3
Medium	276	25	28	54.6
Large	949	4	5	30.1
Total	**142**	**89**	**100**	**100**

Small: less than 100 head; Medium: 100-500 head; and Large: more than 500 head.

Table 15.1: Distribution of flock size in the Muhareb community.

Flock	Av. flock size(head)	No. of Farmers	% of farmers	% of total small ruminants
Small	28	27	62.8	11
Medium	293	13	30.2	55.9
Large	751	3	7	33
Total	**159**	**43**	**100**	**100**

that 67% of farmers own a small flock size and 28% own a medium flock size. Only 5% of farmers own large flocks. However, the medium flock size consisted of more than 50% of the total small ruminants, whereas large flocks consisted of about 30%. The same is applicable at the community level (Tables 15.1 and 15.2). This implies that most farmers are small flock owners and they can provide their sheep with sufficient feed without moving their flocks a long distance outside of the community area.

Farmers who cultivate larger areas have large flocks, although this is only a small portion of the farms (4.7%). Farmers who own a small flock size are in the majority in the selected communities (representing 67.4%), whereas a medium flock size represents nearly

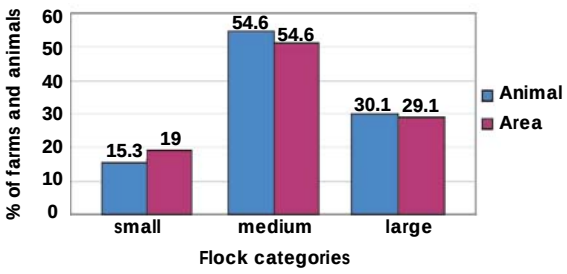

Figure 1. Flock size and average area cultivated for the whole sample.

28% of farms. As shown in Figure 1, there is a positive relationship between flock size and area cultivated. A similar conclusion applies for each community (Tables 16, 16.1 and 16.2).

4.2.2. Livestock production systems

During the past three decades, there has been a change in the livestock production systems. The main livestock

Table 15.2: Distribution of flock size in the Um Al Naám community.

Flock	Av. flock size(head)	No. of Farmers	% of farmers	% of total small ruminants
Small	36	33	71.7	20.3
Medium	256	12	26.1	53.1
Large	1540	1	2.2	26.6
Total	**126**	**46**	**100**	**100**

Table 16: Flock size and average area cultivated for the whole sample.

Flock categories	Av. Area (du)	Av. flock size (head)	%of total ruminant population	% of total area	% of total farmers
Small	58.4	32	15.3	19	67.4
Medium	386.4	276	54.6	51	27.9
Large	1300.75	949	30.1	29.1	4.7
Total	**207.78**	**142**	**100**	**100**	**100**

Table 16.1: Flock size and average area cultivated in the Muhareb community.

Flock categories	Av.Area (du)	Av. flock size (head)	%of total ruminant population	% of total area	% of total farmers
Small	73	28	11	13.5	63.4
Medium	666	293	56	56.7	29.3
Large	1401	752	33	29.8	7.3
Total	**344**	**129**	**100**	**100**	**100**

production system in the past was nomadic grazing, in which flocks used to move around during most of the year according to the availability of forage and water. This system was used so that the steppe rangelands could 'rest' for about 6 months each year for vegetation to recover. Recently, this nomadic grazing system began to diminish due to trucking and mobilization of feed and water. As shown in Table 17, there is a shift in livestock production systems towards semi-intensive systems (77.5%); nomadic production systems are now minimal (16%). The nomadic system is dominant in the Muhareb community compared with the Um Al Naám community. The semi-intensive production system accounts for 91% in the Um Al Naám community (Table 17.1).

4.2.3. Livestock income

The total average income from livestock products was estimated at 8451.6 JD yr^{-1}. This income is generated from the production of milk, wool, weaned and aged animals of sheep and goats. The share of income from weaned animals was the highest of all products (43.6%), followed by milk (36%) (Table 18). The total average income of livestock products is estimated at 13215.5 JD yr^{-1} in the Muhareb community.

Table 16.2: Flock size and average area cultivated in the Um Al Naám community.

Flock categories	Av. Area (du)	Av. flock size (head)	%of total ruminant population	% of total area	% of total farmers
Small	47	36	20.3	39.5	71.1
Medium	107	256	53.1	34	26.7
Large	1000	1540	26.6	26.5	2.2
Total	**83**	**126**	**100**	**100**	**100**

Table 17: Livestock production systems for the whole sample.

Production system	Number of farmers	% of farmers	Av. flock size (head)	% of total sheep population
Intensive	6	6.74	58	2.7
Semi-intensive	69	77.53	125	68.6
Nomadic	14	15.73	259	28.7
Total	**89**	**100.00**	**142**	**100**

Table 17.1: Livestock production systems at the community level.

Production system	Muharebcommunity				Um Al Naám community			
	Number of farmers	% of farmers	Av. flock size (head)	% of total sheep population	Farmers number	% of farmers	Av. flock size	% of total sheep population (head)
Intensive	5	11.6	68	5	1	2.2	5	1
Semi-intensive	27	62.8	115	45.4	42	91.3	132	95
Nomadic	11	25.6	308	49.6	3	6.5	79	4
Total	**43**	**100**	**159**	**100**	**46**	**100**	**126**	**100**

The largest share of income comes from selling weaned animals (52%), followed by milk production (25%) (Table 18.1). In the Um Al Naám community, the total average income from livestock products is estimated at 5206.6 JD yr^{-1}. The largest share of income comes from selling milk (43%), followed by selling weaned animals (33%) (Table 18.2). This community has a larger average flock size than the Muhareb community.

Most farmers sell the milk that they have produced to a middleman (34%). Marketing channels of other products are mainly to neighboring communities and within the same community (Table 19).

Table 18: Livestock production, and marketing of animal products and live animals for the whole sample.

Productive indicators	Sheep	Goats	Family consumption	Market	Price (JD kg^{-1})	Total income (JD)	% of income from source
Milk							
Production, kg	4777.5	1118	866	5895.5	0.58	-	-
Income, JD yr^{-1}	2092	459	502.28	2551	-	3053.2	36.13
Wool							
Production, kg	256.8	-	58	256.8	0.5	-	-
Income, JD yr^{-1}	128	-	29	128	-	157	1.86
Animals							
Weaned, No.	57	9	13	66	38	-	-
Income, JD yr^{-1}	2834.6	356.8	494	3191.4	-	3685.4	-
Aged animals, No.	32	3	3	35	38	-	43.61
Income, JD yr^{-1}	1289	120	147	1409	-	1556	18.41
Total income JD yr^{-1}	**1289**	**935.8**	**1172.28**	**7279.4**	**-**	**8451.6**	**100.00**

Table 18.1: Livestock production, and marketing of animal products and live animals in the Muhareb community.

Productive indicators	Sheep	Goats	Family consumption	Market	Price (JD kg^{-1})	Total income (JD)	% of income from source
Milk							
Production, kg	6960	1090	1084	8050	0.36	-	-
Income, JD yr^{-1}	2581.1	452	390	3033.1	-	3423.1	25.90
Wool							
Production, kg	389	-	15	389	0.56	-	-
Income, JD yr^{-1}	188	-	8.4	188	-	196.4	1.49
Animals							
Weaned, No.	120	10	4	130	40	-	-
Income, JD yr^{-1}	6351	444	160	6795	-	6955	52.63
Aged animals, No.	61	4	18	65	38	-	-
Income, JD yr^{-1}	1825	132	684	1957	-	2641	19.98
Total income JD yr^{-1}	**10945.1**	**1028**	**1242.4**	**11973.1**	**-**	**13215.5**	**100.00**

Table 18.2: Livestock production, and marketing of animal products and live animals in the Um Al Naám community.

Productive indicators	Sheep	Goats	Family consumption	Market	Price (JD kg^{-1})	Total income (JD)	% of income from different sources
Milk							
Production, kg	2763	154	596	3917	0.58	-	43.03
Income, JD yr^{-1}	1430	464.9	345.7	1894.9	-	2240.6	-
Wool							
Production, kg	121		100	121	0.5	-	-
Income, JD yr^{-1}	67		50	67	-	117	2.25
Animals							
Weaned, No.	29	8	4	37	40	-	-
Income, JD yr^{-1}	1258	284	160	1542	-	1702	32.69
Aged animals, No.	12	3	3	15	27	-	-
Income, JD yr^{-1}	906	160	81	1066	-	1147	22.03
Total income JD yr^{-1}	3661	908.9	636.7	4569.9	-	5206.6	100.00

Table 19: Marketing channels of livestock products.

Marketing channel	No. of farmers	(%)
Within the same community	10	21.3
To neighboring communities	11	23.4
Livestock traders	5	10.6
Sheep markets	5	10.6
Middleman	16	34.0

Most households process milk locally into *Labaneh,* cheese, *Jameed* and ghee. They make these products for family consumption and market surplus quantities. The selling price ranged between 2.4 JD kg^{-1} for cheese and up to about 6 JD kg^{-1} for *Jameed* and ghee (Table 20). As the middleman markets most of the milk produced, he determines the price – this results in high marketing margins. Helping local communities in setting an institutional arrangement, such as a cooperative, would help in reducing these marketing margins in favor of producers.

4.2.4. Labor for livestock activities

Farmers hired labor for livestock activities; the average numbers of laborers hired for grazing, feeding, watering and treatment was one laborer (Table 21). However, the average number of laborers hired for milking activity was 2

Table 20: Processing of animal production.

Product	Family consumption (kg)	Selling (kg)	Selling price (JD kg^{-1})	Income (JD) yr^{-1}
Labaneh	26.7	32.7	2.5	148.5
Cheese	26.6	50	2.4	183.8
Jameed	25.9	41.9	6	406.8
Ghee	16.5	21.7	6.4	244.5

Table 21: Hired labor for livestock activities.

Activity	Hired labor	
	Av. No.	Av. wage (JD day^{-1})
Grazing	1	6
Feeding	1	6
Milking	2	8
Wool shearing	4	7
Treatment	1	10

laborers and for wool shearing was 4 laborers. The average wage was about 6 JD day 1 for grazing and feeding, whereas it increased up to 7-8 JD day 1 for wool shearing and milking. Family members are involved in all livestock activities; the percentages of family members who participate in all activities are shown in Table 22.

Grazing, feeding, wool shearing and treatment are mainly the responsibility of the household head, with the help of the wife and sons. However, milk processing is the wife's and daughter's responsibility (78%). The wife and sons are strongly involved in all activities. The percentage share of the daughters' participation was the weakest of all other family members in all activities except milk processing.

4.3. Livelihood Characterization

4.3.1. Household assets

There are five household assets on which individuals draw to build their livelihoods. These are natural, social, human, physical and financial capital, as presented in the following tables.

Natural capital refers to the natural resource stock from which resource flows of useful livelihoods are derived and includes land, rangeland, water and other environmental resources. Results of the survey showed that the average area owned is estimated at 6.8 ha for the whole sample and 7.7 ha for the Muhareb community. A total of 90% of the respondent farmers mentioned that they have water sources. These sources are mainly collecting-wells and cisterns. Rainfall is the main source of irrigation for the surveyed communities; more than 70% of farmers depend on rainfall for irrigating their crops. Rangeland in the communities' area is degraded, as indicated by 90% of farmers in the Um Al Naám community and 54% of farmers in the Muhareb community.

Table 22: Participation of family members in livestock activities.

Activity	Family labor			
	Household head No. (%)	Wife No. (%)	Sons No. (%)	Daughters No. (%)
Grazing	50 (52.1)	13 (13.5)	31 (32.3)	2 (2.1)
Feeding	49 (43.4)	29 (25.7)	31 (27.4)	4 (3.5)
Watering	42 (41.6)	30 (29.7)	28 (27.7)	1 (1)
Milking	8 (8.5)	61 (64.9)	12 (12.8)	13 (13.8)
Wool shearing	32 (57.1)	5 (8.9)	18 (32.1)	1 (1.8)
Milk manufacturing	2 (2.6)	61 (78.2)	1 (1.3)	14 (17.9)
Treatment	47 (68.1)	10 (14.5)	12 (17.4)	0
Taking care of newborns	50 (38.5)	32 (40)	14 (10.8)	14 (10.8)

Note: numbers in parenthesis refer to the percentages

Social capital includes the social resources that people draw on in pursuit of livelihoods, such as a group membership, networks, and access to institutions and influential people. Few farmers mentioned that they had a cooperative membership, whereas about 96% of farmers are not members of any kind of cooperative.

Examples of human capital are the skills, knowledge (including indigenous), labor and health that are necessary for people to make a reasonable living. The average years of experience in agriculture was about 27 years in the communities' area; the average family size was about 9 individuals. In addition, the average number of family members who work in agriculture and livestock was about 3 persons in the Muhareb community and 2 persons for the whole sample. However, the average number of family members who work outside the farm was 2 persons in the Muhareb community and 3 persons for the whole sample. The illiteracy rate was found to be high among the surveyed farmers; it was estimated that the illiteracy rate was 28% for the whole sample.

Physical capital represents the basic infrastructure and production equipment that enable people to pursue their livelihoods. Examples that provide livelihood include transport, shelter, water, energy and communications. More than 90% of farmers at the whole sample level have a cement house; the average total number of small ruminants owned is estimated at 142 head for the whole sample and 159 head for the Muhareb community. More than 67% of farmers own a small flock size (less than 100 head) and only 5% of them own a large flock size (more than 500 head) at the whole sample level. The semi-intensive production system is the dominant type of livestock production system, as indicated by 76% of respondent farmers at the whole sample level. Production equipment, such as machinery for plowing and seeding, is mainly rented, whereas only a few farmers own this type of machinery.

Financial capital can be in the form of cash, credit, savings or remittances. The average annual income for plant production and off-farm income is estimated at 8615 (JD)/farm for the whole sample and estimated at 9753 JD/farm from livestock production and off-farm income. Nearly 38% of income sources are from off-farm income and 62% is from on-farm income at the whole sample level. In the Muhareb community, 66% of on-farm income is from livestock production and only 8% is from crop and olive production. Meanwhile, in the Um Al Naám community, 25% of on-farm production is from livestock production and about 24% is from crop and plant production - this means that most households in the Muhareb community depend on livestock production for their on-farm production. The cost of production was about 10 and 9 JD du^{-1} for barley and wheat, respectively. Meanwhile, the net return was estimated at 8 and 15 JD du^{-1} for the two crops, respectively. The average wage of laborers per day is 5 JD and credit sources are mainly from private banks and are used mainly for livestock production.

1. Natural assets

Assets	Muhareb	Um Al Naám	Whole sample
Total holding area managed and work in, du	325	80	179
Total area owned, du	77	63	68
Total area cultivated, du	286	71	158
Average areas planted with barley, du	299.8	71	165
Average area planted with wheat, du	30	22	23
Average area planted with olives, du	11	16	14
Having water resources, %	90	89	90.3
Average number of grazing months within community area	5	5	6
Rangeland degradation			
Degraded, %	54.1	90.6	71
Severe degradation, %	40.5	9.4	26.1
Water sources for livestock			
Collecting-wells (% of total quantity consumed)	75.26	35.05	62.9
Cisterns (% of total quantity consumed)	21.28	25.61	21.7
Water authority (% of total quantity consumed)	3.46	39.33	15.4
Water sources for irrigation			
Rainfall, %	65.2	70.6	68.2
Collective well, %	10.6	4.7	7.3
Water authority, %	4.5	11.8	8.6
Water cisterns, % from groundwater	19.7	12.9	15.9

2. Social capital (%)

Assets	Muhareb	Um Al Naám	Whole sample
Cooperative membership	3.6	5.1	4.5
Non-member to cooperative	96.4	94.9	95.5
Kind of cooperative (social cooperative)	1.8	1.3	1.5
Home base at community area	92.7	97.5	95.5
Availability of extension services	35	74.1	50.7
Extension services not enough	25	11.1	19.4
Extension services not available	40	14.8	29.9

3. Human capital

Assets	Muhareb	Um Al Naám	Whole sample
Experience in agriculture (years)	27	28	27
Experience in herding (years)	27	28	28
Family size			
Total number of family members	8	9	9
No. of adult males (>15 years)	2	4	3
No. of adult females (>15 years)	2	3	3
No. of children (<15 years)	4	2	3
No. of family members who work in agriculture and livestock	3	2	2
No. of family members who work outside the farm	2	4	3
Total number of family members older than 15 years and illiterate	2	2	2

3. (Continued)

Assets	Muhareb	Um Al Naám	Whole sample
Farmer education level, %			
1. Illiterate	27.3	24.1	25.4
2. Elementary	20.0	10.1	14.2
3. Intermediary	16.4	20.3	18.7
4. Secondary	25.5	35.4	31.3
5. Diploma	5.5	3.8	4.5
6. University degree	5.5	6.3	6

4. Physical capital

Assets	Muhareb	Um-Al-Naám	Whole sample
Having cement house, %	81.8	98.7	91.8
Having tent house, %	9.1	-	9.1
Having stone house, %	9.1	1.3	4.5
Having small ruminants, %	78	58	66
Livestock			
Average total small ruminants, head	159	126	142
Average number of sheep, head	224	135	172
Average number of goats, head	30	22	26
Small flock size (<100 head), %	62.8	71.7	67
Medium flock size (100-500 head), %	30.2	26.1	28
Large flock size (>500 head), %	7	2.2	5
Livestock production system			
Intensive, %	11.6	2.2	6.74
Semi-intensive, %	62.8	91.3	77.53
Nomadic, %	25.6	6.5	15.73
Machinery ownership, %			
Owned, %			
Deep plowing	-	3.4	3.4
Plow 2	-	2.6	2.6
Seed drilling	-	15.6	15.6
Rented, %			
Deep plowing	100	96	96.6
Plow 2	97.4	97.4	97.4
Seed drilling	100	75.4	84.1
Seed sources, %			
Bought, %	95.7	38.3	63.6
Home storage, %	4.3	61.7	36.4

5. Financial capital

Assets	Muhareb	Um-Al-Naám	Whole sample
Average annual income (JD)/farm			
1. Plant production			
1. Selling crop production	240	720.56	704
2. Selling olive production	0	942.69	942.69
3. Plant production (1+2)	240	1663.25	1646.69
Off-farm income (labor wage outside agriculture)	7110	5798	6026

5. (Continued)

Assets	Muhareb	Um-Al-Naám	Whole sample
Total income(plant production and off-farm income)	7350	8403.94	8615.38
2. Livestock production			
Selling livestock products	4220.1	2703.1	3727
Off-farm income (labor wage outside agriculture)	7110	5798	6026
Total income(livestock production and off-farm income)	11330.1	8501.1	9753
Average expenditure (JD)			
• Agriculture inputs(seeds, fertilizer) costs	1946.4	982.65	1805.5
• Feed costs (year)	2181.06	1366.3	1814.38
• Rented labor costs (year)	1596	1500	1512
Cost of production (JD du^{-1})			
Barley	5.69	11	9.63
Wheat	7.98	9.16	9.4
Net return (JD du^{-1})			
Barley	8.77	8	8.25
Wheat	0.96(only from straw)	15.47	15.45
Income sources (%)			
Off-farm income	26.39	51.49	38.05
On-farm income			
• Crop and olive production	7.77	24.00	23.48
• Livestock production	65.84	24.51	38.47
Wages			
Average wage for laborer per day (JD)	5	4	4.66
Average wage for laborer per month (JD)	150	125	126.2
Credit			
Percent of farmers getting credit (%)	17	3.9	9.3
Credit uses			
1. Field crops	11.1	0	8.3
2. Livestock	88.9	100	91.7
Credit sources			
Bank (%)	-	66.7	66.7
Cooperative (%)	-	33.3	33.3
Agricultural credit cooperative (%)	-	-	16.4
Average amount of credit (JD)	9388.9	3466.7	7908.3
Minimum amount (JD)	4000	1200	1200
Maximum amount (JD)	21000	20000	20000
Cost of feed stuff			
Barley grain, %	66.93	58.93	63.81
Barley bran, %	23.00	14.43	20.28
Straw, %	10.07	26.64	15.91
Total farm production (t yr^{-1})	15.10	42.33	41.28
Barley grain (t yr^{-1})	10.53	9.55	9.68
Straw (t yr^{-1})	2.90	20.75	19.55
Wheat grain (t yr^{-1})	0.00	2.26	2.26
Wheat straw (t yr^{-1})	0.00	4.87	4.87
Olives (t yr^{-1})	1.67	4.91	4.98

4.4. Socioeconomic Characteristics

4.4.1. Land tenure

Land ownership. Land ownership is an important factor for the success of proposed activities by the project. Both governmental – including claimed land but not registered – and private ownership were considered to be the best land tenure regimes to deal with the implementation of project activities. Private ownership involves primarily one individual decision-maker; this is the property rights situation that is sought to be more desirable, as the holder of such a right has full control over the resources.

Common property is being used for resources that are commonly owned with determined shares and also used for resources that are commonly owned but with undetermined shares. The first refers to different individuals who bought or inherited a resource and decided to keep the resources undivided for efficiency issues. The second case, which is the most common, refers to resources that are owned by a community or tribe. In this case, community and tribe members are granted user rights and co-ownership rights because of their membership.

Private property is rooted deeply in the land tenure system in Jordan. Private property evaluations have reached a certain level so that the *Meeri* landholders have become assimilated; this has led to the *Mulk* landholders having almost full ownership by conferring rights to sale, bequest and mortgage. The main types of private property tenure are *Mulk* and *Meeri* land. As well as absolute *Mulk*, there is Waqaf *Mulk* (donated to religions), whereas *Meeri* land is composed of others, such as Mouatal, Hiraj, Bir Ma', Saqy, Magarah and Ein ma'.

Privately owned and *Meeri* land tenure were found in the surveyed communities. The overall average farm size of privately owned land is estimated at 12.2 ha, and is estimated at 8.2 ha for *Meeri* land (Table 23). Almost all farmers (98%) have privately owned land tenure. *Meeri* land tenure is operated by only 2% of sample farms.

One farmer indicated that his land

Table 23: Land tenure in the whole sample.

Land tenure	% of farmers	Owned			Meeri		
Field		Av. farm size (du)	% of total land area	% of total farms	Av. farm size (du)	% of total land area	% of total farms
Field 1	46	64	97.5	98.5	107.5	2.5	1.5
Field 2	27.9	59.8	98.6	97.5	32.5	1.4	2.5
Field 3	12.5	59.9	99	97.2	21	1	2.8
Field 4	7.3	167	99.6	95.2	15	0.4	4.8
Field 5	4.5	301.6	98.6	92.3	-	-	-
Field 6	1.4	231.25	100	100	-	-	-
Field 7	0.3	100	100	100	-	-	-
Overall average*	89.81	121.8	98.4	97.5	81.9	2.1	2.5

*This is the weighted average for all fields; field areas used for weighting.

tenure is of 'Tribal' type, with an average area of 5 ha. Land tenure for the Muhareb community and the Um Al Naám community is shown in Tables 23.1 and 23.2, respectively.

The average size of a holding that a farmer manages is 17.9 ha for the whole sample; it was estimated at 32.5 ha for the Muhareb community and 8 ha for the Um Al Naám community. The average size of owned land is 6.8 ha for the whole sample, 7.7 ha for the Muhareb community and 6.3 ha for the Um Al Naám community.

The average area cultivated is 15.8 ha for the whole sample, 26.8 ha for the Muhareb community and 7.1 ha for the Um Al Naám community (Table 24).

Table 23.1: Land tenure in the Muhareb community.

Land tenure Field	% of farmers	Owned			Meeri		
		Av. farm size (du)	% of total land area	% of total farms	Av. farm size (du)	% of total land area	% of total farms
Field 1	47.8	110.7	100	100	-	-	-
Field 2	28.7	103.5	100	100	-	-	-
Field 3	11.3	119.2	100	100	-	-	-
Field 4	7	319	100	100	-	-	-
Field 5	4.3	614	100	100	-	-	-
Field 6	0.9	720	100	100	-	-	-
Field 7	-	-	-	-	-	-	-
Overall average*	33.1	254.7	100	100	-	-	-

*This is the weighted average for all fields; field areas used for weighting

Table 23.2: Land tenure in the Um Al Naám community.

Land tenure Field	% of farmers	Owned			Meeri		
		Av. farm size (du)	% of total land area	% of total farms	Av. farm size (du)	% of total land area	% of total farms
Field 1	44.8	30	91.3	97.4	107.5	8.7	2.6
Field 2	27.3	27.8	95.1	95.7	32.5	4.9	4.3
Field 3	13.4	24.89	96.3	95.7	21	3.7	4.3
Field 4	7.6	65.6	98.1	92.3	15	1.9	7.7
Field 5	4.7	78	91.6	87.5	-	-	-
Field 6	1.7	68.3	100	100	-	-	-
Field 7	0.6	100	100	100	-	-	-
Overall average*	30.4	41	94.1	95.9	81.9	7.3	4.3

*This is the weighted average for all fields; field areas used for weighting

Table 24: Average holding size in all selected communities.

Holding area	Number of farmers	Av. area (du)	Muhareb	Um-Al-Naám
Average area of total land managed (du)	131	179	325	80
Average total land area owned (du)	132	68	77	63
Average total area cultivated	128	158	286	71

Farm size and land use. Farm size is classified into three groups: small, medium and large. Small farms account for 74% of the total number of farms and control nearly 17% of the total area, with an average farm size of 36 du. Medium farms represent 12% of the total number of farms and control 11% of the total area, with an average farm size of 151 du.

However, large farms account for 14% and control 72% of the total area, with an average farm size of 812 du. This clearly shows that a small proportion of farmers control most of the land, whereas the largest group of small farmers control a small proportion of the total area. Such information has important policy implications with respect to the distribution of farm income.

Most of the area (80%) is allocated to crop production, which mainly comes from large farms. Fruit trees are mainly planted by large farms; 16% of the total crop land area is allocated to both crops and tree production. The area devoted to tree production alone is negligible – less than 1%, which is mainly for small farms (Table 25).

Ownership of shared land. As shown in Table 26, nearly 55% of the private land is owned by one owner, as mentioned by 68% of respondents. About 24% of the area is owned by 2-3 persons, as mentioned by 15% of farmers. Meanwhile, 9% of the farmers mentioned that about 18% and 4% of their area is owned by 3 and 5 persons, respectively. This multiple ownership of the land does not imply a wide dispu tation regarding farm operation.

As shown in Table 26, 68% of landowners are single owners of land, with an average-sized area of 128 du; 15% of

Table 25: Average farm size and cultivated land use.

Area/cultivated	Av. farm size (du)	No. of farmers	% of Total area	% of Total farms	Per capita Area (du)
Small	35.8	95	16.8	74.2	3.98
Medium	151	15	11.2	11.7	16.78
Large	811.89	18	72.1	14.1	90.21
Total	**158**	**128**	**100**	**100**	**17.56**
Planting crops					
Small	39.2	75	14.5	58.6	4.36
Medium	151	13	9.7	10.2	16.78
Large	945	12	55.9	9.4	105.00
Total	**162.4**	**100**	**80.1**	**78.1**	**18.04**
Planting trees					
Small	15.2	11	0.8	8.6	1.69
Medium	-	-	-	-	-
Large	-	-	-	-	-
Total	**15.2**	**11**	**0.8**	**8.6**	**1.69**
Planting crops and trees					
Small	32.6	9	1.4	7	3.62
Medium	151	2	1.5	1.6	16.78
Large	545.67	6	16.1	4.7	60.63
Total	**227.6**	**17**	**19.1**	**13.3**	**25.29**

Small: 1-100 (du); Medium: 101-200 (du); and Large: above 200 (du).

Table 26: Number of owners in the shared land and land area cultivated (du).

No. of owners	Av. farm size (du)	Farmers No.	Total area (du)	% of Total area	% of Total farms
One owner	127.57	87	11098.68	54.7	68
2-3 persons	254.26	19	4831	23.8	14.8
3-5 persons	327.8	11	3606	17.8	8.6
>5 persons	67.86	11	746.5	3.7	8.6
Total	**158**	**128**	**20282.18**	**100**	**100**

farmers share ownership (2-3 persons), with an average land area of 254 du; the multi-ownership of land for more than 3 persons is the least common type among all owners (only 8% of the farmers). Although there is more than one person that owns the same land, this does not appear to be a major factor in land plantation; data in Table 27 indicates only 16% of respondent farmers mentioned that multi-ownership is a reason for not cultivating their land.

Table 27: Reasons for not cultivating land.

Reason	No.	%
Multi-ownership of land	5	15.6
Low rainfall	14	43.8
Rocky soils	11	34.4
Capital shortage	2	6.2
Total	**32**	**100**

Farmers stated other important reasons for not cultivating their land. About 44% of farmers do not cultivate their land due to conditions such as rainfall shortage (Table 27), whereas 34% of the respondent farmers indicated that existence of rocky soils is the main reason for not cultivating land.

4.5. Natural Resources

4.5.1. Rangeland management

In the drier zones of Jordan, the low and variable rainfall limits the options available to farmers. Small ruminants (sheep and goats), supported by rainfed barley production and natural grazing in the extensive rangelands, are the principal economic output of these zones.

The best conditions to implement project activities are when the system includes both rangeland and complementary livestock activity. This is because the project is aimed at improving the productivity of degraded rangelands through the utilization of limited available rainfall. The ideal conditions to achieve these objectives are to start from rangelands and to utilize the production directly by livestock.

The following section presents the average number of grazing months in the community, catchment and Badia areas, and the most dominant rangeland species, rangeland status and management.
The average number of months for grazing in the community area range is 6 months and up to 9 months in the Badia area, whereas grazing on crop residues lasts for 3 months.

The native pastures can no longer satisfy such a large proportion of the feed needs of the livestock population, and supplemental feeding with barley grain, straw and other crop by-prod-

ucts has become essential. Attempts to meet the widening 'feed gap' have resulted in an expansion of the area planted to barley (Table 28). Barley is the principal livestock feed, achieved primarily through cultivating previously uncultivated marginal land and by replacing the traditional barley fallow rotations with continuous barley cropping. However, farmers think that barley encroachment into marginal land is weak at the community, catchment and Badia levels, as indicated by more than 80% of farmers.

As indicated by the respondent farmers, the most dominant rangeland shrubs genera and species found in the community area are Artemisia, Odo and Netol; the other species are less dominant in the Badia region (Table 29).

4.5.2. Grazing management

Community rangeland is predominantly managed by livestock owners or shepherds, as indicated by 39% and 33% of the respondents, respectively. Only 5% mentioned that tribal arrangements are used in rangeland management; meanwhile, 4% of the respondents indicated that rangeland is managed by cooperatives. There are some cases in which public institutions, such as agricultural directorates, are responsible for managing rangeland, as mentioned by 8% of the respondents (Table 30).

4.5.3. Rangeland status

The rangeland is deteriorating mainly due to human misuse and to the harsh environmental conditions. Overgrazing, plowing rangelands for cereals crops and insecure land tenure are the main factors that contribute to the degradation of range resources. Data in Table 31 demonstrate that rangeland is degraded at the community, catchment and Badia levels, as indicated by the majority of sample farms. About

Table 28: Expansion of barley planting into marginal lands.

Expansion	Within community area		Within catchment area		Badia area		Crop residues	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Limited	56	82.4	28	82.4	22	95.7	7	77.8
Wide	10	14.7	6	17.6	1	4.3	1	11.1
No change	2	2.9	-	-	-	-	1	11.1
Total	**68**	**100.0**	**34**	**100**	**23**	**100**	**9**	**100**

Table 29: Dominant feed crops and rangeland shrubs.

Rangeland shrubs	Within community area		Within catchment area		Badia area	
	Freq.	%	Freq.	%	Freq.	%
Barley	10	31.3	2	10.0	-	-
Artemisia	6	18.8	3	15.0	3	23.1
Achilla fragratissima	2	6.3	6	30.0	2	15.4
Anabasis aphella	9	28.1	5	25.0	3	23.1
Netol	3	9.4	2	10.0	3	23.1
Gaba	1	3.1	1	5.0	1	7.7
Khobeezeh	1	3.1	-	0.0	-	0.0
Hothan	-	-	1	5.0	-	0.0
Lofeteh	-	-	-		1	7.7
Total	**32**	**100**	**20**	**100**	**13**	**100.0**

Table 30: Rules for managing community rangelands.

Item	Traditional rules for using community rangelands (yes)		Responsibility for managing rangelands (yes)	
	No.	%	No.	%
Livestock owners	12	30.0	38	38.78
Shepherds	11	27.5	32	32.65
Tribal	9	22.5	5	5.10
Cooperatives	3	7.5	4	4.08
Agricultural directorates	5	12.5	8	8.16
No part responsible	-	-	11	11.22
Total	40	100.0	98	100.00

Table 31: The status of rangeland degradation.

Situation	Within community area		Within catchment area		Badia area	
	Freq.	%	Freq.	%	Freq.	%
Not degraded	2	2.9	2	5.7	2	7.7
Degraded	49	71.0	20	57.1	17	65.4
Severe degradation	18	26.1	13	37.1	7	26.9
Total	**69**	**100.0**	**35**	**100.0**	**26**	**100.0**

71% of farmers indicated that community rangeland is degraded and 65% indicated that rangeland at the Badia level is degraded. Nearly one-third of the sample farmers indicated that rangeland is severely degraded. For example, nearly 37% of farmers mentioned that rangeland is severely degraded within the catchment area.

Rangeland rehabilitation is urgently needed to stop further degradation of range resources and to manage them for sustainable use. Farmers' perceptions are important entry points for any rangeland rehabilitation program.

Farmers in the study area perceive water harvesting as the main intervention for improving rangeland, as indicated by 48% of sample farmers. Barley plantation is a second option for farmers, as mentioned by 22% of the respondents. This has important research implications in the form of improving the agronomics of barley plantation in order to decrease land degradation. Some 13% of farmers indicated that shrub plantation is a third option for improved rangeland management (Table 32).

Atriplex appears to be the most-preferred shrub for rehabilitating farmer-owned land, community rangeland and catchment land, as indicated by more than 50% of the respondents. Barley is another preferred species for farmer-owned land, in which Sheeh, Hamad and Gaysoom are preferred for rehabilitating community rangelands (Table 33). Gaysoom is the second preferred shrub, after Atriplex, for rangeland management in catchment regions and Badia.

Table 32: Farmers' opinion on potential options for improving rangeland.

Improve rangeland	No.	%
Planting barley	23	21.7
Planting rangeland shrubs	14	13.2
Water harvesting (small soil dams)	51	48.1
All of the above	18	17.0
Total	**106**	**100**

Table 33: Rangeland shrubs preferred by farmers.

Range shrubs	In farmer-owned land		Community land		Catchment land		Badia	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Atriplex	22	51.2	15	50.0	9	56.3	4	36.4
Any kind	2	4.7	0	0.0	1	6.3	1	9.1
Barley	11	25.6	1	3.3	1	6.3	0	0.0
Sheeh	4	9.3	4	13.3	1	6.3	1	9.1
Cactus	1	2.3	2	6.7	1	6.3	1	9.1
Hamad	1	2.3	5	16.7	1	6.3	1	9.1
Gaysoom	2	4.7	3	10.0	2	12.5	3	27.3
Total	**43**	**100**	**30**	**100.0**	**16**	**100.0**	**11**	**100.0**

Table 34: Potential farmers contribution to rangeland improvement.

Participation	In farmer-owned land		Community land		Catchment land		Badia	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Funding	6	8.7	1	2.2	-	-	-	-
Working	18	26.1	14	31.1	5	33.3	2	33.33
Experience	8	11.6	7	15.6	2	13.4	-	-
Guarding	20	29.0	20	44.4	6	40.0	2	33.33
Giving seeds	3	4.3	0	0.0	-	-	-	-
All of above activities	14	20.3	3	6.7	2	13.3	2	33.34
Total	**69**	**100**	**45**	**100**	**15**	**100**	**6**	**100**

Farmers' participation in rangeland rehabilitation is a key factor for the sustainable management of rangeland. Given the fact that this project is adopting a community approach for the introduction of water-harvesting techniques in the Badia, it is important to elicit farmers' opinions on their contribution in rangeland rehabilitation as proposed by the project. Farmers identified two potential areas for their contribution, including offering their own labor and protecting the shrubs during the establishment period (Table 34).

4.6. Constraints

4.6.1. General constraints

Farmers in the communities' area facele many constraints related to livestock production. The most dominant two constraints are feed shortage and high prices of feed sources, as indicated by 28% and 26% of respondent farmers, respectively (Table 35). Nearly 39% of sample farmers indicated that Enterotoxaemia is the most common disease that infects their animals.

Table 35: Constraints in livestock production.

Constraints	Whole sample		Muhareb		Um Al Naám	
	No.	%	No.	%	No.	%
Diseases	8	8.7	6	7.2	2	22.2
Grazing	5	5.4	4	4.8	1	11.1
Mortality	1	1.1	0	0	1	11.1
Milk drought	2	2.2	1	1.2	1	11.1
Feed shortage	26	28.3	24	28.9	2	22.2
High prices of veterinary services	3	3.3	3	3.6	-	-
Lack of medicine	4	4.3	4	4.8	-	-
High cost of feed sources	24	26	23	27.8	1	11.1
Water shortage	10	10.9	10	12	-	-
High cost of water	7	7.6	7	8.5	-	-
Marketing problems	2	2.2	1	1.2	1	11.1
Total	**92**	**100**	**83**	**100**	**-**	**-**

Table 36: Common diseases that infect the animals.

Common diseases	Whole sample		Muhareb		Um Al Naám	
	No.	%	No.	%	No.	%
Diarrhea	9	11.3	8	15.5	1	3.6
Enterotoxaemia	31	38.8	15	28.8	16	57.1
Subcutaneous inflammation	4	5	2	3.8	2	7.1
Insect-borne disease	5	6.1	4	7.7	1	3.6
PPR disease	3	3.8	3	5.8		
Brucella	2	2.5		0	2	7.1
Dizzyness	2	2.5	2	3.8		
Foot and mouth disease	9	11	7	13.5	2	7.1
Sheep pox	7	8.8	4	7.7	3	10.7
Mastitis	5	6.3	4	7.7	1	3.6
Flu	1	1.3	1	1.9		
Arthropod-borne disease	1	1.3	1	1.9		
Catarrh	1	1.3	1	1.9		
Total	**80**	**100**	**52**	**100**	**28**	**100**

Table 37: Seed constraints.

Constraints	Whole sample		Muhareb		Um Al Naám	
	No.	%	No.	%	No.	%
Unavailability of seeds	31	35	26	37.1	5	26.3
High seed prices	49	55	39	55.7	10	52.6
Poor seed quality	9	10	5	7.1	4	21.1
Total	**89**	**100**	**70**	**100**	**19**	**100**

However, more than 11% of farmers mentioned that diarrhea and sheep pox infects their herds (Table 36).

4.6.2. Constraints to plant production

The constraints to plant production are separated into two aspects. The first aspect is related to seed constraints, whereas the second aspect is related to the constraints of not utilizing the whole land area. Seed constraints mainly relate to difficulties in obtaining and high prices of seeds, as indicated by 35% and 55% of farmers, respectively. Meanwhile, about 10% of the farmers mentioned that poor seed quality is another constraint to plant production (Table 37). On the other hand, constraints related to not utilizing the whole land area are mainly due to capital shortages and unfeasible production, as indicated by 36% and 32% of respondent farmers, respectively (Table 38).

4.6.3. Constraints related to water harvesting

Water harvesting is considered to be a management technique for collecting, storing and distributing rainwater for any productive use. In general, water harvesting can make water available in regions where other sources are too distant or too costly, such as the communities of our project. This makes water harvesting suitable for supplying water to small villages, households, livestock and agriculture. However, water-harvesting techniques are not implemented widely in the communities' area for many reasons - mainly due to capital shortage and the techniques being considered to be useless, as indicated by 40% and 30% of farmers, respectively (Table 39). The constraints

Table 38: Reasons for not planting the whole land area.

Reason	Whole sample		Muhareb		Um Al Naám	
	No.	%	No.	%	No.	%
Capital shortage	42	35.9	31	39.7	11	28.9
No experience	13	11	9	11.5	4	10.5
Long distance from home	2	1.7	-	-	2	5.3
Unavailable working labor	2	1.7	1	1.3	1	2.6
Unfeasible production	38	32.5	27	34.6	11	28.9
Do not want to plant whole farm	6	5.1	1	1.3	5	13.2
Unsuitable for planting	9	7.7	5	6.4	4	10.5
Shared land	3	2.6	3	3.8	-	-
Low rainfall	1	0.9	1	1.3	-	-
Total	**116**	**100**	**78**	**100**	**38**	**100**

Table 39: Exposed to water harvesting but not adopting it.

Reason	Whole sample		Muhareb		Um Al Naám	
	No. of farmers	%	No. of farmers	%	No. of farmers	%
Low rainfall	1	4	-	-	1	10
Lack of time	3	12	1	6.7	2	20
High costs	3	12	2	13.3	1	10
Capital shortage	10	40	7	46.7	3	30
Useless techniques	8	32	5	33.3	3	30
Total	**25**	**100**	**15**	**100**	**10**	**100**

for wide adoption of water-harvesting techniques in the communities' area are mainly due to lack of knowledge about water-harvesting techniquses, low income of farmers and capital shortage, as indicated by 26%, 20% and 19%, respectively, of the respondent farmers (Table 40).

There is a need for the project team to promote more awareness to the community members about water harvesting and ways of implementing the techniques in order to enhance the participation of community members for success of the project activities.

4.7. Opportunities

4.7.1. Water sources in targeted communities

The main source of water in the Badia is rainfall, as indicated by more than 60% of the respondent farmers. Nearly 16% of farmers use water cisterns as another source of water and more than 8% of farmers depend on water authorities and collective wells as other sources of water in targeted areas (Table 41).

As rainfall is the main source of water in the communities' area, there is a need to collect and store rainfall water until it is used beneficially by using water-harvesting techniques.

4.7.2. Exposure to water-harvesting techniques

Water harvesting has become the main priority in the low rainfall areas of Jordan due to a high increase in population growth and limited water resources. However, in the communities' area, nearly 28% of respondent

Table 40: Constraints for wide adoption of water-harvesting techniques.

Constraints	Whole sample		Muhareb		Um Al Naám	
	No. of farmers	%	No. of farmers	%	No. of farmers	%
Lack of knowledge about water-harvesting techniques	57	26.3	28	26.2	29	26.4
Capital shortage	42	19.4	34	31.8	8	7.3
No experience	32	14.7	10	9.3	22	20
Long distance from home	2	0.9	-	-	2	1.8
Low income	43	19.8	29	27.1	14	12.7
Unavailable working labor	9	4.1	5	4.7	4	3.6
Do not care	14	6.5	1	0.9	14	12.7
Unsuitable for planting	5	2.3	-	-	4	3.6
Multi-ownership of land	10	4.6	-	-	10	9.1
Low rainfall	3	1.4	-	-	3	2.7
Total	**217**	**100**	**107**	**100**	**110**	**100**

Table 41: Water sources for irrigation (%).

Water sources	Whole sample	Muhareb	Um-Al-Naám
Rainfall	68.2	65.2	70.6
Collective well	7.3	10.6	4.7
Water authority	8.6	4.5	11.8
Water cisterns	15.9	19.7	12.9
Total	**100**	**100**	**100**

farmers indicated that they have heard about water harvesting. The type of water-harvesting techniques that farmers use are dams, collective wells and contour ridges, as indicated by 47%, 26% and 11% of the respondent farmers (Table 42). The respondent farmers indicated that there are water-harvesting techniques present in the communities' area but that these are not functioning – such as collective wells, ancient collective pools and Artesian wells.

4.7.3. Willingness to cooperate in project activities

The willingness to cooperate in conducting project activities by local communities is integral and a conceptual part of this project. The respondent farmers showed a strong willingness to participate in implementing project activities, as indicated by more than 70% of farmers. In addition, more than 70% of farmers showed an interest in implementing the project activities on their own land. Furthermore, about 76% of farmers are interested in participating in a cooperative to manage water (Table 43).

4.7.4. Land improvement practices on farmers' fields

Land improvement practices on farmers' fields are mainly practices related to stone and rock removal; protection from water and wind erosion; collecting pools, terraces and planting trees as fences, as indicated by 86%, 83%

Table 42: Exposure to water-harvesting techniques used by farmers.

Water-harvesting techniques	Whole sample		Muhareb		Um Al Naám	
	No.	%	No.	%	No.	%
Dams	9	47.4	7	53.8	2	33.3
Terraces around trees	2	10.5	1	7.7	1	16.7
Contour ridges	2	10.5	1	7.7	1	16.7
Collective wells	5	26.3	3	23.1	2	33.3
All of the above	1	5.3	1	7.7		
Total	19	100	13	100	6	100
Water-harvesting techniques (not necessarily functioning)						
1. Collective wells	52	75.4	38	73.1	14	82.4
2. Ancient collective wells	8	11.6	8	15.4	0	0
3. Collective pools	5	7.2	2	3.8	3	17.6
4. Artesian wells	4	5.8	4	7.7	0	0
Total	69	100	52	100	17	100

Table 43: Farmers' willingness to participate in project activities.

Activity	Whole sample		Muhareb		Um Al Naám	
	No.	%	No.	%	No.	%
Desire to participate in project activities	96	77.4	39	75	57	79.2
Participation in implementing project activities on farmers' land	89	71.8	33	63.5	56	77.8
Interest in participating in a cooperative to manage water	97	76.4	41	75.9	56	76.7
Land improvement works	14	10.8	10	18.5	4	5.3

Table 44: Land improvement practices on farmers' fields.

Land improvements	Whole sample		Muhareb community		Um Al Naám community	
	No. of farmers	%	No. of farmer	%	No. of farmers	%
Average treated land area (du)	22		20		23	
Improving field fertility	2	66.7	-	-	2	66.7
Protection from water and wind erosion	5	83.3	2	100	3	75
Stone and rock removal	6	85.7	3	100	3	75
Water passages	3	75	1	100	2	66.7
Collecting pools	2	66.7	-	-	2	66.7
Terraces	2	66.7	-	-	2	66.7
Planting trees as fences	1	50	-	-	1	50
Planting forage	1	50		-	1	50
Collective wells	3	100	3	100	-	-
Water dams	1	100	1	100	-	-

and 67% of farmers, respectively, with an average land area of 2.2 ha. Meanwhile, few farmers use the mentioned practices (Table 44). The authorities responsible for applying these improvements are farmers themselves (43%), the Canadian project (29%) and the Ministry of Agriculture (21%), as shown in Table 45. About 55% of farmers showed an interest in using land improvement practices on their land, with an average area of 4.8 ha.

Table 45: Authorities responsible for land improvements.

Institution helped	No.	%
Ministry of Agriculture	3	21.4
Personal (farmer)	6	42.9
Canadian project	4	28.6
Ministry of Housing	1	7.1
Total	**14**	**100**

4.7.5. Land value and water-harvesting techniques

Land rental prices changed slightly over the last 10 years; the average rental price for good land in 1994 was 2.15 JD du^{-1}, which increased to 2.47 JD du^{-1} in 2004 – the same slight increase was for very good and poor land (Table 46).

4.7.6. Relationship between water-harvesting techniques and land value

The effect of water-harvesting techniques on land value is reflected through the rental prices of good, very good and poor land of farmers who apply water-harvesting techniques and others that do not apply such techniques. As shown in Table 47, the rental prices of good, very good and poor land are higher when water-harvesting techniques are

Table 46: Land values 1994 and 1999.

Year	Good land		Very good land		Poor land	
	No. of farmers	Price	No. of farmers	Price	No. of farmers	Price
		(JD du^{-1})		(JD du^{-1})		(JD du^{-1})
1994	46	2.15	49	2.37	45	2.12
2004	48	2.47	51	3	46	2.45

Table 47: Effect of water harvesting on land value.

Using water harvesting	Good land, 2004		Very good land, 2004		Poor land, 2004	
	Price (JD du^{-1})	No.	Price (JD du^{-1})	No.	Price (JD du^{-1})	No.
Yes	2.8	15	3.27	15	2.7	15
No	2.33	29	2.95	31	2.35	27
Total	**2.49**	**44**	**3.05**	**46**	**2.48**	**42**

used. The percentage increase in rental price due to investment in water harvesting was about 20%, 11% and 15% for good, very good and poor land, respectively. This implies that investment in water harvesting increases the value of the land, which encourages farmers to use this technology.

4.8. Livestock Watering

4.8.1. Water sources for livestock

The main water sources for livestock in the community, catchment and Badia areas are water cisterns and water authorities, as indicated by 52% and 17% of respondent farmers, respectively. Most farmers use both cisterns and water authorities as their main source of water (Table 48).

4.8.2. Water quantity consumed and sources for livestock

The quantity of water consumed varies according to seasonal conditions; the water demands during the summer increase the average quantity consumed – 80.77 m^3 from cisterns, which constitutes more than 90% from all water sources. This decreases to 43.95 m^3 during the winter (Tables 49, 49.1 and 49.2).

4.8.3. Average cost and average prices of livestock watering

The average cost of watering livestock JD per head varies between seasons and according to water source. It was nearly 0.49 JD/head yr^{-1} during the winter, increasing to 0.85 JD/head yr^{-1} during the summer. The average water cost per head per year from all water sources is estimated at 2.45 JD/head yr^{-1} (Tables 50, 50.1 and 50.2).

4.8.4. Average flock size and water quantity consumed

The average flock size for small, medium and large flock categories is about 32, 275 and 949 head, respectively. The average quantity of water consumed decreases as flock size increases – about 2.2, 1.88 and 1.99 m^3/head yr^{-1}, respectively, for small, medium and large flocks, with an overall average quantity consumed of 2.16 m^3/head yr^{-1} (Tables 51, 51.1 and 51.2).

Approximately 60% of farmers own a small flock size, with a higher average water cost per head compared with other flock categories (estimated at 2.26 JD/head yr^{-1}), so they are operating at the upper part of the curve of economies of scale.

4.8.5. Production systems and average water cost

The water cost (JD per head of livestock watering) was estimated for each flock group (small, medium and large) and according to the production system

Table 48: Water sources for livestock in rangeland areas.

Water sources	Within community area		Within catchment area		Badia area	
	Freq.	%	Freq.	%	Freq.	%
Authority	12	17.4	1	3.2	-	-
Cistern	36	52.2	24	77.4	10	83.3
Both (authority and cistern)	15	21.7	2	6.5	2	16.7
Collective well	6	8.7	4	12.9	-	-
Total	**69**	**100**	**31**	**100.0**	**12**	**100**

Table 49: Water quantity consumed and water sources for livestock in the whole sample.

Season	Collecting-wells		Cisterns		Water authority	
	Av. quantity (m^3/flock/ season)	% of total quantity season	Av. quantity (m^3/flock/ season)	% of total quantity season	Av. quantity (m^3/flock/ season)	% of total quantity season
Winter	4.78	8.04	43.95	73.33	11.06	18.63
Spring	3.39	4.8	61.17	86.3	6.34	8.9
Summer	0	0	80.77	90.3	8.66	9.7
Autumn	0	0	46.8	82.7	9.66	17.3
Average	2.04	3.21	58.77	83.16	8.93	13.63

Table 49.1: Water quantity consumed and water sources for livestock in Muhareb community.

Season	Collecting-wells		Cisterns		Water authority	
	Av. quantity (m^3/flock/ season)	% of total quantity season	Av. quantity (m^3/flock/ season)	% of total quantity season	Av. quantity (m^3/flock/ season)	% of total quantity season
Winter	9.56	14.1	57.7	85.1	0.51	0.8
Spring	7	9.1	69.97	90.8	0.35	0
Summer	0	0	98.3	99.9	0.58	0.1
Autumn	0	0	48.8	100	0	0
Average	5.8	5.8	68.69	94	0.36	0.2

Table 49.2: Water quantity consumed and water sources for slivestock in the Um Al Naám community.

Season	Collecting-wells		Cisterns		Water authority	
	Av. quantity (m^3/flock/ season)	% of total quantity season	Av. quantity (m^3/flock/ season)	% of total quantity season	Av. quantity (m^3/flock/ season)	% of total quantity season
Winter	0.3	0.6	30.27	58.8	20.9	40.6
Spring	0	0	52.95	81.6	11.94	18.4
Summer	0	0	64.35	79.9	16.2	20.1
Autumn	0	0	44.94	70.2	18.68	29.8
Average	0.08	0.2	48.13	72.6	16.93	27.2

Table 50: Water cost and prices for the whole sample.

Season	Collecting-wells			Cisterns			Water authority			All sources
	Av. total cost (JD/ flock/season)	Av. price (JD/m³)	Cost (JD/ head/ Season)	Av. total cost (JD/ flock/season)	Av. price (JD/m³)	Cost (JD/head/ Season)	Av. total cost (JD/ flock/season)	Av. price (JD/m³)	Cost (JD/head/ Season)	Total cost (JD/head/ yr)
Winter	6.57	1.17	0.0474	47.77	1.19	0.315	10.2	0.89	0.1297	**0.4921**
Spring	5.32	13	0.0247	71.2	1.17	0.4792	6.12	1.03	0.1152	**0.6191**
Summer	0	0	0	109.76	1.28	0.6297	12.52	1.4	0.2265	**0.8562**
Autumn	0	0	0	46.3	0.99	0.3873	6.52	0.68	0.0918	**0.4791**
Average	**11.89**	**0.62**	**0.0721**	**86.76**	**1.16**	**1.8112**	**8.84**	**1**	**0.5632**	**2.4465**

Table 50.1: Water cost and prices in the Muhareb community.

Season	Collecting-wells			Cisterns			Water authority			All sources
	Av. total cost (JD/ flock/season)	Av. price (JD/m³)	Cost (JD/ head/ Season)	Av. total cost (JD/ flock/season)	Av. price (JD/m³)	Cost (JD/head/ Season)	Av. total cost (JD/ flock/season)	Av. price (JD/m³)	Cost (JD/head/ Season)	Total cost (JD/head/ yr)
Winter	13.18	1.17	0.085	54.2	1.18	0.4256	0.43	0.75	0.0089	**0.5195**
Spring	11	1.3	0.051	73	1.2	0.541	0.34	1	0.0035	**0.5955**
Summer	0	0	0	119.1	1.23	0.7003	0.47	0.75	0.0112	**0.7115**
Autumn	0	0	0	36.38	1	0.4462	0	0	0	**0.4462**
Average	**12.09**	**1.24**	**0.136**	**70.67**	**1.15**	**2.1131**	**0.41**	**0.83**	**0.236**	**2.2727**

Table 50.2: Water cost and prices in the Um Al Naám community.

Season	Collecting-wells			Cisterns			Water authority			All sources
	Av. total cost (JD/ flock/season)	Av. price (JD/m³)	Cost (JD/ head/ Season)	Av. total cost (JD/ flock/season)	Av. price (JD/m³)	Cost (JD/head/ Season)	Av. total cost (JD/ flock/season)	Av. price (JD/m³)	Cost (JD/head/ Season)	Total cost (JD/head/ yr)
Winter	0.37	1.2	0.0122	41.75	1.21	0.2107	19.37	0.89	0.2426	0.4655
Spring	0	0	0	69.53	1.13	0.4215	11.63	1	0.222	0.6435
Summer	0	0	0	101	1.35	0.5638	23.78	1.46	0.4277	0.9915
Autumn	0	0	0	55.57	0.98	0.3323	12.61	0.68	0.1775	0.5098
Average	**0.37**	**1.2**	**0.0122**	**66.96**	**1.17**	**1.5283**	**16.848**	**1.01**	**1.0698**	**2.6103**

Table 51: Average flock size, quantity and cost of water consumed for the whole sample.

Flock size	Av. flock size (head)	Av. quantity consumed (m^3/head yr^{-1})	% of total quantity	Av. cost (JD/head yr^{-1})	% of total farmers
<100 head	32	2.29	73	2.26	67.4
100-500 head	276	1.88	22.7	2.12	28.1
>500 head	949	1.99	4.3	1.9	4.5
Total	**142**	**2.16**	**100**	**2.1**	**100**

Table 51.1: Average flock size, and quantity and cost of water consumed in the Muhareb community.

Flock size	Av. flock size (head)	Av. quantity consumed (m^3/head yr^{-1})	% of total quantity	Av. cost (JD/head yr^{-1})	% of total farmers
<100 head	28	1.99	66.7	2.37	62.8
100-500 head	293	1.76	26.2	2.14	30.2
>500 head	752	1.9	7.1	1	7
Total	**159**	**1.9**	**100**	**2.23**	**100**

Table 51.2: Average flock size, and quantity and cost of water consumed in the Um Al Naám community.

Flock size	Av. flock size (head)	Av. quantity consumed (m^3/head yr^{-1})	% of total quantity	Av. cost (JD/head yr^{-1})	% of total farmers
<100 head	36	2.55	77.9	2.83	71.7
100-500 head	256	1.9	20	2.1	26.1
>500 head	1540	2.27	2.1	3.7	2.2
Total	**126**	**2.36**	**100**	**2.67**	**100**

(intensive, semi-intensive and nomadic). Small flock size and intensive production systems have the highest water cost per head of all flock groups and production systems. A cost of 2.83 JD/head for the intensive production system decreases to about 2.1 JD/head for the nomadic system for small-sized flocks (<100 head); it is estimated that a cost of 2.23 JD/head for the intensive production system decreases to 1.94 JD/head for a medium-sized flock (100-500 head) at the whole sample level. The same is applicable at each community level (Tables 52, 52.1 and 52.2).

4.9. Feed Cost

4.9.1. Feed sources and feed costs

The animal production sector in Jordan is characterized by a shortage of locally produced feedstuffs derived from rangelands, forage plants and by-products. This is exacerbated by insufficient rainfall, overgrazing, early grazing and a high stocking rate.

The common available sources of feed for sheep in Jordan are rangeland shrubs and grasses, cereal stubble, imported barley, wheat bran, veg-

Table 52: Livestock production system and water costs of livestock watering for the whole sample.

Flock categories	Production system	Av. flock size (head)	Water cost (JD/head yr^{-1})	% of total water quantity	% of total farmers
<100 head	Intensive	9	2.83	0.4	5.6
	Semi-intensive	34	2.64	13.8	57.3
	Nomadic	35	2.1	1.1	4.5
100 500 head	Intensive	300	2.23	2.4	1.1
	Semi-intensive	251	2.22	29.8	16.9
	Nomadic	314	1.94	22.4	10.1
>500 head	Intensive	0	0	0	0
	Semi-intensive	104	2.43	24.9	3.4
	Nomadic	650	0.86	5.2	1.1
Total	**Intensive**	**58**	**2.73**	**2.7**	**6.7**
	Semi-intensive	**125**	**2.54**	**68.6**	**77.5**
	Nomadic	**259**	**1.9**	**28.7**	**15.7**

Table 52.1: Livestock production system and water costs of livestock watering in the Muhareb community.

Flock categories	Production system	Av. flock size (head)	Water cost (JD/head yr^{-1})	% of total water quantity	% of total farmers
<100 head	Intensive	10	2.64	0.6	9.3
	Semi-intensive	31	2.3	9.7	48.8
	Nomadic	27	2.5	0.8	4.7
100 500 head	Intensive	300	2.22	4.4	2.3
	Semi-intensive	209	2.42	12.2	9.3
	Nomadic	335	1.97	39.3	18.6
>500 head	Intensive	0	0	0	0
	Semi-intensive	803	1.14	23.5	4.7
	Nomadic	650	0.86	9.5	2.3
Total	Intensive	68	2.56	5	11.6
	Semi-intensive	115	2.28	45.4	62.8
	Nomadic	308	1.97	49.6	25.6

etable residues and agricultural by-products. The number of grazing days on natural herbs in the communities' area ranges from 33 in a drought year to about 82 days in a good year, whereas grazing on planted barley and crop residues ranges from 33 days in a drought year to 88 days in a good year (Table 53). Usually, farmers supplement their flocks with barley, barley and wheat bran, straw and barley, but very few farmers add minerals, salts and vitamins or try to offer complete rations.

Table 52.2: Livestock production system and water costs of livestock watering in the Um Al Naám community.

Flock categories	Production system	Av. flock size (head)	Water cost (JD/head yr^{-1})	% of total water quantity	% of total farmers
<100 head	Intensive	5	3.6	1	2.2
	Semi-intensive	36	2.88	18.7	65.2
	Nomadic	43	1.66	1.5	4.3
100-500 head	Intensive	0	0	0	0
	Semi-intensive	266	2.14	50.5	23.9
	Nomadic	150	1.77	2.6	2.2
>500 head	Intensive	0	0	0	0
	Semi-intensive	1540	3.7	26.6	2.2
	Nomadic	0	0	0	0
Total	Intensive	5	3.6	0.1	2.2
	Semi-intensive	132	2.7	95.8	91.3
	Nomadic	79	1.7	4.1	6.5

Table 53: Feeding sources for grazing.

	Drought year		Normal year		Good year	
	No. of days	%	No. of days	%	No. of days	%
Grazing days	80	21.9	108	29.6	141	38.6
Grazing on natural herbs	33	41.25	57	52.78	82	58.16
Grazing on planted barley	38	47.5	56	51.85	88	62.41
Grazing on crop residues	31	38.75	56	51.85	85	60.28

Table 54: Feeding sources of rangelands.

	Sources		Rental prices
	Within community borders	Outside community borders	(JD)
Rangelands (months)	6	8	2.5
Barley planted in rangelands	3.3	4.5	2.33

Most farmers keep their flocks in the communities' area between August and February (7 months). From November to June (8 months), flocks are moved towards the steppe area (outside the community area). More than 80% of farmers stay in the steppe area during March and April, and they stay in the stubble and barley crop residues areas during June and July; the price of renting a barley field is 2.33 JD du^{-1} (Table 54).

As described previously, small ruminants in Jordan depend mainly on rangeland and cereal stubble grazing as their major feed sources. However, farmers usually supply their sheep with barley grain and wheat bran as supplemental feed, but

with insufficient quantities due to the high costs. Cereal straw is an important source for winter feeding. Tables 55, 55.1 and 55.2 show that the quantities produced and purchased, and the prices of feed stuff components, and it is obvious that farmers depend on purchasing the needed quantities rather than on their own production.

The feed at the selected communities' area consists mainly of barley, barley bran and straw. The total cost of barley grain for a whole sample was 1,158 JD, which is 63% of the total feed cost. The cost of barley bran is about 368 JD, which is about 20% of the cost of the total feed stuff, followed by barley straw, which is about 16% of the total cost (total cost: 289 JD) (Table 55).

Most farmers practice hand feeding of cereal, straw and concentrates throughout the year, except during May and June when they are dependent on stubble grazing and grazing on planted barley. In a good year, this might extend to August. However, in drought years, the duration becomes shorter, as shown in Tables 56 and 57.

4.10. Baseline Information

In line of the proposed interventions by the project, a number of relevant performance indicators were specified (Table 58) in collaboration with biophysical scientists involved in the project implementation. As these performance indicators will be estimated at the end of the project to assess the impact, baseline information needs to be established. This was done by using farm survey data.

Table 55: Feed resources for the whole sample.

Feed stuff	Production	Purchased	Prices (JD)	Cost (JD)	% from total cost
Barley grain (t)	6	13.8	83.9	1157.82	51
Wheat bran (t)	2.7	5.5	66.9	367.95	16
Straw (t)	13.9	4.9	58.9	288.61	13
Crop residues	6.5		70	455	20
Total				2269.38	100

Table 55.1: Feed resources in the Muhareb community.

Feed stuff	Production	Purchased	Prices (JD)	Cost (JD)	% from total cost
Barley grain (t)	7.9	17.4	83.9	1459.86	67
Wheat bran (t)		7.6	66	501.6	23
Straw (t)	25	3.6	61	219.6	10
Crop residues		-	50	0	0
Total				2181.06	100

Table 55.2: Feed resources in Um Al Naám community.

Feed stuff	Production	Purchased	Prices (JD)	Cost (JD)	% from total cost
Barley grain (t)	6.1	9.7	83	805.1	41
Wheat bran (t)	2.8	2.9	68	197.2	10
Straw (t)	13	6.5	56	364	19
Crop residues	6.5	-	90	585	30
Total				1951.3	100

Table 56: Months for grazing on natural herbs, planted barley and crop residues during a drought year.

Grazing	Drought year													
	Jan+Feb		Mar+Apr		May+Jun		July+Aug		Sep+Oct		Nov+Dec		All year	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Grazing months during season	17	12.7	22	16.4	10	7.5	5	3.7	4	3	1	0.7	3	2.2
Grazing on natural herbs	14	10.4	8	6	-	-	-	-	-	-	-	-	-	-
Grazing on planted barley	2	1.5	16	11.9	29	21.6	5	3.7	-	-	-	-	-	-
Grazing on crop residues	-	-	1	0.7	19	14.2	11	8.2	-	-	-	-	-	-

Table 57: Months for grazing on natural herbs, planted barley and crop residues during a good year.

Grazing	Good year													
	Jan+Feb		Mar+Apr		May+Jun		July+Aug		Sep+Oct		Nov+Dec		All year	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Grazing months during season	22	16.4	38	28.4	36	26.9	24	17.9	15	11.2	3	2.2	4	3
Grazing on natural herbs	19	14.2	30	22.4	14	10.4	3	2.2	1	0.7	-	-	-	-
Grazing on planted barley	2	1.5	18	13.4	45	33.6	27	20.1	7	5.2	-	-	-	-
Grazing on crop residues	-	-	2	1.5	34	25.4	39	29.1	16	11.9	-	-	-	-

Table 58: List of applied interventions on the farmers' field: expected outputs and indicators (indicators that are presented in the communities' characterization survey).

Interventions	Outputs	Indicators
1. Contour ridges 2. Contour ridges with fodder shrubs (one site) 3. Contour ridges with barley (one site) 4. Contour strips with barley (two sites)	Productivity-enhancing • Water quantity • Barley production	• Yield (kg du^{-1}) • GM (JD dus^{-1}) • Feeding cost (JD/head) • Livestock watering (JD US$/head) • WP (kg m^{-3})

4.10.1. Baseline indicators that were calculated from the survey

Yield. The average yield of crops varies according to seasonal conditions; the highest yield obtained for barley grain was estimated at 140 kg du^{-1} in a good year and drops to about 40 kg du^{-1} during a drought year. Although the average yield of wheat production is nearly 150 kg du^{-1} in a good year, it drops to about 15 kg du^{-1} in a drought year and usually, during severe drought, no grain production is obtained (Tables 59 and 59.1).

Table 59: Average yield of crops (kg du^{-1}) for the whole sample.

Crop	Normal year		Good year		Drought year	
	Grain	Straw	Grain	Straw	Grain	Straw
Barley	73	140	140	208.3	40.5	66.3
Olives	211	-	367.9	-	65.1	-
Wheat	91.1	135	149.6	150.6	15	24

Table 59.1: Average yield of crops (kg du^{-1}) in the Muhareb and Um Al Naám communities.

Crop	Normal year		Good year		Drought year	
	Grain	Straw	Grain	Straw	Grain	Straw
Muhareb community						
Barley	58.6	122	126.9	130.4	39	47.5
Olives	307.8	-	618.7	-	109.2	-
Wheat	-	-	200	75	16	24
Um Al Naám community						
Barley	79.8	146	148.5	245	41	71
Olives	141	-	179.8	-	49	-
Wheat	91.1	135	137	160	14	-

Table 60: Net return (JD du^{-1}) of crops planted in the whole sample.

Crop	Total return	Total costs	Net return
Wheat	24.85	9.4	15.45
Barley	17.88	9.63	8.25

Table 60.1: Net return (JD du^{-1}) of crops planted in the Muhareb and Um Al Naám communities.

Crop	Total return	Total costs	Net return
Muhareb community			
Wheat	8.94	7.98	0.96
Barley	14.462	5.69	8.77
Um Al Naám community			
Wheat	24.63	9.16	15.47
Barley	19	11	8

Net return. The net return of barley and wheat was estimated from the data of the farm survey: it was estimated that 15 JD du^{-1} of wheat and about 8 JD du^{-1} of barley could be obtained for the whole sample. The net return of wheat was estimated at less than 1 JD du^{-1} for the Muhareb community, in which wheat is not suitable for planting, especially during the drought years (Tables 60 and 60.1).

Feeding cost (Feed gap). The feeding cost per head of flocks was estimated at 27.8 JD per head yearly for the whole sample and increases to about 31 JD/head in the Um Al Naám community (Tables 61, 61.1 and 61.2). The total feed consumption per head per year was estimated at 301 kg, whereas the feed gap is nearly 244 kg per head per year (the feed gap is the difference between feed consumption and farm production). In addition, as farm production increases, the feed gap

Table 61: Feed stuff components and costs for the whole sample.

Feed stuff	On-farm Production (t)	Purchased (t)	Prices (JD/t)	Total Cost (JD)	Av. flock size	Costs (JD/head)	Total feed consumption (kg/head/ yr)	Feed gap (kg/head/ yr)
Barley grain	2	12.4	80.3	1276		19.67	177.2	167.23
Wheat bran		4.6	67.1	310.3		2.9	44.56	44.56
Straw	3.17	1.56	59	326.6	142	5.1	78.27	32.67

The total feed consumption equals the on-farm production plus the purchased feed.
The feed gap equals the feed consumption minus the on-farm production.

Table 61.1: Feed stuff components in the Muhareb community.

Feed stuff	On-farm Production (t)	Purchased (t)	Prices (JD/t)	Total Cost (JD)	Av. flock size	Costs (JD/head)	Total feed consumption (kg/head/ yr)	Feed gap (kg/head/ yr)
Barley grain	0.2	17.4	83.9	1412		17.3	129.9	206.07
Wheat bran	-	7.19	66	483.2		3.1	47.94	47.94
Straw	0.66	1.3	61	120	**159**	3.7	65.11	55.71

The total feed consumption equals the on-farm production plus the purchased feed.
The feed gap equals the feed consumption minus the on-farm production.

Table 61.2: Feed stuff components in the Um Al Naám community.

Feed stuff	On-farm Production (t)	Purchased (t)	Prices (JD/t)	Total Cost (JD)	Av. flock size	Costs (JD/head)	Total feed consumption (kg/head/ yr)	Feed gap (kg/head/ yr)
Barley grain	4.64	7.78	76.4	1147.4		22	223.3	130.34
Wheat bran	-	2.2	68.46	150		2.7	41.35	41.35
Straw	5.49	1.75	56	518	126	6.4	90.7	10.7

The total feed consumption equals the on-farm production plus the purchased feed.
The feed gap equals the feed consumption minus the on-farm production.

decreases, which reflects an improvement in farmers' livelihoods.

Total income and per capita income. The poverty line is the level of income below which an individual cannot afford to purchase all the resources that they require to live. The World Bank has defined the international poverty line as US$ 1 and US$ 2 per day in 1993 Purchasing Power Parity. The average per capita income was measured for the respondent farmers in the selected communities and it was estimated at US$ 0.67 day^{-1}. Nearly 78% of farmers have an average per capita

income of less than US$ 1, thus are considered to be below the poverty line (Table 62). However, about 82% of farmers have an average on-farm income that is estimated at US$ 0.45 per capita per day. Meanwhile, 58% of farmers have an average off-farm income that is estimated at US$ 1 per capita per day. This indicated that farmers who depend on on-farm income as their major source of income are poorer than other farmers for whom off-farm income is their major source of income (Tables 62.1, 62.2, 62.3).

Food and feed security. Food security for the whole sample is estimated at 232.8 kg/capita yr^{-1}; this is calculated by dividing the total quantity of wheat produced (2095.3 kg yr^{-1}) by the average number of community members (9). This was not calculated for the Muhareb community because there was no wheat production. However, it was about 222.44 kg/capita yr^{-1} for the Um Al Naám community; the total wheat production was 2002 kg yr^{-1} (Table 63).

The feed security is estimated at 269.36 kg/head yr^{-1}. for the whole sample and was calculated by dividing the total production of barley (grain and straw) by the total number of flocks; feed

Table 62: Total income and per capita income.

Community	Muhareb	Um Al Naám	Whole sample
Average annual income (JD)/farm			
1. Plant production			
1. Selling crop production	240	720.56	704
2. Selling olive production	0	942.69	942.69
Plant production (1+2)	240	1663.25	1646.69
Off-farm income (labor wage outside agriculture)	7110	5798	6026
Total income (plant production and off-farm income)	7350	8403.94	8615.38
2. Livestock production			
Selling livestock products	4220.1	2703.1	3727
Off-farm income (labor wage outside agriculture)	7110	5798	6026
Total income (livestock production and off-farm income)	11330.1	8501.1	9753
• Average number of family members	8	9	9
• Average per capita income (JD day 1)	1 .93	1.04	1.37
• Average per capita income (US$ day 1)	2.7	1.46	1.92

Table 62.1: Average per capita income per day in each income category (US$).

Income categories	Average per capita income day^{-1} (US$)	No. of farmers	% of total farmers
Less than US$ 2	0.61	59	72.8
Between US$ 2.1 and US$ 5	3.3	14	17.3
More than US$ 5	9.1	8	9.9
Total	**1.92**	**81**	**100**

Table 62.2: Average per capita income per day in each income category at the community level (US$).

Income categories	Average per capita income day^{-1} (US$)	No. of farmers	% of total farmers
Um Al Naám community			
<US$ 2	0.67	40	78.4
US$ 2.1-5	3.53	9	17.7
>US$ 5	7.89	2	3.9
Total	1.46	51	100
Muhareb community			
<US$ 2	0.5	19	63.3
US$ 2.1-5	2.92	5	16.7
>US$ 5	9.47	6	20
Total	2.7	30	100

Table 62.3: Average per capita on-farm and off-farm income per day in each income category for the whole sample (US$).

Income categories	Off-farm			On-farm		
	Av. per capita income day^{-1} (US$)	No. of farmers	% of total farmers	Av. per capita income day^{-1} (US$)	No. of farmers	% of total farmers
<US$ 2	1.09	7	58.3	0.45	48	82.8
US$ 2.1-5	3	5	41.7	2.99	5	8.6
>US$ 5	0	0	0	10.7	5	8.6
Total	**1.92**	**12**	**100**	**1.56**	**58**	**100**

Table 62.4: Average per capita on-farm and off-farm income per day in each income category at the community level (US$).

Income categories	Off-farm			On-farm		
	Av. per capita income day^{-1} (US$)	No. of farmers	% of total farmers	Av. per capita income day^{-1} (US$)	No. of farmers	% of total farmers
Um Al Naám community						
<US$ 2	1.08	6	60	0.44	30	93.8
US$ 2.1-5	3.16	4	40	3.09	1	3.1
>US$ 5				8.85	1	3.1
Total	**1.91**	**10**	**100**	**0.78**	**32**	**100**
Muhareb community						
<US$ 2	1.1	1	50	0.45	18	69.2
US$2.1-5	2.76	1	50	2.96	4	15.4
>US$ 5				11.18	4	15.4
Total	**1.93**	**2**	**100**	**2.52**	**26**	**100**

Table 63: Food and feed security at the community level.

	Muhareb	Um-Al-Naám	Whole sample
Food security (wheat) kg/capita yr^{-1}.	-	222.44	232.8
Feed security (barley) kg/head yr^{-1}	340.5	150.8	269.36

security was about 340.5 kg/head yr^{-1} for the Muhareb community and about 150.8 kg/head for the Um Al Naám community. Table 64 shows details of livestock watering.

Water productivity. Historically, farm productivity was measured in yield du^{-1}, as land was the constraining resource. However, as water is now considered to be a limiting factor for food production, the common measure that is emerging to measure water productivity is kilograms of grain produced per ton of water.

Oweis et al. (2006) define water productivity as the ratio of the physical yield of a crop and the amount of water consumed, including both rainfall and supplemental irrigation. Yield is expressed as a mass (kg or Ton), and the amount of water as a volume (m^3). In the two surveyed communities, water productivity was calculated for wheat and barley and estimated at 0.04 kg/m^3 for barley for the Muhareb community and 0.06 for wheat for the Um Al Naám community. This is compared with about 0.86 kg/m^3 of wheat under irrigation in the Jordan valley, which means that water productivity in the community area is very low (Table 65).

Summary of baseline indicators. Baseline information on related performance indicators were carefully collected and presented in this section. Table 66 summarizes all indicators that were calculated from household survey data, including production, net return, feed costs, feed gap, cost of livestock watering, average annual income, status of food and feed security, and water productivity. Other economic, environmental and social indicators (Table 67) will be developed in cooperation with biophysical scientists and based on the results of on-farm demonstrations.

Table 64: Average total cost of livestock watering and average quantity consumed per year for the whole sample.

Item	Muhareb	Um-Al-Naám	Whole sample
Average total cost of livestock watering (JD/yr/flock)	247.55	354	30.2.04
Average cost of livestock watering (JD/head yr^{-1})	2.27	2.61	2.45
Average total quantity consumed)(m^3/yr/flock	280.18	270.4	275.18
Quantity consumed (m^3/head yr^{-1})	1.9	2.38	2.16

Table 65: Water productivity (WP kg/m^3).

Item	Muhareb	Um Al Naám	Whole sample
Yield/crops (kg du^{-1})			
Barley	58.6	79.8	73
Wheat	-	91.1	91.1
Average annual rainfall, mm	152	164	159
WP (kg/m^3)			
Barley	0.039	0.049	0.046
Wheat	-	0.055	0.057

Table 66. List of baseline indicators that were calculated from the community characterization survey.

Indicators		Muhareb	Um Al Naám	Whole sample
Yield (kg du^{-1})	**Barley:**			
	Grain	58.6	79.8	73
	Straw	122	146	140
	Wheat:			
	Grain	-	91.1	91.1
	Straw	-	135	135
Net return (JD du^{-1})				
Barley		8.77	8	8.25
Wheat		0.96	15.47	15.45
Feed cost (JD/head yr^{-1})		24.1	31.1	27.67
Feed gap (kg/head yr^{-1})		309.72	182.39	244.46
Cost of livestock watering (JD/head yr^{-1})		2.27	2.61	2.45
Quantity of water consumed (m^3/head yr^{-1})		1.9	2.38	2.16
Average annual income (JD/farm)				
Total income (plant production and off-farm income)		7350	8403.94	8615.38
Total income (livestock production and off-farm income)		11330.1	8501.1	9753
• Average number of family members		8	9	9
• Average per capita income (JD day^{-1})		1.93	1.04	1.37
• Average per capita income (US$ day^{-1})		2.7	1.46	1.92
Food security (wheat) (kg/capita yr^{-1})		-	222.44	232.8
Feed security (kg/head yr^{-1})		340.5	150.8	269.36
Water productivity (kg/m^3)				
Barley		0.039	0.049	0.046
Wheat		-	0.055	0.057

Table 67: Other baseline information indicators that need to be collected.

Interventions	Outputs	Indicators
1. Contour ridges	Forage biomass	Profitability US$/m^3
2. Contour ridges with fodder shrubs (one site)	Selling water	B/C ratio IRR
3. Contour ridges with income barley (one site)		% increase in family farm
	Environmental outputs	Top soil loss (USLE)
4. Contour strips with barley (two sites)	Biodiversity conserved	Carbon content Organic matter
	Soil erosion	
	Soil fertility	
	Groundwater table level	
	Social outputs	Qualitative description
	Settlement	regarding what has
	Migration	happened before and after
	New labor opportunities	No. of male/female workers

5. Conclusions

A survey of 134 farmers from the Muhareb and-Um-Al Naám communities provided data to characterize livelihoods and production systems and establish baseline information for related performance indicators. The major outcomes of the study are as follows.

- Barley-livestock is the dominant production system. In addition to wheat and olives, the dominant crops were barley, wheat and olives. Nearly 89% of farmers in the Muhareb community plant barley (with an average area of 300 du), whereas average barley area in the Um Al Naám community is only 71 du.

- There are five household assets - natural, social, human, physical and financial capital. For natural capital, the average area owned is estimated at 68 du for the whole sample and 77 du for the Muhareb community. Nearly 90% of the respondent farmers mentioned that they have water sources. These sources are mainly collecting-wells and cisterns. Rainfall is the main source of irrigation in these communities; more than 70% of farmers depend on rainfall for irrigating their crops. Rangeland in the communities' area is degraded, as indicated by 90% of farmers in the Um Al Naám community and 54% of farmers in the Muhareb community. Social capital was severely limited: about 96% of farmers are not members of any kind of cooperative. Regarding human capital, the average number of years of experience in agriculture was about 27 years in the communities' area; the average total number of family members was about 9 individuals. In addition, the average number of family members who work in agriculture and livestock production was about 3 persons in the Muhareb community and 2 persons for the whole sample.

- However, the average number of family members who work outside the farm was 2 persons in the Muhareb community and 3 persons for the whole sample. The illiteracy rate was found to be high in the surveyed farmers: 28% for the whole sample. Physical capital results showed that more than 90% of farmers at the whole sample level have a cement house. The semi-intensive production system is the dominant type of livestock production system, as indicated by 76% of respondent farmers at the whole sample level. Production equipment, such as machinery for plowing and seeding, are mainly rented; only a few farmers own this type of machinery. Financial capital can be in the form of cash, credit, savings or remittances. In the communities' area, nearly 38% of income sources are from off-farm income and 62% is from on-farm income at the whole sample level. In the Muhareb community, 66% of on-farm income is from livestock production and only 8% is from crop and olive production. Meanwhile, in the Um Al Naám community, 25% of on-farm production is from livestock production and about 24% is from crop and plant production. This means that most households in the Muhareb community depend on livestock production for their on-farm production. The cost of production was about 10 and 9 JD du^{-1} for barley and wheat, respectively. Meanwhile, the net return was estimated at 8 and 15 JD du^{-1} for the two crops, respectively. The average wage of laborers per day is 5 JD and credit sources are mainly from private banks and are used mainly for livestock production.

- Nearly 48% of farmers in the Muhareb community own flocks with an average flock size of about 159 head compared with about 52% of farmers in the Um Al Naám community whom own flocks with an average flock size of 125 head. About 63% of farmers in the Muhareb community own a small flock with an average flock size of 28 head, followed by a medium-sized flock (30%) with an average flock size of 293 head. Only 7% of farmers own a large flock with an average flock size of 751 head. However, about 72% of farmers in the Um Al Naám community own a small flock with an average flock size of 36 head. A medium-sized flock is owned by 26% of farmers with an average flock size of 256 head. Only 1% of farmers own a large flock, with an average flock size of 1540 head. Farmers who cultivate larger areas own larger flocks, although this is a small proportion of the farms (4.7%). Farmers who own a small flock are the majority in the selected communities, representing 67.4%; a medium flock size represents nearly 28% of farms. There is a positive relationship between flock size and area cultivated.

- Most households in the communities' area process milk locally into Labaneh, cheese, Jameed and ghee. They make these products for family consumption and marketing of surplus quantities. The selling price ranged between 2.4 JD kg^{-1} for cheese and up to about 6 JD kg^{-1} for Jameed and ghee.

- Farmers hired labor for livestock activities; the average number of hired laborers for grazing, feeding, watering and treatment was 1 laborer. However, the average number of hired laborers for milking was 2 laborers and for wool shearing was 4 laborers. The average wage was about 6 JD day 1 for grazing and feeding, whereas it increases up to 7-8 JD day 1 for wool shearing and milking. Family members are involved in all livestock activities: grazing, feeding, wool shearing and treatment are mainly the responsibility of the household head, with the help of the wife and sons. However, milk processing is the wife's and daughters' responsibility (78%). The wife and the sons are strongly involved in all activities. The percentage share of daughters' participation was the weakest of all other family members in all activities except for milk processing.

- Privately owned and Meeri land tenure were found in the surveyed communities. The overall average farm size is estimated at 122 du for privately owned land and 82 du for Meeri land. Almost all farmers (98%) have privately owned land tenure. Meeri land tenure is operated by only 2% of sample farms. One farmer indicated that his land tenure is of the 'Tribal' type, with an average area of 50 du.

- About 71% of farmers indicated that community rangeland is degraded and 65% of the farmers indicated that the Badia land is degraded. Nearly one-third of the sample farmers indicated that rangeland is severely degraded. For example, nearly 37% of farmers mentioned that rangeland is severely degraded within the catchment area.

- Community rangeland is predominantly managed by livestock owners or shepherds, as indicated by 39% and 33% of the respondents, respectively. Only 5% mentioned that tribal arrangements are used in rangeland management; meanwhile, 4% of the respondents indicated that rangeland

is managed by cooperatives. There are some cases in which public institutions, such as agricultural directorates, are responsible for managing rangeland, as mentioned by 8% of the respondents.

- The native pastures can no longer satisfy such a large proportion of the feed needs of the livestock population. Attempts to meet the widening 'feed gap' have resulted in an expansion of the area planted to barley. The principal livestock feed is achieved primarily through cultivating previously uncultivated marginal land and by replacing the traditional barley fallow rotations with continuous barley cropping. However, farmers think that barley encroachment to marginal land is weak at the community, catchment and Badia levels, as indicated by more than 80% of farmers.

- The major constraints of livestock production are feed shortage and high prices of feed, as indicated by 28% and 26% of respondent farmers, respectively. Nearly 39% of farmers indicated that Enterotoxaemia is the most common animal disease. The constraints of plant production are mainly related to unavailability and high prices of seeds, as indicated by 35% and 55% of farmers, respectively. Meanwhile, about 10% of the farmers mentioned that bad quality of seeds is another constraint of plant production. Constraints related to not utilizing the whole land area are mainly due to capital shortage and unfeasible production, as indicated by 36% and 32% of respondent farmers, respectively.

- Water-harvesting techniques are not widely used, for many reasons mainly capital shortage and techniques being considered to be useless, as indicated by 40% and 30% of farmers, respectively. Constraints for the wide adoption of water-harvesting techniques in the communities' area, as indicated by the farmers, are mainly due to lack of knowledge about water-harvesting techniques, low income of farmers and capital shortage (26%, 20% and 19%, respectively).

- Land improvement practices on farmers' fields are mainly practices related to stone and rock removal; protection from water and wind erosion; collecting pools, terraces and planting trees as fences, as indicated by 86%, 83% and 67% of farmers, respectively, with an average land area of 22 du.

- The effect of water-harvesting techniques on land value is reflected by rental prices of good, very good and poor land of farmers who apply water-harvesting techniques and others that do not apply them. The rental prices of good, very good and poor land are higher when water-harvesting techniques are used. The percentage increase due to investment in water harvesting was about 20%, 11% and 15% for good, very good and poor land, respectively. This implies that water-harvesting investment in the land increases its value, which encourages farmers to use this technology.

- The main water sources for livestock at the community, catchment and Badia level are water cisterns and water authorities, as indicated by 52% and 17% of farmers, respectively. Most farmers use both (cisterns and water authorities) as their main source of water. The average cost of watering livestock (JD per head) varies between seasons and according to water source. It was nearly 0.49 JD per head per year during the winter, increasing to 0.85 JD per head per year during the summer. The average

water cost per head per year from all water sources is estimated at 2.45 JD per head per year.

- The feed in the selected communities' area consists mainly of barley, barley bran and straw. The total cost of barley grain in the Muhareb community was 1460 JD, which constitutes 67% of the total feed cost. The cost of wheat bran is about 502 JD, which is about 23% of the total feed stuff cost, followed by barley straw, which constitutes about 10% of the total cost (total cost: 220 JD). However, the total cost of barley grain in the Um Al Naám community was 805 JD, which constitutes 59% of the total feed cost. The cost of wheat bran is about 197 JD, which is about 14% of the total feed stuff cost. Meanwhile, barley straw constitutes about 27% of the total cost, with a cost of 364 JD.

- Baseline information on related performance indicators were calculated from household survey data, including production, net return, feed cost, feed gap, cost of livestock watering, average annual income, food and feed security, and water productivity.

- The average yield of barley grain in good years is about 140 kg du^{-1}, which decreases to about 40.5 kg du^{-1} in drought years. During drought years, crops are grazed and no grain is produced. The average wheat yield in good years is 149 kg du^{-1}, which drops to about 15 kg du^{-1} in drought years. The net return was estimated at 15 JD du^{-1} of wheat and about 8 JD du^{-1} of barley in the whole sample. The net return of wheat was estimated at less than 1 JD du^{-1} in the Muhareb community,

- The feeding cost of flocks was estimated at 27.8 JD per head per year for the whole sample, increasing to about 31 JD/head for the Um Al Naám community. Total feed consumption per head per year was estimated at 301 kg, with a feed gap (difference between feed consumption and farm production) of nearly 244 kg per head per year. As farm production increases, the feed gap decreases, which reflects an improvement in farmers' livelihoods.

- The average per capita income was measured was estimated at US$ 0.67 per day. Nearly 78% of farmers have per capita income less than US$ 1; these farmers are considered to be below the poverty line. About 82% have an average on-farm income estimated at US$ 0.45 per capita per day. Meanwhile, 58% of farmers have an average off-farm income that is estimated at US$ 1 per capita per day. Thus, farmers who depend on on-farm income as their major source of income are poorer than others for whom off-farm income is their major source.

- Food security for the whole sample is estimated at 232.8 kg/capita yr^{-1}. This was not calculated for the Muhareb community because there was no wheat production. However, it was about 222.44 kg/capita for the Um Al Naám community.

- Feed security is estimated at 269.36 kg/head yr^{-1} for the whole sample, 340.5 kg/head yr^{-1} for the Muhareb community and 150.8 kg/head for the Um Al Naám community.

- Water productivity was estimated at 0.04 kg/m^3 for barley in the Muhareb community and 0.06 for wheat in the Um Al Naám community. This is compared with about 0.86 kg/m^3 of wheat under irrigation in the Jordan valley, which means that water productivity of the community area is very low.

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