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PHASE II

Resource Management Series

Volume 15

RAPID RURAL APPRAISALS

Rainfed Areas of Egypt

Editors
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Volume 15

Resource Management Rapid Rural Appraisals: Rainfed Areas of Egypt

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Foreword

Limited soil and water resources and threatened sustainability of agricultural production call for an effective resource management strategy and farming systems approach in agricultural research. Implementing a long-term research program where more emphasis would be on systems-oriented rather than commodity-oriented agricultural research would represent such a strategy. Therefore, the Resource Management Component of the Nile Valley Regional Program (NVRP) of the International Center for Agricultural Research in the Dry Areas (ICARDA) was developed. The Component, which started in 1994 in one of the Nile Valley countries, Egypt, and is expected to be extended to the others, aims at achieving sustainable production at a high level, based upon the need to protect the resource base (land and water) through good management. This would be achieved through basic intensive technical research (long-term on-station trials) and on-farm extensive monitoring of resources in farmers' fields and farmers' decision making logic.

Preparatory studies were carried out prior to conducting the trials and monitoring activities. The objectives of these studies were to define and characterize the major farming systems of the main agroecological environments; to identify and prioritize—with respect to the natural resources—the constraints to optimum utilization and the threats to sustainable production; and to provide an outline for the strategy, design and implementation of the long-term research activities.

The preparatory studies involved three procedures for information collection: **Inventory Studies**, in which existing information and details of the ongoing research and development, related to soil and water management, agronomy and cropping systems, and socioeconomics were collected; **Rapid Rural Appraisals**, which included qualitative sampling of farmers and extension views concerning current limitations, constraints, dangers, and opportunities in the utilization of soil, water, and inputs; and **Multidisciplinary Surveys**, which employed short-focused questionnaires to fill some important information gaps. In general, information collected in the preparatory studies dealt with resource description, resource utilization and management, productivity, and threats to sustainability. This knowledge was used in planning the long-term research activities at selected locations by identifying high-priority researchable resource management problems, in the context of realistic cropping sequences and farm level economics.

The outcome of these studies is hence presented in what is called the **Resource Management Series**. The series includes a total of 18 volumes on Inventory Studies, Rapid Rural Appraisals, and Multidisciplinary Surveys in the Old Irrigated Lands, New Lands, and Rainfed Areas. In the Inventory Studies, five volumes on the research and development activities and findings in each of the Old and New Lands were compiled. These volumes were on Agronomy, Soil Fertility and Management, Water Management, Socioeconomic Studies, and a Synthesis of all the latter. The Inventory Studies of the Rainfed Areas included two volumes, one on the Northwest Coast and the other on North Sinai.

These studies were conducted in Egypt with the involvement of the Agricultural Research Center (ARC), Desert Research Center (DRC), National Water Research Center (NWRC), National Research Center (NRC), Ain Shams University and ICARDA within the NVRP with financial support from the European Commission. Appreciation is expressed to all those who contributed to these important reviews and studies.

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Weights and Measures

1 feddan (fed) = 0.42 hectare = 1.037 acres

1 hectare (ha) = 2.38 feddans

1 ardab wheat = 150 kg

1 ardab barley = 120 kg

1 kela wheat = 12.5 kg

1 kela barley = 10 kg

1 ardab lentil = 160 kg

Acronyms

ARC = Agricultural Research Center

DM = Dry Matter

EU = European Union

FAO = Food and Agriculture Organization

FCRI = Field Crops Research Institute

GTZ = Gesellschaft für technische Zusammenarbeit (German Agency for Technical Cooperation)

ICARDA = International Center for Agricultural Research in the Dry Areas

ILO = International Labor Organization

JICA = Japan International Cooperation Agency

LE = Egyptian Pound

MALR = Ministry of Agriculture and Land Reclamation

NVRP = Nile Valley Regional Program

NWRC = National Water Research Center

PBDAC = Principal Bank for Development and Agricultural Credit

RRA = Rapid Rural Appraisals

UNDP = United Nations Development Program

UNESCO = United Nations Educational, Scientific and Cultural Organization

USAID = United States Agency for International Development

WFP = World Food Program

Background

Introduction

Egypt has a total land area of one million square kilometers. Only about 3% of the total area (7.5 million feddans/3.2 million ha) is cultivated, resulting in one of the world's lowest per capita levels of agriculturally productive land: 0.13 feddan (0.05 ha) per capita.

Rainfed agriculture in Egypt is carried out on 2–3% of that agricultural land. Although this may not appear significant, it is very important to local communities and economies.

The main constraints to agriculture in Egypt are limited water and land resources, coupled with inefficient management practices. Better management of these resources, especially in the rainfed areas, will contribute to the conservation of natural resources and better sustain the livelihood of local communities.

To date, only a few agricultural research programs have been conducted in the rainfed areas of Egypt. The government program to assist the Bedouins has undertaken efforts towards intensifying production under changing socioeconomic conditions, making better use of surface water and improving management of rangelands with less mobility of livestock. The Agricultural Research Center (ARC), the Egyptian universities, and international organizations such as GTZ, FAO, UNDP and WFP have also carried out projects. But although these projects were useful and added to the general knowledge of the area, they did not include interactive research programs designed to respond to the specific needs of the area. Consequently, there was no effective mechanism to identify priorities or to facilitate regular updating of ongoing research and extension programs. As a result, such research has not met the needs of the rainfed areas.

Objectives

The main objective of the current study was to describe the farm environment and identify problems and constraints in order to plan comprehensive research on resource management systems for the rainfed areas of the Northwest Coast and North Sinai. Solutions to these diverse problems call for evaluation and understanding of both the agro-ecological, social and production systems, and for the rational utilization of resources for sustainable production.

Study Areas

The Rapid Rural Appraisal for rainfed areas was conducted in two locations:

- The Northwest Coast.
- North Sinai.

The Northwest Coast extends about 300 km from Ras El Hekma in the east to El Salloum in the west, and ranges from 30 to 40 km wide (Fig. 1). The area is beyond the reach of Nile water and has no known supplies of usable groundwater. It thus relies exclusively on rainfall for agricultural production. The study area comprises four administrative districts: East Matrouh, West Matrouh, Sidi Barrani and El Salloum.

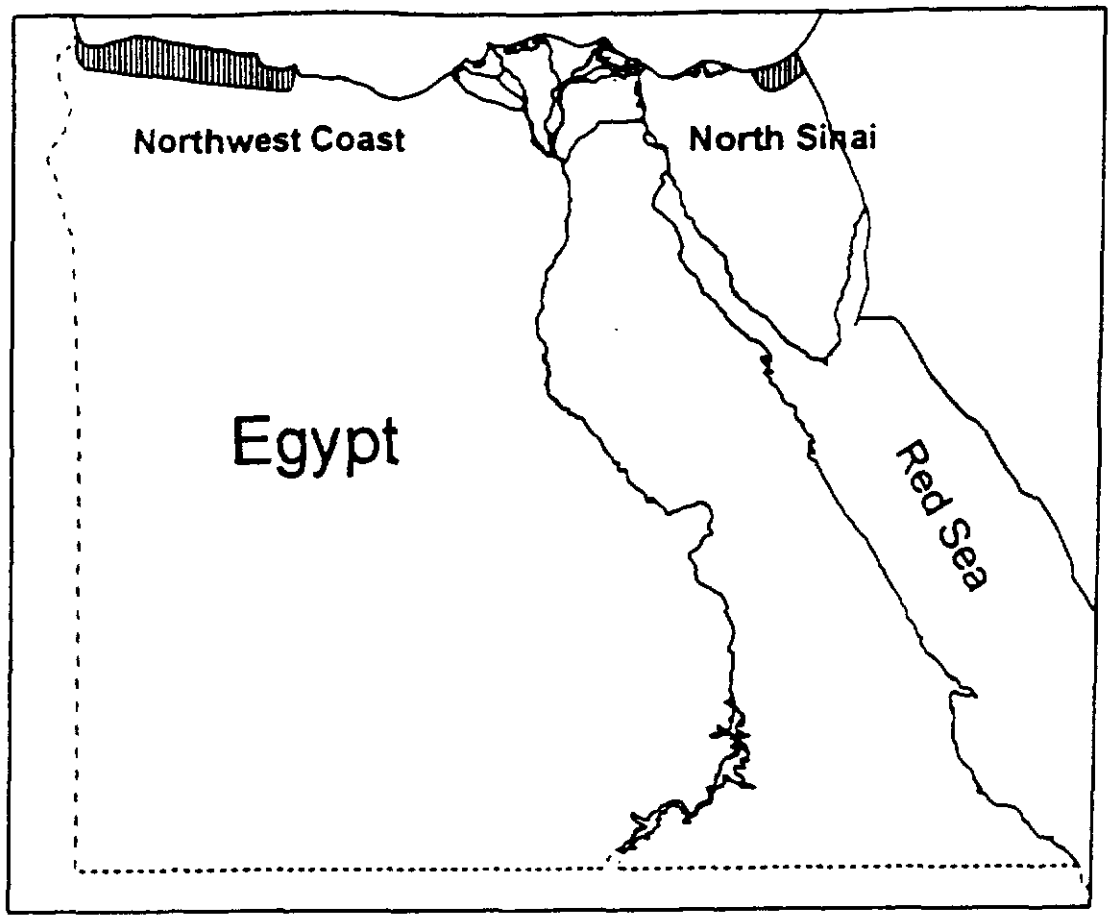

Fig. 1. RRA rainfed study areas.

The second part of the study was conducted in North Sinai, an area about 70 km long, from El Arish in the west to Rafah in the east, and about 80 km wide. That area is expected to be irrigated by the new El Salam Canal in the near future. About 16% of the cultivated land is irrigated with groundwater while the rest relies exclusively on rainfall for agricultural production. The study area comprises four districts: El Arish, El Sheikh Zoweid, Rafah and El Hassana.

Methodology

The Rapid Rural Appraisal is a relatively new and different approach for conducting action-oriented research in developing countries. Rapid Rural Appraisal is used in the early stages of project planning to produce preliminary hypotheses for later testing by development work or further research activities. The Rapid Rural Appraisal for the rainfed areas of the Northwest Coast and North Sinai was designed to:

- Describe the prevailing farm environment and farming practices within the existing rainfed farming systems.
- Ascertain major system constraints to resource management in the area.

Livestock

- Animal husbandry.
- Supplementary feeding for animals.
- Increases and decreases in livestock over time.
- Changes in rangeland areas over time.
- The planting of forage trees in the study areas.
- Rangeland carrying capacity.
- Problems and constraints.
- Contribution to household income.

Inputs and credit

- Input and credit sources and availability.
- Farm machinery availability.
- Problems and constraints.

Labor

- Family labor required for various activities.
- Hired labor required for various activities, availability and cost.
- Responsible persons for household tasks, harvesting, animal breeding and grazing.
- Percentages of farm and off-farm household income.
- Availability of rural support services.

Local Bedouin groups were invited to participate in the meetings, as well as key informants and local leaders. The appraisal took the form of a cycle of dialogues with the farmers in the four communities in the Northwest Coast and the five communities in North Sinai. The dialogues were informal but guided along the paths previously identified. The multidisciplinary team posed open-ended questions and probed new topics as they arose. The dialogue format helps to ensure that research design and implementation will benefit from the knowledge and experience of the Bedouins concerned. This increases the likelihood that projects will achieve their objectives of productivity and sustainability.

The number of attendees at the meetings varied between 14 and 22. Because of rainy weather, the Bedouins were sowing their crops, and it was difficult to gather them together in large numbers. All meetings were attended by at least three of the *awakel* (eldest wise men).

Consultation with government and local officials and researchers as well as local leaders and key informants is as much a part of the Rapid Rural Appraisal as the interviews and discussions with groups and individuals at the community level.

After the completion of the field work in the nine communities, several meetings were held in Cairo to discuss the results.

The Northwest Coast

Study Locations

Previous studies have shown that the agro-ecological features of the rainfed areas of the Northwest Coast of Egypt are not homogeneous. Therefore, four locations were carefully selected to represent the major variables in available resources and production systems, and to reflect the constraints and diverse problems relevant to the management of these available resources. Descriptions of the four locations (Fig. 2) follow.

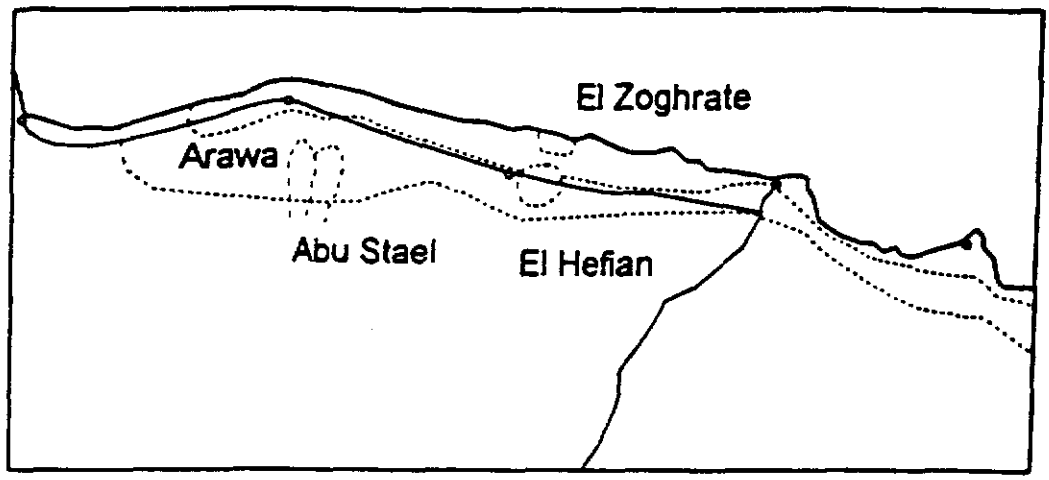

Fig. 2. Study locations in the Northwest Coast.

El Zoghrate is located in the coastal zone and extends about seven kilometers southwards from the shoreline. It has good potential in terms of soil characteristics and water availability. Tree cultivation dominates in the coastal plain, *wadis* and *rakabas* (short, shallow *wadis*). Cereal and vegetable production is practiced on the coastal plain, *wadi* fans and on the plateau. The escarpment is used for rangeland.

El Hefian extends along both sides of the Alexandria–El Salloum main road and reflects an inter-mix between the *wadi* and open land systems. Tree production dominates in the minor *wadis* and in the feeders of the main *wadis* and depressions. Cereals and vegetables are grown in more suitable flat areas, while rangelands are located in the less fertile areas.

Abu Stael is located about 12 kilometers south of the Alexandria–El Salloum main road. The area is typical of the farming systems in the southern parts of the mixed production zone. Tree production is carried out in the *rakabas* and some depressions. Cereal crops dominate in the depressions, and livestock graze on the flat areas. There are no *wadis* in the area, which relies exclusively on rainfall, but it has good potential for agricultural production in terms of soil characteristics and total moisture storage capacity.

Arawa is located in the southern part of the mixed production zone, adjacent to the rangeland zone. Its main features are deep depressions surrounded by rangeland and catchment areas. There are no *wadis* in the area, but it has good potential for agricultural production in terms of soil characteristics and water storage capacity.

Results

Characteristics of the Study Locations

The results of the study reflect the different environments of the Bedouins, the distribution of resource availability and farming systems and the major constraints in the study area. Table 1 summarizes the main characteristics of the four locations.

Table 1. Selected locations in the Northwest Coast.

	El Zoghrate	El Hefian	Abu Stael	Arawa
Attendees	16	22	15	14
Area (feddan†)	16,875	31,657	24,834	15,255
Population	2,000	1,500	1,000	900
Landholders	Oshaibata	El Hefian	El Sheresat	Arawa
Water resources	rainfall, groundwater wells, desalinized water	rainfall	rainfall	rainfall
Trees	45,00	20,000	2,000	10,000
	fig, olive, almond	olive, fig	olive, fig	olive, fig
Cereals (feddan)	10,000	15,000	18,000	20,000
barley	60%	70%	95%	85%
wheat	40%	30%	5%	15%
Watermelon (feddan)	80	50	20	20
Animals:				
sheep/goats	5,000	12,500	25,000	18,000
camels	-	800	-	1,000

† 1 hectare = 2.38 feddans.

El Zoghrate occupies 16,875 feddans (7,090 ha) and is dominated by the Oshaibata sub-tribe, which has a total population of 2,000. Tree production is the major crop, followed by watermelon production. There are 45,000 productive fig, olive and almonds trees in the area. Eighty feddans (33.6 ha) are devoted exclusively to watermelon production. In addition, 10,000 feddans (4,201 ha) are cultivated with cereals, of which 60% are cultivated with barley and 40% with wheat. Livestock production is an important economic activity, with 5,000 sheep and goats in the area.

El Hefian occupies a total of 31,657 feddans (13,301 ha) and is inhabited mainly by El Hefian sub-tribe. The total population is 1,500. Agricultural production relies exclusively on rainfall. Sheet runoff is stored mainly in cisterns. Cereal crop and livestock production are the major activities. A total of 15,000 feddans (6,302 ha) is cultivated with cereals. Seventy percent is cultivated with barley, while 30% is cultivated with wheat. In addition, there are 50 feddans (21 ha) dedicated to watermelon production. There are only a few small dikes to collect rainwater and prevent soil erosion. Livestock production is practiced by the majority of the Bedouins in the area. The total number of sheep and goats is 12,500, and there are 800 camels. Tree production also contributes to the household income. There are 20,000 olive and fig trees planted in the minor *wadis* as well as in the feeders of the main *wadis*, protected by stone and earth dikes.

Abu Stael is located in the Sidi Barrani district, and has a total area of 24,834 feddans (10,434 ha). It is dominated by El Sheresat sub-tribe, with a total population of 1000. The major farming system is barley/livestock. There are 18,000 feddans (7,563 ha) cultivated with cereal crops; 95% are planted to barley, while wheat accounts for only 5%. No water harvesting constructions are used for cereal production. Watermelon is grown on 20 feddans (8.4 ha), which are located in barley and wheat fields. There are 2,000 olive and fig trees planted in depressions, without stone and earth constructions. The total number of sheep and goats is 25,000. There is no camel breeding in Abu Stael.

Arawa is also located in the Sidi Barrani district, and has a total area of 15,255 feddans (6,409 ha). Landholders are from Arawa sub-tribe, with a total population of 900. Agricultural production relies exclusively on rainfall, and sheet runoff is used to cultivate about 20,000 feddans (8,496 ha) with cereals, of which 85% is barley and 15% is wheat. Water harvesting techniques are not used. There are about 20 feddans (8.4 ha) of watermelon, which is cultivated in the barley and wheat fields. There are about 10,000 olive, fig and grape trees in the area. Animal production is an important economic activity, with a total population of sheep and goats of 18,000, in addition to 1,000 camels.

Agro-ecological Characterization

The results of the Rapid Rural Appraisal as well as data from secondary sources, show that the study area can be divided into three main agro-ecological zones in terms of geomorphology, climate, soil and water resources, and farming systems. These are: the coastal zone, the mixed production zone, and the rangeland zone (Fig. 3). The main characteristics of these zones are summarized in Table 2.

Following is a description of the available resources in these zones.

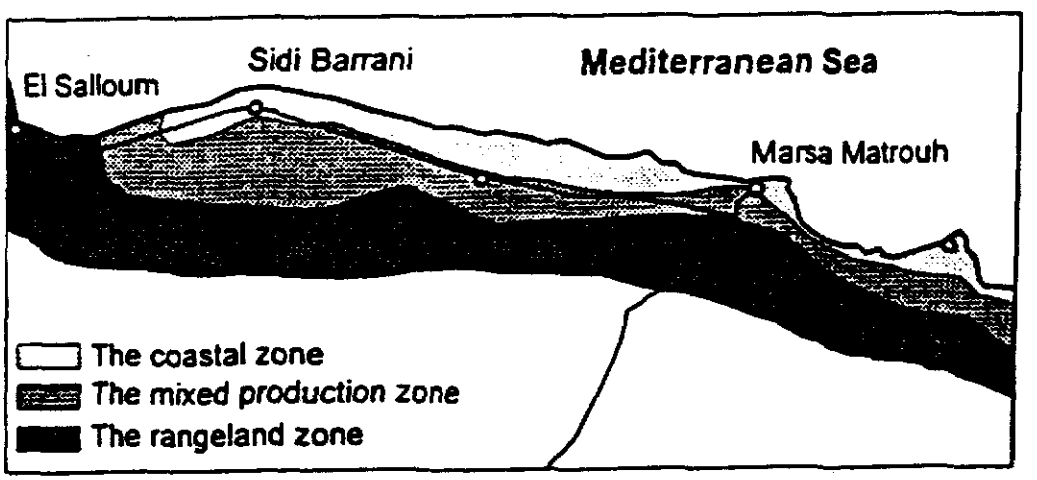

Fig. 3. Agro-ecological zones in the Northwest Coast.

Table 2. Agro-ecological zones in the Northwest Coast.

	Coastal zone	Mixed production zone	Rangeland zone
Width (km inland from the coast	10	10–20	20–50
Elevation (m asl)	0–50	50–100/140	100/140–200
Geomorphology	1. Coastal basin 2. Escarpment with numerous *wadis*	North plateau where *wadis* and catchment areas begin	Southern plateau including flat plains and hummocky dunes and shallow depressions
Soils	Deep soils (>1 m) in the coastal plain and *wadi* floors	Deep depressions in *rakaba*, *wadis* and alluvial fans	Shallow soils (< 80) cm in depressions
Climate			
Rainfall (mm/yr.)	150–125	100–125	<100
Mean monthly max. temp. (°C)	14.5–27.4	13.7–30.1	13.0–30.6
Mean monthly min. temp. (°C)	9.4–21.3	6.8–20.3	6.6–19.3
Max. daily relative humidity (%)	94.9 (June) 72.0 (Sept.)	93.4 (May) 86.2 (Dec.)	94.5 (Mar.) 79.4 (Oct.)
Min. daily relative humidity (%)	76.1 (Aug.) 46.9 (Feb.)	54.4 (Jan.) 33.8 (May)	55.9 (Jan.) 25.8 (Apr.)
Water			
Surface water	Runoff from *wadis* generated from bare rocky escarpment.	Water flows from gullies, catchment areas. Some water seeps into the soil in the alluvial fans.	No runoff reaches the mixed production zone. Most of the water is available for range plants.
Groundwater	available	no	no
Desalinized water	available	no	no
Water pipelines	available to the east	no	no
Total Area (%)	5	22.2	72.8
Crops (%)			
Cereals	23	75	2.0
Vegetables	59.5	40.5	–
Figs	71	28	1.0
Olives	58	39	3.0
Rangeland (%)	3.47	19.7	76.83
Livestock (%)			
Owners	28	34	38
Sheep/goats	33	40	27

The coastal zone represents 11% of the total study area. It lies from 0 to 50 meters above sea level, and has a maximum width of about 10 kilometers. It consists of a coastal basin formed mainly from active coastal dunes of white sand near the sea, followed by interdunal depressions, the interdunal plain, ancient dunal ridges, and alluvial plains sloping gently seaward with soils up to two meters deep. The escarpment is characterized by its steep slopes to the north and numerous *wadis* that deposit a thick layer of alluvial soil with a

sandy brown silt texture. The slopes are composed of sandy limestone and are exposed to water and wind erosion, which seems to be more severe in the northern parts.

The mean annual rainfall varies between 150 and 125 mm. The mean monthly maximum temperature ranges between 14.5 and 27.4°C, while the mean monthly minimum temperature fluctuates between 9.4 and 21.3°C. The maximum daily relative humidity varies from 94.9% in June to 72.0% in September, while the minimum daily relative humidity varies between 76.1% in August and 46.9% in February.

Surface water (rainfall) is the main source of water in the coastal zone. The escarpment leading from the northern plateau to the coastal plains is cut by 218 *wadis*. Most of the runoff from the *wadis* comes from the bare rocky surfaces of the escarpment. The annual usable runoff in the *wadis* represents a small fraction of the total annual rain falling in the catchment area of each *wadi*; it varies between 1.5% and 3.2%, depending on the location of the *wadi*, the size of the catchment area, slope and other morphological characteristics. However, the peak discharge in the *wadis* is high and may exceed 3 $m^3/s/km^2$ in the steep and rocky catchment areas of less than 1 km^2. The runoff velocity is estimated to range from 1 to 4 m/s.

Outside the catchment areas, sheet runoff accumulates in depressions where different crops are cultivated. It is also used for filling the cisterns. Sheet runoff varies from 10 to 30% of the total rainfall, depending on the slope and permeability of the soil, the presence or absence of vegetation, the intensity of the rain and the length of the course. Cement dikes (in *wadis*) and earth and stone dikes (outside catchment areas) constructed parallel to the contours retard the *wadi* flow and the surface runoff and allow more water to percolate into the soil. In addition, they protect soils against erosion.

Groundwater is the second source of water in the coastal zone. The *wadi* runoff spreads and is stored behind the system of coastal sand dunes and dikes, although some *wadis* spill directly into the sea. The aquifer in this zone consists of a layer of sweet water on the sea water table which has been exploited by wells and galleries since ancient times. Water lifting from galleries and wells is done with portable diesel, gasoline or kerosene pumps.

Water from desalinization plants or from the Alexandria–Marsa Matrouh pipeline is available for household use and, to a certain extent, for animal husbandry, but it is too expensive to use for irrigation.

The soil and water are potentially suitable for tree crop and vegetable production as well as for the small ruminant/cereal combination. Tree crops are associated with the coastal plain, *wadis* and *rakabas* where more fertile soils have accumulated. In these areas runoff can be readily concentrated through the use of dikes. Trees are also suitable for the coastal sand dunes where there is sweet groundwater.

The available data show that fruit trees dominate the coastal zone, and that 71 and 58%, respectively, of the Northwest Coast fig and olive trees are planted in this zone. Twenty-three percent of the total cereal area and 59.5% of the total vegetable area are located in the coastal zone.

The distribution of animal ownership by zone shows that 28% of the total number of owners live in the coastal zone and that they have some access to the rangelands in the southern plateau. They own 34% of the total number of sheep and goats in the study area. The

production ratio (number of births : total number of sheep) for sheep in the coastal zone is 63, while for goats it is 98.

The mixed production zone represents about 29% of the total study area. It is from 50 to 140 m above sea level. It parallels the sea in a narrow strip between 10 and 20 km inland and includes the northern tableland where the *wadis* and their catchment areas begin. There are wide branched *wadis* in the eastern part with some narrow incised *wadis* in the western part. Alluvial deposits are concentrated on the *wadi* floors as well as in the *wadi* fans. These areas are considered to have good agricultural potential.

The tableland in this zone is interspersed with numerous alluvial fans, ancient fields and some *rakabas* where deep soils with moderately fine to coarse texture are formed. These areas are considered to have good agricultural potential. The plateau is relatively flat, inclining to the north, and is considered to be of little use except as rangeland.

The mean annual rainfall in the mixed production zone varies between 125 and 100 mm. The mean monthly maximum temperature varies between 13.7 and 30.1°C, while the mean monthly minimum temperature fluctuates between 6.0 and 20.3°C. The maximum daily relative humidity varies from 93.4% in May to 86.2% in December, while the minimum fluctuates between 54.5% in January and 33.8% in May.

Surface water (rainfall) is the main source of water in the mixed production zone. The southern border of the zone coincides with the southern limitation of the *wadi* catchment areas. Because the southern tableland is virtually flat, no runoff can be expected to reach the mixed production zone except in the western parts of the study area in Sidi Barrani and El Salloum. Along the southern end of the zone the slope increases within a limited area to about 1%. This, coupled with a crust formation on the soil surface, enhances surface runoff. Thus there is some sheet runoff and some runoff in the *rakabas*. Due to the decrease in slope further to the north, the outflow from these *rakabas* disperses again in silt fans. Sheet runoff and *rakaba* outflow spread over vast areas, then seep into the soil. In these areas cisterns have been excavated to store rainfall. The dikes cause the sheet runoff to accumulate in narrow strips upstream from the dike, providing enough water to sustain crops in some parts of the area.

Groundwater in the mixed production zone is very limited, and the test wells drilled in this zone have not shown promising results. It is likely, however, that fresh water layers can be found further north, at the edge of the *wadi* catchment area. But this is not expected to be a dependable water source. Water from desalinization plants is available for household use only, and is very expensive.

Data show that 28% of the fig trees and 39% of the olive trees for the Northwest Coast are located in the mixed production zone, usually confined to *wadi* beds and depressions. There is a tendency for tree crops to be associated with dike construction in the *wadis*. About 75% of the total barley and wheat areas are located in this zone, grown with or without small water harvesting constructions. Vegetable production in the mixed zone accounts for about 40.5% of the total vegetable acreage in the study area. Vegetable production is restricted to very small plots served by domestic cisterns located close to the house.

The mixed production zone accounts for 19.7% of the total rangeland in the study area. Of this, 0.8, 1.2, 11 and 6.7% are very dense, dense, sparse and very sparse rangelands, respectively.

The distribution of sheep and goat ownership by zone shows that 34% of the total number of owners live in the mixed production zone. They own 39% of the total number of sheep and goats in the study area. The production ratio for sheep is 58 and 72 for goats.

The rangeland zone covers the majority of the study area (60%). Its elevation is between 140 to 200 m above sea level. It consists of a southern tableland and is made up of very flat plains (less than 0.3% slope), the hummocky inland dunes, some scattered shallow depressions (*hataya*) in the north, and an extended tableland intersected by an inland cliff. It begins about 20 km inland and is about 50 km wide. The predominant features are the inland dunes with their coarse and deep soil, the shallow depressions with their shallow textured soil and the catchment areas. The shallow depressions, which are considered to have good potential for rangeland, are surrounded by the inland dunes, where the loose sand traps enough water to support a thick natural vegetative cover and is considered to have medium potential. The southern tableland and the inland cliff have low potential. Catchment areas are located on the sloping surfaces with coarse-textured soil.

The mean annual rainfall in the rangeland zone is less than 100 mm. The mean monthly maximum temperature ranges between 13.0 and 30.6°C, while the mean monthly minimum temperature fluctuates between 6.6 and 19.3°C. The maximum daily relative humidity varies between 94.5% in March and 79.4% in October, while the minimum daily relative humidity fluctuates between 55.9% in January and 25.8% in April.

Most of the surface water in the rangeland zone is used by weeds and range plants, while, because of the flat nature of the land, only a negligible amount percolates into deeper layers. In some areas in the southern plateau, runoff is concentrated in the gullies, and, where soil depth allows the storage of surface runoff in the root layer, depressions collect surface runoff from surrounding areas. A few of these depressions have been successfully planted with figs, olives, grapes and watermelon. A number of cisterns have been excavated to store rainwater in this zone.

Groundwater is negligible in the rangeland zone. This, however, does not exclude the possibility of groundwater formation by concentration in karstic caverns and faults, but this is for further investigation in the future.

Fruit trees, barley and watermelons are cultivated in scattered areas where water availability and soil suitability permit. The data indicate that about 1.0% of the total fig trees, 3.0% of the total olive trees, and 2.0% of the total cereal crops (mainly barley) are located in the rangeland zone. This strip also accounts for 76.83% of the total rangeland. Of this, about 19.0% is very dense rangeland located on the hummocky inland sand dunes. Less than 3% is dense rangeland, while 33 and 22% are sparse and very sparse rangelands, respectively.

The rangeland strip is where animal husbandry is considered a more important economic activity than in the coastal or mixed production zones. Thirty-eight percent of the total number of sheep and goat owners live in this zone, and own 27% of the total of sheep and goats in the study area.

Production System

The process of the Bedouin sedentarization which has taken place in the Northwest Coastal region over the last three decades has considerably changed the traditional farming system of pastoralism (animal grazing with some barley cropping) to sedentary farming, relying on

an integrated production system of cereal cropping, animal breeding and tree production (mainly figs and olives). The Bedouins have tended to increase their tree areas at the expense of barley areas in the most favored soils with high water availability because trees are considered a secure source of income during drought years. The total barley area has also increased considerably. In addition, the dramatic transition of the Bedouins from nomads and semi-nomads to sedentary farmers has resulted in changes in the farming systems and types of land use, with heavy dependence on cereal and tree production as well as livestock breeding.

The secondary data from 1993 indicate that the total acreage of cereal production in the study area is 131,852 feddans (55,400 ha). Of these, 98,102 feddans (41,219 ha) are cultivated with barley and 33,750 feddans (14,180 ha) with wheat. The total orchard area is 18,029 feddans (7,575 ha), of which 12,333 feddans (5,181 ha) are figs, 4,155 feddans (1,743 ha) are olives, and 1,581 feddans (644 ha) are cultivated with almonds, guava, grapes, peach and lemon. Summer vegetables occupy 3,961 feddans (1,664 ha), while winter vegetables are cultivated on 239 feddans (100 ha). Table 3 shows the total cultivated area for cereals, fruit trees and summer and winter vegetables in the project area for 1994.

Table 3. Cultivated area in the Northwest Coast (feddan).

	East of Matrouh	West of Matrouh	Sidi Barrani	Total
Cereals				
Barley	46,302	27,300	24,500	98,102
Wheat	6,700	21,710	5,340	33,750
Trees				
Fig	6,400	2,890	3,023	12,313
Olive	1,523	1,997	635	4,155
Almond	63	40	-	103
Grape	7	26	885	918
Peach	14	28	30	72
Guava	440	3	-	443
Lemon	1	4	-	5
Summer vegetables				
Watermelon	365	385	2,015	2,765
Melon	3	160	470	633
Tomato	325	48	13	386
Others	45	72	60	177
Winter vegetables				
Mint	13	22	10	45
Peas	8	12	5	25
Tomato	18	22	49	89
Cucumber	4	5	3	12
Broad bean	10	15	17	42
Bean	6	5	2	13
Phaseolus	5	4	4	13
Totals	62,252	54,748	31,261	154,061

Cereal production

Barley is the main crop cultivated in the project area. It is the traditional source of flour for the Bedouins and the key element in the feeding regime of small ruminants. Barley grows quickly, matures earlier than wheat and better withstands local soil and climate conditions. Recently, the government has promoted wheat production in an effort to achieve higher levels of self-sufficiency in wheat flour. Seed has been supplied at a 75% price subsidy to encourage the adoption of wheat cultivation in the area. Thus, wheat has been incorporated into the production system, mainly at the expense of barley. But barley is still more desirable than wheat, because of the reasons given above. Wheat also has a higher moisture requirement than barley. Farmers cultivate wheat on land which has (relatively) assured water availability, i.e., mainly on land immediately upstream of water harvesting structures or in the lower areas which have a high chance of rainfall collection. This has tended to displace barley to the marginal cultivated land. This may have an adverse effect on barley yields from the point of view of water availability and soil fertility. On the other hand, wheat cultivation is favored only if there is rainfall in late December and January.

The area planted to barley and wheat varies markedly between good and bad rain years but averages 90,000 feddans (37,815 ha), reaching as high as 180,000 feddans (75,630 ha) in very good years. In general, the cultivated area varies with land availability under the traditional rights of access and the perceived reliability of the rains.

About 33,000 feddans (13,865 ha) of cereal land are served by some form of water harvesting structures, generally very low stone dikes to restrict the flow of runoff.

Barley and wheat are sown with a minimum amount of seedbed preparation, which takes place from late October to early January depending upon the perceived reliability of the season's rainfall. The most appropriate time for barley sowing is from the end of October to early December. When early rainfall is poor, the total rainfall up to January becomes an important criterion for the decision to plant wheat. All Bedouins sow their cereal fields manually and plow the soil immediately after sowing.

Formerly, land was cultivated using plows drawn by animals (donkeys or camels), but is now mainly prepared by tractors using moldboard or chisel plows. The poorest farmers continue to use animal draft power. Access to the funds necessary for tractor hire is another important factor—for the majority of the Bedouins who do not own a tractor—affecting the total area sown to cereal crops.

Plowing is shallow and is normally done in a single pass following the broadcasting of seed and the first substantial rain. Farmers who own tractors plow before the rain as well as after broadcasting the seed. Early plowing improves rainfall penetration and thus crop establishment.

Local barley varieties are grown in the area, and the primary source of seed is the Bedouins' personal stocks. The cooperative and commercial dealers are the second and the third sources of barley seed. The main source of wheat seed is the cooperative, where it is supplied at a 75% subsidy. No Bedouins buy wheat seed from commercial sources.

Seed is not treated before sowing. No Bedouins practice chemical treatment, sifting or cleaning of seeds before sowing. Seeding rate varies from one site to another depending on the amount of rainfall and soil depth. In the coastal strip (El Zoghrate) the seeding rate is higher than in the mixed production zone. Within the mixed production strip, the seeding rate is higher in Sidi Barrani than in El Hefian because of the difference in rainfall, the depth of the soil, and, consequently, moisture storage capacity.

Crop rotation is not practiced by the Bedouins in the area. They cultivate barley and wheat yearly. Because of the drought conditions and lack of water management, fallow rotations occur on alternating areas as a means of fertility maintenance. Fallow rotations minimize the adverse effects of continuous cultivation.

All the Bedouins said that they use no chemical fertilizers or manures for barley and wheat crops because soil fertility is primarily determined by the availability of water. The manuring which results from the traditional practice of grazing animals on cereal aftermath, together with the beneficial effects of leguminous weed growth, appears to be sufficient to permit long-term cultivation of cereals on the same land. However, field observations and Bedouin experts say that some ancient barley fields have been abandoned due to the deterioration of soil fertility.

Weed control is also not practiced in barley and wheat fields. In poor rain years the annual weed growth within the crop provides important forage for small ruminants to supplement their feeding. The annuals are mainly drought-tolerant, early-maturing legumes which not only provide an additional source of protein for animals but also have a beneficial effect on fertility maintenance in shallow soils.

Pest infestation and disease are not major problems from the Bedouin point of view because of the low rainfall. But they say that there is leaf rust, black stem rust and some insects which attack their barley and wheat crops in some areas. They say that they face problems getting insecticide from the cooperatives, and that the cost is high.

The Bedouins harvest their barley fields between the end of April and the first of June, while wheat fields are harvested between the end of June and the first of July. Harvest is done manually by both men and women by pulling up the barley and wheat plants and collecting them into low piles in the field. Barley and wheat threshing is done using animal-drawn sleds or by direct trampling by animals. Winnowing is done by hand. After winnowing, the grain and straw are hauled to flat areas close to the homes where they are stored.

Barley and wheat yields are low and highly unpredictable due to the variability in the average annual rainfall, water accumulation in the field, soil depth, seedbed preparation, seeding rates, and the percentage of fields used for grazing. In general, the average yields for barley and wheat are higher in the coastal zone (El Zoghrate) than in the mixed production zone. Moreover, within the mixed production zone, barley and wheat yields are higher in Sidi Barrani (Abu Stael and Arawa) than in El Hefian. The Bedouins also said that on a given site within the project area the grain yield of wheat is about one half to two thirds that of barley. Table 4 shows the main characteristics of barley and wheat in the study area.

Table 4. Barley/wheat production in the Northwest Coast.

	Coastal zone	Mixed production zone		
	El Zoghrate	El Hefian	Abu Stael	Arawa
Cultivated area (fed†)	10,000	15,000	18,000	20,000
Barley	60%	70%	95%	85%
Wheat	40%	30%	5%	15%
Seeding rate (kela‡/fed)				
Barley	4.0	3.0	3.5	3.5
Wheat	3.0	3.0	3.0	3.0
Manuring	no	no	no	no
Fertilization	no	no	no	no
Weed control	no	no	no	no
Yield (ardab§/feddan)				
Barley: Good rainfall	6.0	5.0	7.0	6.0
Average rainfall	3.0	3.0	3.0	3.0
Poor rainfall	1.0	1.0	1.0	1.0
Wheat: Good rainfall	4.0	4.0	3.0	3.0
Average rainfall	2.0	2.0	1.5	2.0
Poor rainfall	1.0	1.0	0.5	1.0

† 1 *hectare* = 2.38 *feddans*.
‡ 1 kela wheat = 12.5 kg; 1 kela barley = 10 kg.
§ 1 ardab wheat = 150 kg; 1 ardab barley = 120 kg.

A portion of the harvested barley grain is retained for planting the following season, but, following crop failure, seed can be purchased from larger farmers or from outside the area. Wheat grain is retained for household consumption only.

The barley harvest varies from one year to another regardless of the total area under cultivation. In poor rain years, there is no grain harvest, and the Bedouins let their sheep and goats graze on the crop, either in the green stage or instead of harvesting. In good rain years, some Bedouins still allow their livestock to graze a part of the field and harvest the remainder. In general, the final area harvested represents 50 to 70% of the area sown.

Vegetable production

The total acreage under vegetable production varies from one year to another—as well as from one zone to another—depending on the amount and distribution of rainfall. The total area ranges between 1,000 and 3,500 feddans (420 and 1,470 ha).

The main vegetables cultivated under rainfed conditions in the Northwest Coast are watermelon, sweet melon and onion. Other vegetables, such as mint, and garden

rocket, are produced on a small scale, irrigated with groundwater (4% of the total vegetable area) or with cisterns. Small quantities of vegetables are grown associated with orchards in the coastal zone as well as in the high potential areas of the mixed production zone.

In 1992, the area cultivated with summer vegetables (watermelon, sweet melon and tomatoes) in the study area was 3,961 feddans (1,664 ha). Winter vegetables were cultivated on 239 feddans (100 ha).

Recently, protected agriculture has been introduced to the area and about 107 greenhouses are now operational. They produce mainly tomato, cucumber, and other leafy vegetables.

Watermelon is the most important row crop for the Bedouins in the coastal zone as well as in the high potential areas of the mixed production zone. Watermelon is sown in April in fields used exclusively for its production. The land is plowed in three passes. The seeds are planted after soaking in water for about ten days. Moisture content is the main criterion used to determine the size of the cropped area. The seeding rate is 0.3 kg/fed (0.7 kg/ha) in the coastal zone and 0.25 kg/fed (0.6 kg/ha) in the mixed production and rangeland areas.

The Bedouins use no chemical fertilizer or manure for watermelon, but they do depend on the manuring that results from the traditional practice of grazing animals after harvest. Weed control is practiced in watermelon fields, as well as in the fields of other vegetables, because the Bedouins are well aware of the fact that weeds act as hosts to insects, plant diseases, and rodents. In addition, the Bedouins know that weeds cause yield loss due to competition with vegetables for water and nutrients. All the Bedouins said that they change watermelon fields every three years as a means of fertility maintenance.

The Bedouins said that they see pests and diseases in their watermelon fields, as well as with other vegetables, and they control them carefully. They get insecticides from the cooperatives. Extension services under the Ministry of Agriculture and Land Reclamation (MALR) also provide support for farmers in controlling pests and insects.

Harvest is manual, and the Bedouins sell their produce in the marketplace or in the tourist areas.

The production of watermelons depends largely on rainfall and soil characteristics. The yield of watermelon varies between 3 to 6 t/fed (7.1 to 14.3 t/ha).

The average greenhouse production of cucumbers is about 20 kg/m^2, with three production cycles possible each year. The greenhouse covers an area of 540 m^2, suggesting that the total annual production from each unit may be on the order of 1,000 tons of tomatoes and 700 tons of cucumber.

Tree production

The fruit trees grown in the area are fig, olive, grape vines, guava, almonds and peach. Fruit trees are usually cultivated in the most favored soils, where water harvesting is possible.

The principal tree crops are figs and olives, which cover 91.46% of the total acreage of the tree production area. In the coastal zone, fig trees are planted abundantly close to the sea, whereas the number of olive trees increases with the distance from the coast.

Pre-planting operations include the removal of shrubs, land leveling and plowing. The Bedouins dig holes for seedlings and, after planting, irrigate their young trees during the summer months. Due to the relative availability of water, the amount and frequency of irrigation are higher in the coastal areas than in the mixed production zone. East of Marsa Matrouh, water for supplemental irrigation is available from public water resources, while in the coastal strip, water is available from groundwater wells and galleries. West of Sidi Barrani, water for supplemental irrigation is available from groundwater wells in Wadi El Khor. In the mixed production strip, water for supplemental irrigation is available from cisterns.

The Bedouins in the coastal zone use supplemental irrigation for their old trees, while in the mixed production zone such irrigation is rare.

Some of the farmers manure their fruit trees every two or three years, at a rate of 4 kg/tree.

Generally, farmers use cultivators to plow between trees in summer to control weeds and reduce surface evaporation. Near the trees they use hoes to control weeds. They prune trees yearly after harvest to remove unnecessary or dead material. Pruning is more extensive in dry years than in years of good rainfall.

Fig trees produce fruit three years after planting and olive trees produce a crop after four years. Production varies from one zone to another, as well as from one year to another, depending upon the total amount and distribution of rainfall. Tree age also affects production.

Livestock production

The inhabitants of the Northwest Coast, the Awlad Ali tribe, keep a variety of domesticated animals of economic importance such as sheep, goats, camels, donkeys, some cattle, some horses and poultry. Livestock is not only a means of income but represents a way of life to most Bedouins. Sheep and goats are the principle animals in the study area.

Poultry production varies from traditional care to modern techniques aimed at market distribution. Traditional and extensive poultry production is practiced in Bedouin houses where poultry is usually the source of household eggs, meat and an everyday currency. Poultry products and distribution are not as greatly affected by the ecology of the study area as is other livestock.

Donkeys are used for transport and as riding stock for women and boys (who attend school) as well as for agricultural operations such as barley threshing and plowing in some inland areas. Horses are found in the coastal strip only (El Zoghrate).

The Bedouins in some areas are very interested in camel breeding (800 head in El Hefian, 1,000 head in Arawa), while in El Zoghrate and Abu Stael there is no camel breeding. In general, Bedouins have no breeding or fattening system for camel production, but let the animals graze on either shrubs or the low-quality spiny plants in the interior that are not eaten by sheep and goats. The Bedouins said that during recent years camel population has radically decreased because of a reduction of the natural grazing pasture and the introduction of pickup trucks, which have replaced the camel as the popular means of transport.

Although there are only a few cattle (mainly cows) in the region, the number is increasing slowly because of the increasing demand for milk in the tourist areas. In addition, some Bedouins in the coastal strip use only the fresh milk of cows for drinking.

Sheep and goats, the principle animals in the study area, are thought of as ready income as well as food for household consumption. Their population has paralleled the changes in the amount of rainfall during the past three decades due to the availability of range plants.

The secondary data show that the number of sheep and goats increased rapidly between the mid Sixties and 1984 to meet an increasing demand for meat by other Arab countries. The Bedouin herds increased from half a million in 1965, 0.8 million in 1972, one million in 1978, to 1.4 million in 1984. However, between 1985 and 1987, the population declined to

1.2 million because of drought. Today, the total population of sheep and goats has climbed to 1.95 million in the Northwest Coast.

The results of the Rapid Rural Appraisal show that the number of sheep and goats increases in parallel with increases in the area planted to barley in both the study areas and the whole Northwest Coast. There are 5,000 head in El Zoghrate, 12,500 head in El Hefian, 25,000 head in Abu Stael and 18,000 head in Arawa. The Bedouins in the study locations rate sheep as the best economic producers, while goats are usually kept to fulfill social needs. For this reason the Bedouins said that they reduce their sheep flock size toward the end of each year, while goat flock size remains stable. The Bedouins said that the decision to sell or retain animals depends on food availability, and, consequently, on the total amount of rainfall. They also said that large herd size is generally associated with a large family.

Not only does the total population of sheep and goats change over time, but also the herd composition, i.e. the ratio of sheep to goats. Traditionally, the ratio was 1:1. This increased to 2:1 in 1965, and 4:1 in 1984. Between 1985 and 1987 the ratio decreased to 2.7:1, due to the increasing preference for goat meat locally and in the Arab Gulf countries. In 1992 the ratio was 2.2:1. The ratio increases westward, reaching 3:1 in Sidi Barrani.

Animal nutrition

The major sources of animal nutrition are grazing and feed supplements. The Bedouins allow their animals to graze all year-round. The proportion of feed from grazing varies from one season to another and from one zone to another. In El Zoghrate, animals depend heavily on grazing for three months in spring, with no supplemental feed, while in the northern parts of the mixed production zone (El Hefian) they depend heavily on grazing for four months in spring and into early summer. In the southern parts of the mixed production zone (Abu Stael and Arawa) animals depend heavily on grazing for five months because of the availability of rangeland. During the summer, 50% of the animals' feed comes from grazing, which lasts four months in the coastal zone (El Zoghrate) and three months in the mixed production zone. About 90% of the animals' feed is met by supplemental feed for four months in all production zones.

Natural grazing occurs in three areas: uncultivated arable lands belonging to the Bedouins, rangelands interspersed within the tribal areas beyond crop production boundaries, and the communal rangeland. The uncultivated arable land is suitable for cultivation but, because of low rainfall or topography, is used for grazing. The vegetation in these areas includes annual grasses and weeds as well as shrubs and sub-shrubs. In the years of good rainfall, the pasture in these areas is generally good and the animals graze there first. Others are not allowed to graze their animals in these areas without permission from the landholder. During the last twenty years the natural vegetative cover in these areas, especially within the coastal and mixed production zones, has been adversely affected by overgrazing, cutting for firewood, and plowing for barley production in the most favored soils.

The interspersed rangelands, which are mostly non-arable lands distributed within the tribal boundaries, provide most of the pasture land. During the rainy season, when the forage is abundant, the Bedouins allow their animals, especially sheep and goats, to graze in these areas. All flocks belonging to the tribe converge on these areas, which is seen as mutually advantageous among the tribe members. Other tribes are not allowed to graze their animals in these areas without permission from the sheikh or the council of elders.

In the communal areas south of the tribal boundaries, where rainfall is as low as 50 mm/year, pasture is considered common property, but herds normally move within defined areas. Rights to use the pasture in these areas are based primarily on a principle of first occupancy, and access for grazing is regulated through the control of cisterns (water availability) which are generally owned by specific tribes. Rights for newcomers depend on the acceptance by the existing land users. Some areas have been excluded from grazing in order to rest the pasture so that it may be used in very dry years, especially in the southern parts of Sidi Barrani.

In general, rangeland in the Northwest Coast covers more than 95% of the total area. The distribution of rangeland varies from one location to another by zone and intensity. About 5% is in the coastal zone, while about 25% is found in the mixed production zone. More than 70% of the total rangeland is found in the rangeland zone. The density of the rangeland varies from one area to another even within the same zone. About 16% of the total rangeland is considered very dense, and is generally located in the rangeland zone on the hummocky inland sand dunes of the south plateau. In the second and third zones, less than 5% is considered dense rangeland. Fifty percent of the rangeland is considered sparse and is concentrated in the mixed production and rangeland zones. The remaining very sparse 30% is divided between the mixed production and rangeland zones, with only a small fraction in the coastal zone.

The most valuable rangeland is concentrated in the northern part of the rangeland zone. The development of rangeland should focus on the mixed production and rangeland zones, where climate and soil conditions are favorable.

The increase in animals, which is associated with an increase in the area planted to barley, has resulted in a decrease in dependence on rangeland. The Bedouins let their sheep and goats graze the fringes of the barley fields. In poor cropping years, all farmers let their sheep and goats graze on a portion of the field. In good rainfall years, the pasture is abundant and grazing on barley fields is rare.

Stubble grazing usually starts immediately after harvest and lasts through the summer. Letting animals graze on crop residue is practiced by the farmers on their own fields. Field observations show that one feddan (0.42 ha) of cereal aftermath (125–150 kg DM) is enough for 100 sheep and goats.

Farmers transport large amounts of feed concentrates into the area. The major sources of supplemental feed are cotton seed cake, grain, barley and legume straw. The dependence upon animal feed supplements increases in autumn and winter and decreases in spring and summer. The Bedouins said that among the major constraints on animal production is the availability and quality of concentrates and their high price. Fig. 4 shows the typical annual feeding regime in the study area.

Carrying capacity

Carrying capacity in the study area depends on a multitude of factors and varies from one year to another depending on the amount and distribution of rainfall and consequently on plant growth. It also varies from one locality to another depending on soil characteristics. Carrying capacity is also affected by the type of plant being exploited, the manner of exploitation and the availability of water for animal drinking. The collection of fuel wood also affects the carrying capacity of the area.

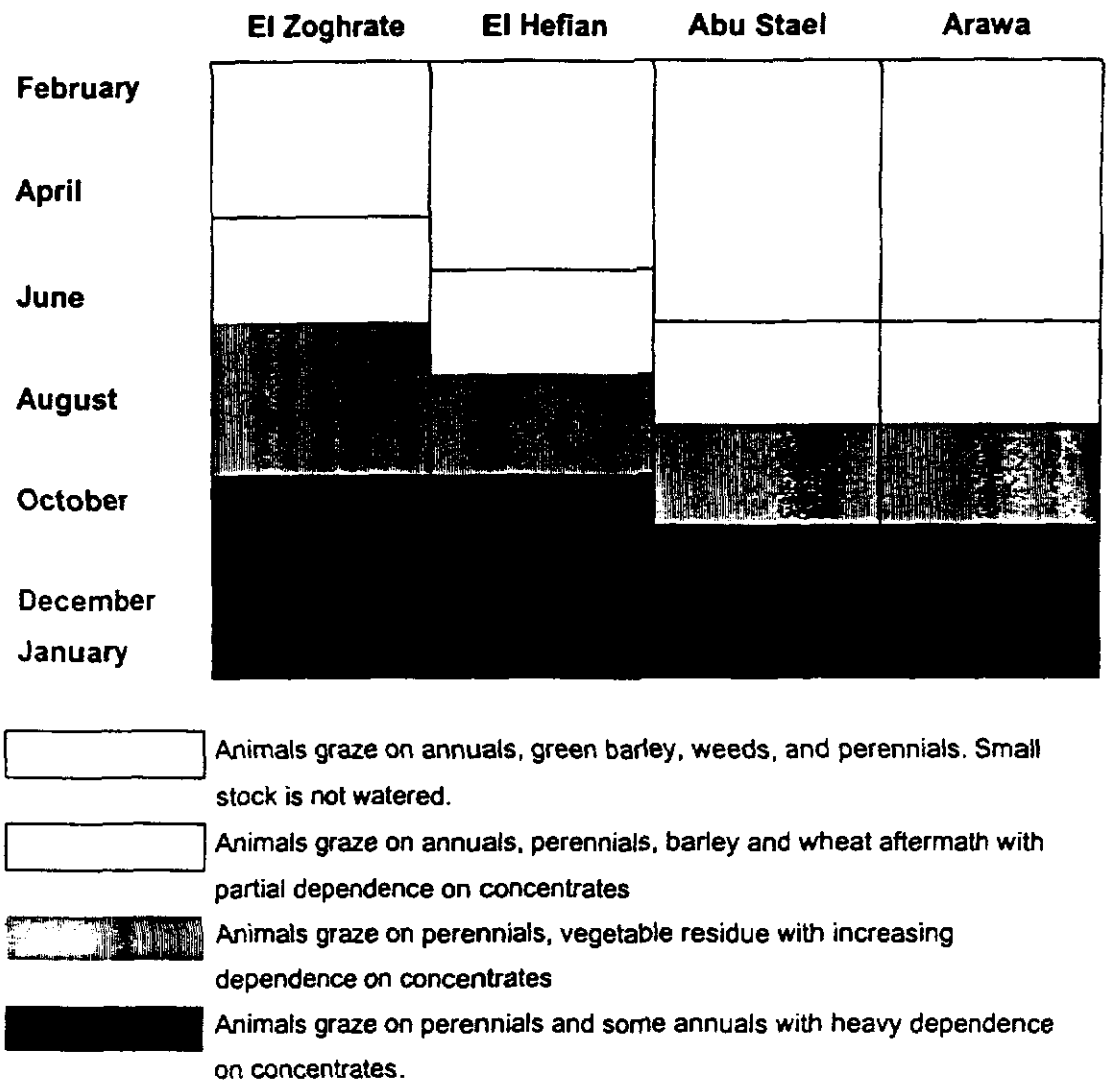

Fig. 4. Typical annual feeding regime in the Northwest Coast.

The Bedouins use their various grazing resources in succession, thus partially compensating for seasonal variations in forage quality and quantity at any one location. The pasture closest to the dwelling plays an important role in livestock production. This resource differs greatly from place to place in specific carrying capacity. The communal rangeland can support only one sheep or goat per 20 feddan (8.4 ha) year-round, but the interspersed rangeland can support one head per 10 feddans (4.2 ha) for a six-month dry season. Therefore, the improvement of rangeland can have a considerable impact on the overall carrying capacity of the whole study area.

Improvement of rangelands

Several trials have been made to introduce acacia trees (*Acacia saligna* and *Atriplex* spp.) to the area, and some Bedouins have planted them on their own fields, but there are many factors at play which affect Bedouin acceptance and expansion. These trees need a lot of

water and more than three years to be productive, thus the Bedouins prefer to plant fruit trees to ensure an income. They said that the acacia is inadequate for animal feeding. After three years the Bedouins use these trees to prove land ownership.

Socioeconomic Considerations

Land tenure in the Northwest Coast

The Bedouins in the study area physically occupy land which belongs to the state. No outsider can purchase the land from the state and utilize it without the consent of the Bedouin occupiers and without payment of a handsome compensation to them. Furthermore, if a tribesman wishes to sell his share in the tribal property, he must give priority to the members of his sub-tribe, and the price of the land may be reduced if one of his relatives wishes to purchase the land.

The Bedouins have traditionally been a pastoral and nomadic people, roaming the desert with their sheep, goat and camel herds. Historically, each tribe and sub-tribe established itself on an expanse of the desert and maintained exclusive rights to it. The territorial conflicts which arose among the sub-tribes were settled by the formation of the *Majlis Orfy*. The *Majlis Orfy* is an intertribal arbitration committee consisting of the *omdas* and sheikhs of all the tribes and sub-tribes. It adjudicates, according to Arab norms and customs, the conflicts—particularly the territorial disputes—arising among the Bedouins. The *Majlis Orfy* assigns an area—demarcated by natural landmarks such as hills, plateaus, *wadis* or artificial low heaps of stones—to each sub-tribe, and issues documents so that the land can be inherited without dispute. To this day, the *Majlis* continues to exercise its authority, dominated by the powerful Awlad Ali tribe.

Within the territories of the sub-tribes the land is communally owned, but each tribal holder knows quite well the shape and boundaries of his particular share. With continued use, the land becomes virtually owned, in the sense that the tribesman has exclusive rights to its use and can pass these rights on to his descendants.

The Bedouins have their own traditional documents which specify the land owned by each sub-tribe. However, although the boundaries of the territories of the sub-tribes, and of individual plots within them, are clearly known to the Bedouins, these boundaries are seldom recorded in any form of land register or set out clearly on cadastral maps. Nowadays there are no conflicts over land boundaries, and land has been distributed down to the family level even in the most fertile *wadis*. The location and size of settlements within the tribal boundaries are uncertain due to the mobility of the Bedouins, particularly within tribal boundaries. When a tribe has land in several zones, a family may plant trees and live in the coastal zone, cultivate barley on the north plateau and graze their flocks on the south plateau. Even families with land limited to a single zone may rent holdings elsewhere for the cultivation of barley and may send their flocks with hired herdsmen to distant areas for grazing.

Farm size

The farm in the study area may be categorized into three sizes on the basis of land area and livestock ownership. Farm size is evidently closely linked to social status and the degree of relative affluence. The results of the Rapid Rural Appraisal, supported by secondary

information, show that about 50% of the farming households fall in the small farm category. These farms consist of less than 10 feddans (4.2 ha) and fewer than 20 head of small ruminants. Forty percent of the farms are 10–20 feddans (4.2-8.4 ha) with between 20 and 100 head. Ten percent have access to over 50 feddans (21 ha) and own over 100 head.

The results show that, in general, the land has been fragmented to some extent in the most fertile areas in the coastal zone (i.e., in the coastal plain and the main *wadis*) where land tenure is mostly individual. In the mixed production zone, household and extended family holdings dominate. In the rangeland zone there are no individual holdings but rather sub-tribal communal holdings.

Labor

The availability and use of family labor for agricultural production in the study area is mainly related to family size, livestock and landholdings, and off-farm employment. Small families may have to hire labor if their land is too large to be cultivated by the family alone. Larger and more affluent farmers may rely more on hired labor and less on family labor than small, poorer farmers, regardless of family size. Large farmers hire labor to harvest cereal and tree crops, for threshing and for livestock herding. The average family size in the study area is 6.4, with approximately three labor units available (one adult = one labor unit).

Land preparation, planting, irrigation, pruning fruit trees, cereal and horticultural crop harvesting, and transport and herding of livestock when animals are grazing away from the home compound, are all undertaken by adults. Boys assist in these activities, especially in herding. Adult males purchase inputs and sell the surplus farm products.

Women help the men in cereal and horticultural crop harvesting and cereal threshing and tend to have primary responsibility for weeding of horticultural and vegetable crops. Women and girls take care of the watering and feeding of animals when the herds are in or close to the home compound. They are also responsible for milking goats and gathering manure for application to tree crops. Manpower requirements are estimated from the Rapid Rural Appraisal as follows:

- 0.84 man per feddan (2 men/ha) for vegetables for six months a year
- 0.17 man per feddan (0.4 man/ha) for fruit trees
- 0.03 man per feddan (0.07 man/ha) of barley or wheat
- 1 man per 100 animal flock

The peak labor demand occurs every year during the cereal harvest, which takes place in the months of May and June, and often results in farmers hiring labor to supplement family labor.

Farm income

Animal husbandry, especially of sheep and goats, is the basic Bedouin economic activity. Agriculture, particularly fruit tree, barley and wheat cultivation, has become increasingly important since Bedouins have begun to settle. This can be seen most in the coastal zone, where an estimated 70% of the Bedouins' gross income is from agriculture.

Particularly in north areas such as El Zoghrate, the Bedouins depend equally on animal husbandry and field crops, about 28 and 22%, respectively. However, their income is

supplemented by fruit tree cultivation, which represents about 50% of the total farm income. Bedouins exclusively dependent on breeding and herding flocks are becoming increasingly rare.

In the other zones in the study area, animal husbandry accounts for 55 to 70% of the total farm income. Cereal production contributes between 15 and 25%. Tree production in the mixed production zone is approximately 30%, decreasing to 10% to the south.

In general, the average annual income is roughly 350 LE per capita from agriculture. This varies from year to year and from family to family. It is difficult to assess in-kind income, as well as income from non-agricultural activities, but an attempt was made to calculate the output value and value-added for the main crops according to different farm sizes in the study area (Table 5).

Table 5. Output for main crops in the Northwest Coast.

	El Zoghrate		El Hefian			Abu Stael			Arawa		
	L‡	S	L	M	S	L	M	S	L	M	S
Area (fed†)											
Barley	15	3	20	15	2.5	25	10	2	60	12	9
Wheat	10	1	15	5	1.5	3	3	1	20	3	4
Watermelon	10	–	–	–	–	2.5	1.5	1	12	–	2
Melon	10	–	–	–	–	2.5	1.5	1	5	–	–
Fig	15	1	7	4	1	5	3.5	7	4	–	–
Olive	5	1	1	2	1	–	1.5	–	6	2	–
Ave. income (LE/fed)											
Barley	170	170	159	159	159	263	263	263	225	225	225
Wheat	248	248	155	155	155	194	196	189	248	248	248
Watermelon	609	–	–	–	–	738	737	738	523	–	484
Melon	609	–	–	–	–	738	737	738	523	–	–
Fig	680	680	760	760	760	1400	1400	1400	680	–	–
Olive	1474	154	890	890	890	–	2054	–	1154	1154	–

† 1 hectare = 2.38 feddans.

‡ L = Large; M = Medium; S = Small.

Non-agricultural income

An additional 10–25% of the Bedouin household income comes from marginal, non-agricultural activities. An analysis of the Rapid Rural Appraisal results gives a breakdown of the different non-agricultural activities as follows:

- commerce 27%
- transport 15%
- vocational jobs 16%
- traditional handicrafts 7%
- agro–processing 13%
- employees 10%
- real estate 2%

The role of woman

The Bedouin society in the Northwest Coast is strictly patriarchal. It is also hierarchical in terms of privileges granted for age and position in the family. However, once a male is considered an adult, his decisions supersede those of women. While older women may have a say in matters, generally men have to approve activities, especially those involving outsiders (such as training) and matters of income (such as the undertaking of a new economic activity in the household).

Women are responsible for the daily running of the household, including the preparation of food, the making of carpets and sometimes the cultivation of small vegetables plots, and poultry breeding. They are thus indirectly responsible for significant portions of the in-kind income of the family. Their contribution to cash income is, however, minimal.

The older women have privileges in mobility and decision making that are not normally given to younger women. For instance, an older woman, particularly *El Agooz* (wife of the head of the household) can travel to Marsa Matrouh, is allowed to converse with men, and can participate in some decision making. In some instances, probably due to the death of the head of household, *El Agooz* may be put in the position of running the household.

In general, women and children are responsible for fetching water. In the northern zone, where wells and cisterns are close, children usually fetch the water for household and animal use. In the mixed production zone, women bring the water most of the time. In the southern parts of the study area, the women are always the ones to fetch the water. Thus the women have a right to a say regarding the location of wells and cisterns.

Since women do the cooking and baking they also have a say in the kind of oven used by the household. Furthermore, they have a say on how the household money is spent, particularly when it involves the women's domain, i.e., food, furniture, clothes, etc.

Women may own sheep and goats and other small animals such as chickens, pigeons and rabbits. They are given some of the wool for spinning and weaving carpets and blankets, which also become their property. Women also produce head covers, necklaces, and embroidered pillowcases. While such items are normally produced for home consumption, women keep the cash if they are sold. This cash is always spent on clothes, jewelry, furniture and gifts. Sometimes women give the money to their husbands to buy feed concentrates for their flocks.

Agricultural Support Services

Credit and financial services

There are three sources of financing of agricultural activities in the study area. They are:

- Central Agricultural Cooperative
- Matrouh Bank for Development and Agricultural Credit
- Informal sources

The Central Agricultural Cooperative acts as a conduit for financing of development activities conducted by international projects. Financing is available for main lines of credit such as tractors, water pumps, loaders, plasticulture, generators, and sprayers.

The Matrouh Bank for Development and Agricultural Credit lends money directly to producers at preferred interest rates. The bank requires standard guarantees, normally some form of collateral. The bank's loans are for vegetable marketing, rabbit raising, water pumps, tractors, electrical generators, agricultural machinery, egg production, and olive salting, etc.

Informal sources such as lending between relatives, traders, wholesalers and agro-processing plants also provide some financing. This tends to be an advance against delivery of a crop or livestock.

Marketing and markets

The market in the study area is dominated by private traders, wholesalers and cooperatives. The cooperative purchases a sizable portion of the production, ensuring that the producers receive a fair price. The marketing of livestock does not present a problem, as the strong local demand for sheep and goats guarantees a better than average price. Due to inconsistent attention to quality, fruits and vegetables do not always commands good prices. Figs are usually sold fresh to the markets in Alexandria and Cairo.

The principle markets of the study area are at Sidi Barrani, Negeila, and Marsa Matrouh. The cooperatives also buy animals from the Bedouins. However, since the supply offered is normally higher than demand, the central cooperative determines purchase quotas for the local cooperatives. Wool is sold at the central cooperative in Matrouh or to private traders. Goat hair is used locally for tents; these tents and rugs made from sheep wool are rarely sold. Goat and sheep milk, as well as homemade butter and cheese, are consumed by the family and are not sold.

Projects

International cooperation projects:

There are a number of international projects in the Northwest Coast, funded by USAID, WFP, ILO, GTZ, and the World Bank. Following is a summary of the objectives and activities of these projects.

USAID

The United States Agency for International Development (USAID) has operated the National Organization for the Development of the Egyptian Village since 1979. The project provides governorates all over Egypt with funds to be used directly for local development. In the present project area these funds go towards operating youth and health centers, water provision projects, infrastructure projects, establishment of car repair workshops and schools, and the development of social cooperatives.

WFP

The World Food Program (WFP) has been active in the Northwest Coast since 1979, aiming to increase Bedouin sedentarization, decrease erosion, and improve soil resources and socioeconomic conditions.

FAO

The Food and Agriculture Organization (FAO) project aims to develop agricultural production in the Northwest Coast by introducing modern agricultural methods, irrigation systems and greenhouses. The project is active in some pilot areas such as El Negeila and El Khor in Sidi Barrani.

ILO

The International Labor Organization (ILO) is developing self-help measures for farmers who are members of the cooperatives. ILO has also funded a fig jam factory and a wool spinning and dying unit in the project area.

GTZ

The German Agency for Technical Cooperation (GTZ) is active through El Qasr Rural Project, which works on rural development in El Qasr.

The World Bank

The World Bank project to improve resource management for sustainable production is now very active in the area from Ras El Hekma to El Salloum.

National projects

There are many projects in the Northwest Coast carried out by national agencies such as the Agricultural Research Center, the Desert Research Center, and Alexandria University. All these projects aim to collect data and to carry out small research activities, specifically in the areas of soil, water management, rangeland, livestock, and cereal production.

Problems and Constraints

Although the rainfed areas of the Northwest Coast of Egypt have potential for improved agricultural production, there are many problems that affect resource management and production levels in the area. They are discussed briefly in this section.

Natural resources

- The north winds cause movement of the coastal sand dunes which affects agricultural areas in the north. Sand-carrying south winds in the spring also affect vegetation in particular; and causes the continuous erosion of the rangelands. Wind erosion also affects the ridges and the sides of the *wadis* and cause damage to fields and orchards.
- More than half of the year is completely dry, with no rainfall at all, leading to water shortages in the summer and early fall. During the rains, floods cause erosion of the *wadis* and soil. Part of this runoff is then lost to the Mediterranean. On the northern part of the plateau, surface water causes erosion of the surface soil in cultivated fields.
- There is a lack of information on soils needed for soil conservation and management practices such as infiltration rates and moisture characteristics.
- There is a lack of information on the catchment areas as well as the characteristics needed for the management of these areas.

- Water harvesting and the storage of surface water in currently existing cisterns does not sufficiently cover water needs in summer months.
- Dam and dike systems are not commonly used for the purpose of intensifying and sustaining agriculture.
- There is a prevalence of unpalatable plants due to heavy overgrazing, use of shrubs for fuel and unregulated plowing for barley cultivation.
- Desertification is on the rise, especially in the ancient barley fields.
- Soil salinity is increasing in those areas irrigated by groundwater.

Crop production

- The limited amount of available water is the main constraint to improving crop production.
- Water is inadequately distributed in the fields.
- There is a decline in soil fertility.
- Poor crop management systems are being used, including land preparation, fertilization, weed and pest control, harvesting and post harvesting practices.
- There is a lack of marketing and the quality of products is poor.
- The potential for crop production in the southern zone of the study area is poor.
- There is a lack of research, extension, and training services due to inadequate staffing, limited information and limited research, extension and training facilities.
- There is a lack of formal follow-up for the introduction of improved varieties (mainly barley and wheat) by extension services.
- Research and extension services in the area are not able to provide the necessary information and educational support needed to train the farmers on how to improve their crop production and sustain their resources.
- Coordination between research and extension agencies is weak.
- Interaction between the research and extension services and the people in the area is weak.
- Crop rotations, which are needed to maintain soil fertility, are not employed.

Livestock production

- There has been a deterioration in the rangeland because of overgrazing, use of shrubs for fuel, and unregulated expansion of agriculture (mainly barley).
- There is a lack of information on the carrying capacity of the rangeland, the size of flocks and patterns of seasonal flock migration, all of which affect grazing management.
- Reproduction rates of small ruminants are low, due to inadequate feeding and health care conditions, and perhaps the absence of genetic selection.
- Products are of poor quality and marketing is inefficient.

- There is a lack of rural extension and veterinary services.
- There is a lack of animal feed concentrates.
- There is not enough water for the animals in the rangeland.
- There is a lack of coordination between research, extension, veterinary services and animal breeders.

Rural support services

- Access to rural services is limited.
- Existing facilities are poorly staffed and equipment is poor.
- There is an absence of skilled professionals to serve in the area.
- Regulations for social development authorities are not suitable for local conditions.
- Road networks are insufficient.
- There is a lack of post and telecommunication facilities.

Development Potential

The dramatic shift of the Bedouins from nomads and semi-nomads to sedentary farmers requires an equally dramatic change in their farming systems and types of land use. The higher food demands for a growing population call for crop intensification. Increasing demand for higher consumptive income calls for the expansion of cash crops, and the detrimental effects of the present land use and farming systems requires the adoption of resource management policies that lead to sustainable agricultural development.

Most of the area's deep soils are found in the coastal region, where the availability of water is also best. Here there is a high potential for intensification rather than expansion through:

- Raising productivity per unit area.
- Introducing proper soil and water management systems.
- Improving crop production systems.
- Developing productive wind breaks on the coastal dunes, on the escarpment slopes and around orchards.
- Adoption of better fruit trees pruning.

The mixed production zone has good potential for an absolute increase in agricultural productivity and therefore in the total value of crop yield. This can be achieved through:

- Increasing the density of field crops (barley and wheat) by improved water harvesting and farming systems, especially on the table lands, depressions, alluvial fans and ancient fields.
- Intensification and stabilization of barley and wheat production by using terraces and retention basins, introducing high-yielding varieties and cultivars which meet the quality requirements for domestic and market consumption, introducing fertilization schemes, and practicing plant protection and weed control.

- Improving winter and summer vegetables by flood watering, terraces, retention basins, and by groundwater where possible through trickle irrigation in greenhouses or plastic tunnels.
- Improving rangeland and rangeland management practices through the introduction of range rotation, water harvesting for rangeland improvement, re-seeding of local rangeland plants, introduction of new species and varieties, fodder afforestation, and by allowing some of the rangeland to rest.
- Improving the catchment areas to increase water-use efficiency.
- Increasing fruit trees, especially on *wadi* floors, alluvial fans, and short *wadis*.
- Introducing productive wind break cultivation.

The rangeland zone has good potential for improvement as both pasture land and increasing cereal production in depressions. The conservation of rangeland should be regarded as a regional aim.

The Rapid Rural Appraisal results show that all Bedouins are willing to participate in research activities to improve production levels and sustain available resources.

North Sinai

Study Locations

Five locations, which represent the major variables in available resources and production systems and reflect the constraints relevant to the management of these resources, were carefully selected. They are: Lehfin, El Kawaza, Qabr Amir, El Barth, and Wadi El Omar (Fig. 5).

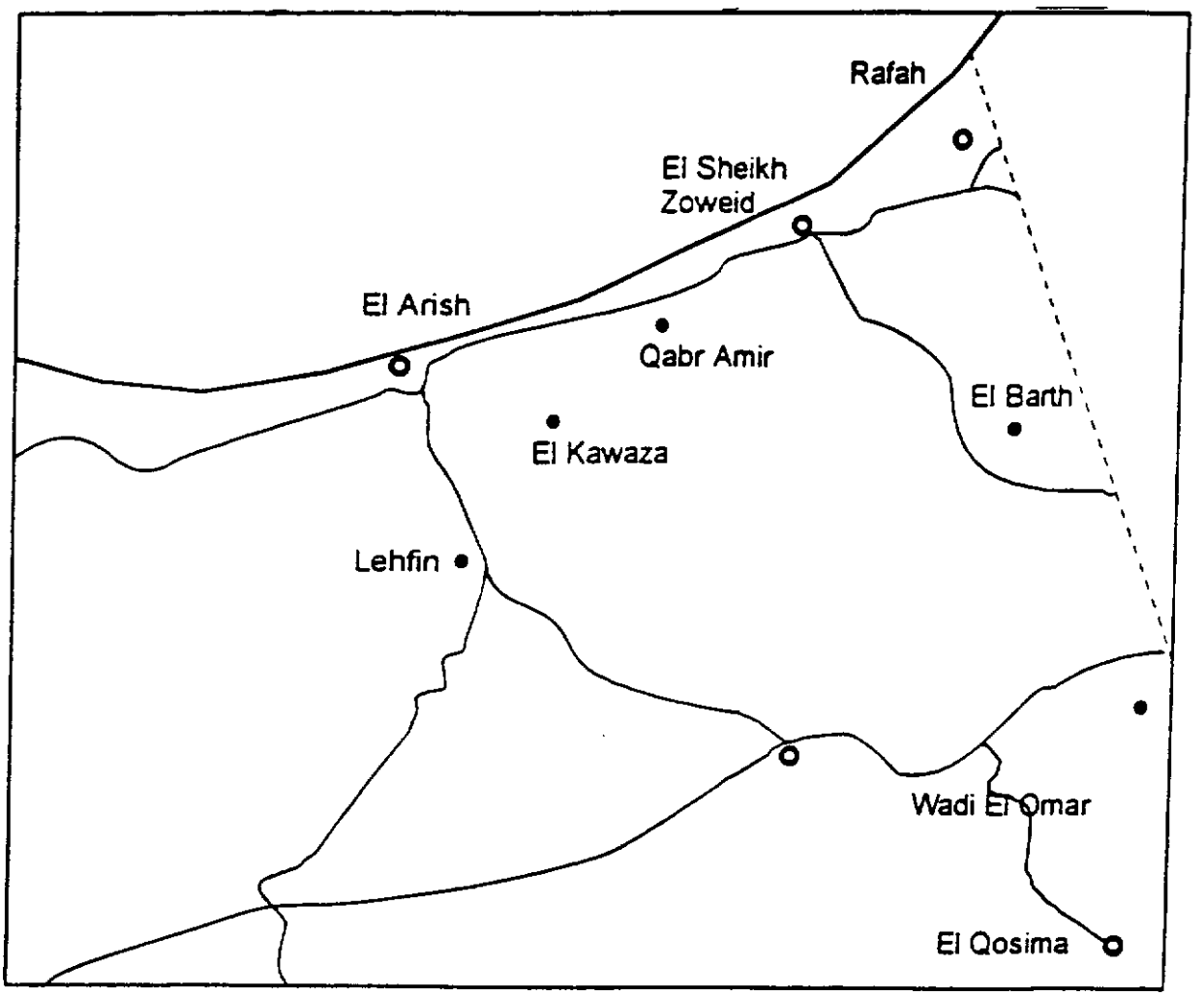

Fig. 5. Study locations in North Sinai.

Results

The secondary data on North Sinai show that the total cultivated area in the districts of El Arish, El Sheikh Zoweid, Rafah and El Hassana is 134,026 feddans (56,313 ha). Of these, 42,240 feddans (17,747 ha) are cultivated with cereals; 84,135 feddans (35,350 ha) are

planted with trees, 2,677 feddans (1,124 ha) with legumes, and 4,974 feddans (2,089 ha) with vegetables.

The secondary data indicate that on the district level, cereal cultivation is dominant in El Hassana to the south, while tree production is dominant in Rafah. In El Arish and El Sheikh Zoweid, cereals and trees equally represent the main activities for the majority of the people.

The total number of sheep and goats in the study area is 143,264: 35.54% are in El Arish, 20.88% in El Sheikh Zoweid, 11.95% in Rafah, and 31.63% in El Hassana. Some 8,330 camels are raised in the area: 43.22% in Rafah, 21.61% in El Sheikh Zoweid, 21.01% in El Hassana, and 14.17% in El Arish.

Characteristics of the Study Locations

The results of the Rapid Rural Appraisal include resource availability, the existing farming systems, and major constraints.

Lehfin

Lehfin is located on the main course of Wadi El Arish, 20 km south of the coast. The area has good potential in terms of soil characteristics and water availability, and is considered one of the main centers for cereal production in North Sinai. Lehfin occupies about 40,000 feddans (16,806 ha) and is dominated by El Tarabeen tribe, with a total population of 1,500.

Agricultural production relies exclusively on rainfall, and the cereal/livestock system is the major economic activity. A total of 2,000 feddans (840 ha) are cultivated with cereals, of which 60% are in barley and 40% are in wheat. About 300 feddans (126 ha) are planted with grapes, olives and almond trees which are located in the low places of the *wadi*. Watermelon is the main row crop, and is cultivated on specific fields. Sparse rangelands are located on the shoulders of Wadi El Arish as well as on the elevated areas outside the *wadi*.

Livestock breeding is practiced by the majority of the farmers in the area, with a total number of 12,500 goats and sheep, in addition to 20 camels.

El Kawaza

El Kawaza is located about 10 km south of the coast and represents one of the more developed areas in North Sinai. A total of 20,000 feddans (8,403 ha) are dominated by El Sawarka tribe, with a total population of 1,300 people.

Vegetable production is the major activity for the majority of the people in the area. The farmers cultivate all vegetables except cucumbers under low plastic tunnels using drip irrigation systems. Groundwater is the main source of water for irrigation. About 350 feddans (147 ha) are planted to olive trees. Cereals are cultivated on 1,000 feddans (420 ha): 40% barley and 60% wheat. Cereal crop production depends mainly on rainfall.

There are 1,100 sheep and goats, which graze most of the time outside of the area.

Qabr Amir

Qabr Amir is located in El Sheikh Zoweid district and is representative of the major economic activities of the coastal strip. The total area is 30,000 feddans (12,605 ha), inhabited by 1,600 Bedouins from El Tarabeen tribe.

Agricultural production relies exclusively on rainfall, and tree production is the main economic activity, followed by wheat and barley cultivation in the southern parts of the area. Peaches, figs and grapes are planted on 1,300 feddans (546 ha), while cereals occupy another 1,300 feddans (546 ha). Wheat is the dominant cereal crop in this area and is cultivated on 65% of the total cereal acreage.

There are 3,000 goats and sheep, with no camel breeding.

El Barth

El Barth is located on the eastern side of the North Sinai and is representative of the rainfed agriculture along the north coast of the Sinai. The area encompasses 35,000 feddans (14,705 ha) and is dominated by El Romeilate tribe. The total population is 1,800.

Agricultural production in El Barth relies exclusively on rainfall. The inhabitants use a cereal/livestock system, which is the major economic activity. Some 8,000 feddans (3,361 ha) are cultivated with cereals, of which 55% is cultivated with barley and 45% with wheat. Watermelon is the main row crop in the area. Peach and almond trees are planted on 1,700 feddans (714 ha) in the northern part of El Barth, while cereal production dominates to the south.

Livestock production is practiced by the majority of the people in the area. There are about 20,000 head of goats and sheep in addition to 300 head of camels.

Wadi El Omar

Wadi El Omar is located 55 km south of the coast and is representative of the inter-mix of the *wadi* and open land systems, with a heavy dependence on cereal cultivation and livestock grazing.

The total area of Wadi El Omar is 80,000 feddans (33,613 ha), which are inhabited by 3,000 people from El Tarabeen tribe.

About 10,000 feddans (4,201 ha) are cultivated with cereals, 60% barley and 40% wheat. Cereals are cultivated on the shoulders of the *wadis*, on the sloping surfaces and on the flat areas. In addition, 700 feddans (294 ha), located mainly in the low places of Wadi El Arish tributaries, are planted with grapes, olives and almonds. Watermelons are planted in the same fields as wheat and barley. The rangeland is located on the hilly localities and to the south.

Livestock production is a major activity for all Bedouins in the area. The total number of goats and sheep is 3,500, and there are 50 camels.

Table 6 summarizes the characteristics of the selected locations in the North Sinai.

Table 6. Selected locations in North Sinai.

	Lehfin	El Kawaza	Qabr Amir	El Barth	Wadi El Omar
Area (fed†)	40,000	20,000	30,000	35,000	80,000
Population	1,500	1,300	1,600	1,800	3,000
Cereals (fed)	2,000	1,000	1,300	8,000	10,000
barley	60%	40%	35%	55%	60%
wheat	40%	60%	65%	45%	40%
Trees (fed)	300	350	1,300	1,700	700
	grape, olive, almond	olive	peach, fig, grape	peach, almond	grape, olive, almond
Vegetables	watermelon	all except cucumber	watermelon	watermelon	watermelon
Legumes			lentil		
Sheep/Goats	1,400	1,100	3,000	20,000	3,500
Camels	20	-	-	300	50
Barley yield (kg/fed)					
good	250	500	400	270	250
medium	200	280	200	180	170
low	100	100	100	100	50
Wheat yield(kg/fed)					
good	150	350	300	150	200
medium	100	240	200	100	100
low	50	100	50	50	50
Grazing (months)					
100%	6	3	3	6	6
50%	3	3	4	3	3
10%	3	6	5	3	3
Income (%)					
trees	30	20	60	20	10
vegetables	15	50	10	10	5
cereals	20	20	10	25	30
livestock	35	10	20	45	55
Non-agr. income	10	3	5	1	10

† 1 hectare = 2.38 feddans.

Agro-ecological Characteristics

The physical characteristics of North Sinai vary from north to south (Fig. 6). The results of the Rapid Rural Appraisal, as well as the secondary data, show that the region can be divided into four agro-ecological zones in terms of geomorphology, climate, water resources, soils and farming systems. Following is a description of the natural characteristics of these zones.

The shoreline

The shoreline is a narrow belt of coarse-textured soil and sand dunes, 1 km wide. Annual rainfall varies from 150 to 250 mm and increases from west to east as well as from south to north. A shallow layer of groundwater floating over the saline water exists at a depth of 1-2 m. It is of good quality and is used mainly for the production of vegetables. The shallow groundwater is recharged from sheet runoff, *wadi* runoff and deep infiltration, and is stored behind the coastal sand dunes. Palm trees are abundant in the coastal belt. A few animals are raised, although they are heavily dependent on supplemental feed.

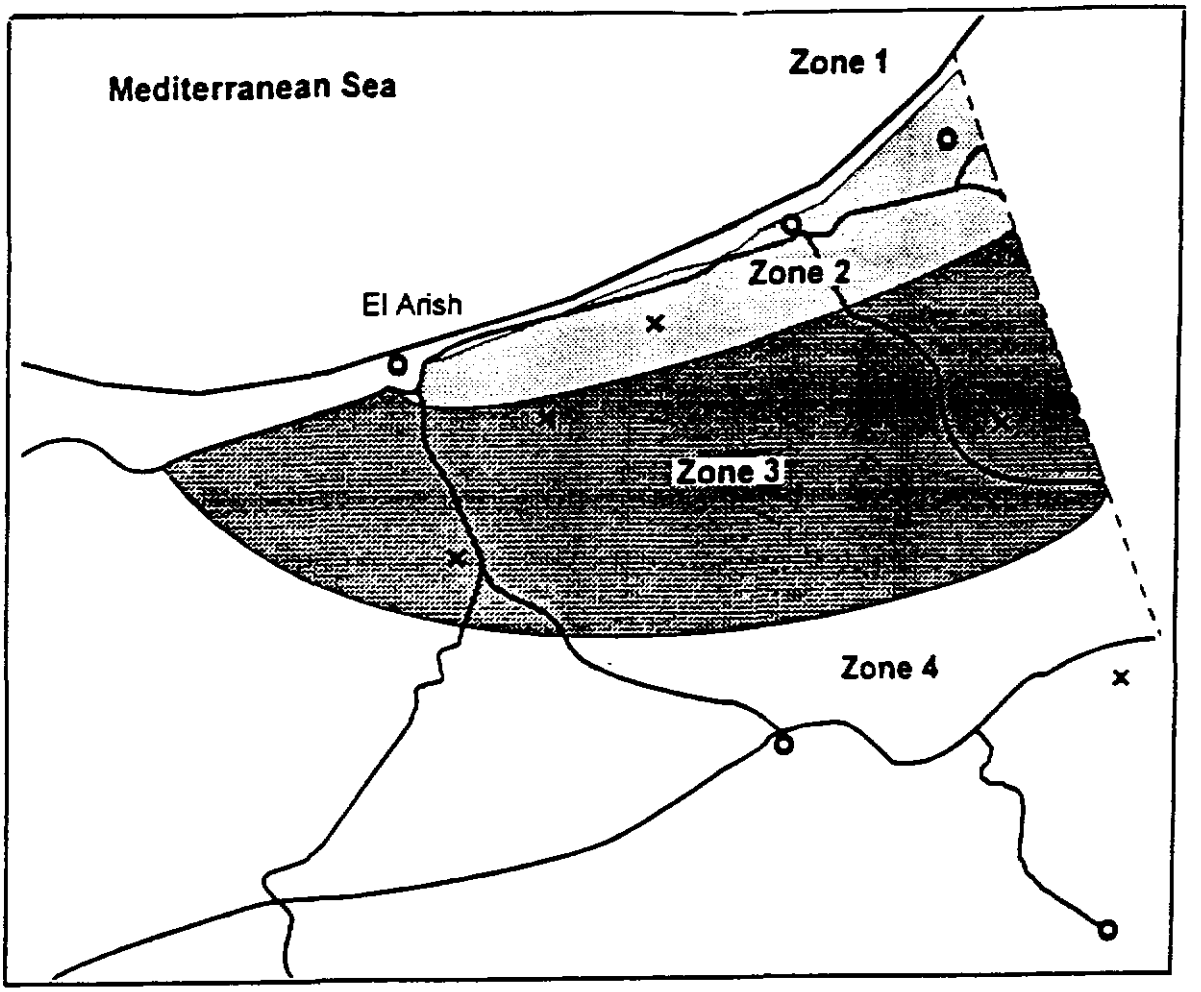

Fig. 6. Agro-ecological zones in North Sinai.

The Coastal Plain

This is a narrow belt about 10 km wide which slopes to the north. The soil is generally deep sandy loam. Annual rainfall varies from 120 to 200 mm with the amount increasing from west to east and from south to north. Rainfall is used mainly for the production of trees, with some legumes and cereals (wheat, barley). Groundwater is relatively deep (30 to 80 m) and of good to moderate quality. It is used for domestic purposes and the production of vegetables. Groundwater is recharged from *wadi* flow and sheet runoff. Sheep and goats are raised in this zone if there is access to the southern rangelands.

The Cereal/Livestock Production Zone

This zone lies south of the coastal plain and is about 30 km wide. Geomorphologically it includes the main course of Wadi El Arish, the very slightly undulating surrounding areas to the east, and the flat areas to the west. The soil is generally deep calcareous sandy loam. The annual rainfall varies from 100 to 150 mm. The gentle slope, coupled with crust formation at the soil surface in the southern parts, enhances surface water accumulation as sheet runoff and gully flow. This sheet runoff spreads over vast areas and seeps into the soil causing increases in water availability. Barley and wheat equally dominate the southern parts, while

in the northern parts tree plantings dominates, along with intercropped barley, wheat and lentil. Dikes have been erected in Wadi El Arish, while cisterns have been constructed in the flat areas to store rainwater. Groundwater is relatively deep and of moderate to low quality. It is used mainly for domestic purposes. Livestock breeding is a major economic activity, integrated with the production of barley.

The Inland Zone

This zone includes 14 tributaries of Wadi El Arish in addition to some lower areas. It begins 30 km from the coastline and stretches to the south and west. The soil is generally moderate to deep sandy loam and rich in $CaCO_3$. Annual rainfall is less than 75 mm. Groundwater is very deep (> 800 m) and of low quality. It is used mainly for domestic purposes. Livestock grazing is the major activity, with easy access to the southern rangelands. Barley and wheat are produced in the low places and on the sides of the tributaries. The bottoms of the Wadi El Arish tributaries have good potential in terms of soil characteristics and water availability. Olives and almond trees are planted there.

Production Systems

Although the production systems in the rainfed areas of Egypt are generally similar, there are some differences between the production systems in the Northwest Coast and North Sinai. In the Northwest Coast, barley and wheat crops occupy 85.57% of the total cultivated areas, while they represent only 31.52% of the cultivated area in North Sinai. The introduction of wheat cultivation into barley fields is more acceptable in North Sinai than in the Northwest Coast. Barley and wheat occupy 74.4% and 25.6% of the total acreage of cereals in the Northwest Coast, and 29.67 and 70.33% in North Sinai, respectively. Production practices also differ in the two regions. The results show that there is no manuring or weed control in barley and wheat fields in the Northwest Coast, while in North Sinai, farmers apply manure to their barley and wheat fields and collect weeds for animal fodder.

Tree cultivation is dominant in only 11.7% of the total cultivated areas in the Northwest Coast, but 62.77% in North Sinai. A few Bedouins apply small amounts of manure to their fruit trees in the Northwest Coast, while the majority of North Sinai Bedouins apply high rates of manure to their fruit trees.

The number of sheep and goats in North Sinai is only about 30% of the total number of sheep and goats in the Northwest Coast (1,200,000 head). Sheep are the dominant animal in the Northwest Coast, while goats are dominant in North Sinai.

Cereal production

Wheat was recently introduced into the rainfed areas of the Sinai Peninsula and has been incorporated into the production system. But barley is still the main desirable crop in the area because it grows quickly, matures early and needs less water. The expansion of wheat cultivation at the expense of barley has led to changes in the farmers' traditional systems.

The amount of barley and wheat cultivation varies markedly from year to year depending on the amount and distribution of rainfall. The total area of barley and wheat in 1993 was estimated at 49,573 feddans (20,828 ha), with 28.79% barley and 71.21% wheat.

Cereal production relies exclusively on rainfall and is not supported by any water harvesting structures. Cereals are cultivated in the sandy calcareous soils and on the gently sloping areas. There is a minimum of seedbed preparation before sowing, which takes place in late October to early December for barley and from December to early January for wheat. Planting depends upon the perceived reliability of rainfall. Many factors affect the ratio between barley and wheat, such as the amount of rainfall, livestock ownership, and type of soil. Farmers tend to plant barley in the shallow or elevated soils.

Cereal crops are sown manually. Immediately after sowing, the soil is plowed. Land is cultivated by tractors using moldboard or chisel plows.

Some farmers, especially the poorest farmers, are still using animal draft power for cultivation of barley and wheat. The availability of tractors also affects the ratio of area sown to barley and wheat.

Plowing is normally done in one shallow pass following the broadcasting of seed and the first substantial rain. The farmers said that plowing in two passes improves crop establishment and increases yield. Plowing on the sloping surfaces is vertical on the contour lines to prevent soil erosion, while on the lower parts plowing is parallel to the contour lines to increase water infiltration into soils.

Local barley varieties are grown in the area and are preferred over the introduced Hybrid 89 and Giza 123. The primary source of local barley seed is the Bedouins' personal stocks, while the cooperative stocks are the source of improved barley seeds. The main source of wheat seed is the cooperative, which distributes Giza 164, Sakha 69, and Sakha 8. None of the Bedouins buy wheat seed from commercial sources.

Barley and wheat seed is not treated before sowing. Bedouins do not practice chemical treatment, sifting or cleaning of seeds before sowing. Seeding rates of barley and wheat vary from one site to another depending on the amount of rainfall, soil moisture capacity, and soil depth.

In the areas of high rainfall and deep soils with high moisture capacities (Lehfin, El Barth and El Kawaza) the barley seeding rate is higher (35 kg/fed) than in the relatively low rainfall areas (Wadi El Omar), where the seeding rate is 30 kg/fed. The seeding rate for wheat is also higher (40 kg/fed) in areas receiving higher rainfall than in areas receiving relatively low amounts of rainfall (35 kg/fed).

No crop rotations are practiced by the Bedouins in the study area. The Bedouins cultivate barley and wheat yearly, and, because of the drought-like climate and lack of water management, cereal rotations occur in alternating areas. In areas where vegetable production relies on low-quality groundwater (El Kawaza), soluble salts accumulate on the soil surface. The Bedouins there cultivate barley in the vegetable fields every two years to leach out the accumulated salts. This practice depends on direct rainfall.

All the Bedouins in the northern parts of the study area manure their cereal fields, while in the southern locations there is no manuring or chemical fertilization for barley or wheat. The manuring which results from the traditional practice of grazing animals on cereal aftermath appears to be sufficient for long-term cultivation of cereals on the same land.

Weed control is practiced in barley and wheat fields and the Bedouins use collected weeds for animal fodder. In poor rain years the annual weed growth within the crop provides an

important forage for small ruminants, supplementing their feeding on the crop aftermath. The annuals are mainly drought-tolerant, early-maturing legumes which not only provide an additional source of protein for animals but also have a beneficial effect on fertility maintenance in the shallow soils.

The Bedouins said that pest infestation and disease are not major problems for cereal production due to the low amount of rainfall. They added, however, that there is leaf rust and black stem rust, and that some insects attack the barley and wheat crops in small areas. They said that they have difficulty getting insecticides from the cooperatives, and that the price is high.

The farmers harvest their barley from the end of April to the first of June, while wheat is harvested from the end of June to the first of July. Harvest is done manually by both men and women by pulling up the barley and wheat plants and collecting them into low piles.

Barley and wheat threshing is done using animal-drawn sleds or by direct trampling by animals. Winnowing is done by hand. After winnowing, the grain and straw are hauled to flat areas close to the house where they are stored.

The results of the Rapid Rural Appraisal show that barley and wheat yields are generally low and vary widely according to the average annual rainfall, the potential for water accumulation in the field, the soil depth, the soil moisture retention capacity, the seedbed preparation, and the seeding rate.

In general, the average yield of barley and wheat is higher in the coastal areas and decreases southwards. The farmers said that in a given area the grain yield of wheat is about two thirds that of barley. Table 6 includes the main characteristics of cereal production in North Sinai.

The farmers retain a portion of the harvested barley grain for planting the following season, but they may also purchase seeds from large farmers or from outside the area following crop failure. Wheat grain is retained exclusively for household consumption. The Bedouins receive wheat seed from the cooperatives at subsidized prices every year, thus they do not retain any wheat grain for planting.

In poor rain years, the Bedouins let their sheep and goats graze on the barley and wheat crop in the green stage instead of harvesting, mainly in those areas where barley and wheat grains cannot be harvested. In good rain years some farmers allow sheep and goats to graze a part of the barley field and harvest the remainder.

Legume production

Lentil has been recently introduced to the Bedouins in North Sinai. Lentil is intercropped with peach and almond trees under rainfed conditions in the northern areas, while in the bottom of Wadi El Arish lentil is cultivated as a single crop in the upstream areas of earth and stone dikes.

In the study area, about 2,672 feddans (1,122 ha) are cultivated with lentil, either intercropped with fruit trees or in separate fields. Sixty-six percent is cultivated in El Sheikh Zoweid, 16.4% in Rafah, 14.7% in El Hassana, and 2.9% in El Arish.

Lentil is planted in November and December. Two main lentil varieties are cultivated in the rainfed areas of North Sinai; they are Giza 370 (small seed) and Shami (large seed), which matures earlier.

The lentil crop is harvested manually in April, and yields vary from one year to another depending on the total amount of rainfall and the type of soil. Yields increase as the amount of rainfall and the retained soil moisture content increase.

Lentil yield in North Sinai varies between 1 and 2 ardab/fed (381 and 762 kg/ha), but in years of very good rainfall it may reach 2.5 ardab/fed (952 kg/ha).

Vegetable production

The total acreage under vegetable production in North Sinai varies from one year to another as well as from one location to another depending on the amount and distribution of rainfall and the availability and quality of the groundwater. The total area cultivated with vegetables in 1993 was 4,974 feddans (2,089 ha). Of these, 2,066 feddans (868 ha) were summer vegetables and 2,908 feddans (1,211 ha) were winter vegetables.

The main vegetables cultivated under rainfed conditions are watermelons and sweet melons. Other vegetables are irrigated with the available groundwater. About 14% of the total vegetable area is cultivated under low plastic tunnels using drip irrigation. Table 7 shows the cultivated area and yields of vegetables in the summer and winter seasons for 1993.

Table 7. Vegetable area and yield in North Sinai (1993).

Crop	Area (fed)				Total area (fed)	Yield (t/fed)
	El Arish	El Sheikh Zoweid	Rafah	El Hassana		
Summer vegetables						
Tomato	345	152	269	43	809	11
Cucumber	53	132	177	-	362	7
Pepper	15	32	248	-	295	6
Watermelon	60	28	88	25	201	12.3
Cantaloupe	44	5	4	21	74	4.1
Eggplant	7	5	277	-	289	8
Squash	30	-	6	-	36	4.7
Winter vegetables						
Tomato	303	252	537	6	1,098	12.8
Cantaloupe	604	448	314	16	1,366	7.6
Cucumber	3	198	93	-	294	8.3
Eggplant	5	-	14	-	19	6.2
Pepper	3	2	14	-	20	5
Squash	4	4	117	-	25	5.2
Phaseolus	-	38	32	-	70	2
Totals	1,476	1,296	2,190	111	5,073	

1 hectare = 2.38 feddans.

Watermelon is the most important rainfed row crop for the Bedouins in the study area. It is sown from mid March to mid April on specific fields. The Bedouins plow their fields in one pass and the seeds are then planted. In the coastal sand dunes belt, where wind erosion is a critical problem, the Bedouins may replant their seeds many times. They use the traditional plow drawn by camels, while in the inland areas they use tractors. After the seedlings appear, the Bedouins reduce the number of plants many times to maximize production per plant.

Weed control is practiced in the watermelon fields as well as with other vegetables. Bedouins collect weeds and grasses to feed their animals. They say that they also practice weed control to protect their vegetables from insects and diseases and to reduce competition for water and nutrients.

Harvest is done manually and lasts two months (July and August). The farmers sell their produce in the marketplaces of the villages and towns, and some of them even transport their produce to the markets of Cairo and Ismailia.

Watermelon production varies between 20 and 50 kg/fed (48 and 119 kg/ha)) depending largely on the amount of rainfall and moisture storage capacity of the soil. The production of watermelon seed is about 50 kg/seed per feddan.

Tree production

The fruit trees grown in the northern areas of the Sinai peninsula are peach, almonds, olive, grape, fig, citrus, apple and palm. They are cultivated in areas characterized by deep soil of relatively fine texture with good possibility of water accumulation.

There are 84,135 feddans (35,350 ha) planted to fruit trees in the study area. Of this amount, 69% is cultivated with peach, 12.8% with almond, 7.7% with olive, 3.0% with grape, 2.2% with fig, 1.0% with citrus and 0.6% with apple. Palm trees occupy about 3.6% of the total tree acreage in the study area.

The Bedouins plant fig seedlings in January, while olive seedlings are planted all year-round. They irrigate their young trees during the summer. Irrigation amount and frequency are higher in areas where fresh groundwater stored in cisterns is available. None of the Bedouins use supplemental irrigation for old trees. They manure their trees every year. Manuring rates are higher in the coastal areas (10 kg/tree) than in the inland areas (2 kg/tree).

Weed control is practiced by all farmers in the study area. Plowing between trees is common.

Pruning is done yearly after harvest to remove unnecessary or dead material. Pruning is more severe in dry years than in years of good rainfall.

Harvesting of fruit trees is done manually by men and women, almost always by family labor. Yield varies from one year to another and from one location to another depending on the amount of rainfall, soil moisture storage capacity and the age of trees. Table 8 shows the main characteristics of tree production in the study locations.

Table 8. Tree production in North Sinai

Crop	Lehfin	El Kawaza	Qabr Amir	El Barth	Wadi El Omar
Total area of trees (fed†)	300	350	1,300	1.700	700
Types	grape, olive, almond	olive	peach, fig, grape	peach, almond	grape, olive, almond
Supplemental irrigation	rarely for young trees	rarely for young trees	rarely for young trees	rarely for young trees	rarely for young trees
Manuring	yearly	yearly	yearly	yearly	yearly
Weed control	plowing	plowing	plowing	plowing	plowing
Yield (ton/fed)					
Peach					
good	–	–	4.5	4.5	3.0
average	–	–	3.5	3.5	2.0
low	–	–	2.0	2.0	1.0
Almond					
good	1.5	–	–	2.0	1.5
average	1.0	–	–	1.5	1.0
low	0.5	–	–	1.0	0.55
Olive					
good	2.5	3.5	–	–	3.0
average	2.0	2.5	–	–	2.0
low	1.0	2.0	–	–	1.0
Grape					
good	1.5	–	2.0	–	1.5
average	1.0	–	1.5	–	1.0
low	0.5	–	1.0	–	0.5
Fig					
good	–	–	1.5	–	–
average	–	–	1.0	–	–
low	–	–	0.5	–	–

† 1 hectare = 2.38 feddans.

Livestock production

The results of the Rapid Rural Appraisal show that livestock production as a tribal occupation retains a high status and is the major economic activity for the Bedouins who are living in the northeast coast of the Sinai. Animal husbandry in these areas varies from traditional practices to modern techniques and can be carried out in combination with crop production or not. Sheep and goats are the principle animals.

Poultry production is practiced in the Bedouin houses where poultry provides a source of household eggs, meat and an everyday currency.

Donkeys are used for transport and riding stock for women and boys as well as for agricultural operations such as plowing. There are 9,743 donkeys in the study area, 14.61% in El Arish, 21.1% in El Hassana, 41.7% in Rafah, and 22.7% in El Sheikh Zoweid. The Bedouins in the coastal sand dune areas in Rafah own many donkeys because they use them to cultivate their watermelon fields as well as for other field operations. In the inland areas, donkeys are more important for transporting water and dry shrubs for home consumption.

The importance of camels in the northeast coast of the Sinai has diminished because of the reduction of natural pasture available for grazing as well as the introduction of the pick-up truck, which has replaced the camel as a popular mode of transportation. Also, camels are not included as items for export trade. The total population of camels is 8,330, distributed throughout the study area.

Some 1,240 cattle, mainly cows, are concentrated in the three coastal districts. There is no cattle breeding at all in El Hassana, located to the south.

Sheep and goats are the principle animals in North Sinai. They are considered a ready source of income for the Bedouins as well as a source of food for household consumption. The secondary data show that there are 143,265 sheep and goats in the study area, concentrated mainly in El Arish and El Hassana (35.5 and 31.6%, respectively). Only 12.0 and 20.9% are raised in Rafah and El Sheikh Zoweid, respectively. The ratio of goats to sheep varies from one district to another. It is 1.8:1 in El Arish, 1.08:1 in El Hassana, 0.7:1 in Rafah, and 1.4:1 in El Sheikh Zoweid.

The results of the Rapid Rural Appraisal indicate that the number of sheep and goats has decreased during the last three decades because of deterioration of the rangeland as well as the expansion of trees and barley fields into the rangeland.

The results also show that the number of sheep and goats increases as the acreage planted to barley and wheat increases, which gives an indication of the interrelatedness of cereal production and small ruminant breeding. There are 1,400 head in Lehfin, 1,100 head in El Kawaza, 3,000 head in Qabr Amir, 20,000 head in El Barth and 3,500 head in Wadi El Omar. The Bedouins said that the availability in spring and summer of range on the top of hills and mountains is the main reason why goats are preferred, since they can climb the mountains more easily than sheep. They also said that the decision to sell or retain animals depends on feed availability and consequently on the amount of rainfall.

Animal nutrition

The two major sources of animal nutrition are grazing and feed supplements. The Bedouins allow their animals to graze all year-round, but the proportion of feed from grazing varies from one season to another and from one location to another. In Lehfin, El Barth, and Wadi El Omar animals depend heavily on grazing for the six months from February to July because of the availability of rangeland. During the summer, 50% of the total feed requirements come from livestock grazing on barley and wheat stubble and range plants. This lasts for three months. About 90% of the animal feed requirements comes from supplemental feed for the three months of November, December and January.

In El Kawaza and Qabr Amir, animal grazing on the rangeland meets 100% of the animal feeding needs for the three months from February to April. From May through July or August animal grazing meets about 50% of the feeding needs. During the period from July or August through January, supplemental feed represents more than 90% of the total animal feeding requirements. Fig. 7 shows the typical annual feeding regime in North Sinai.

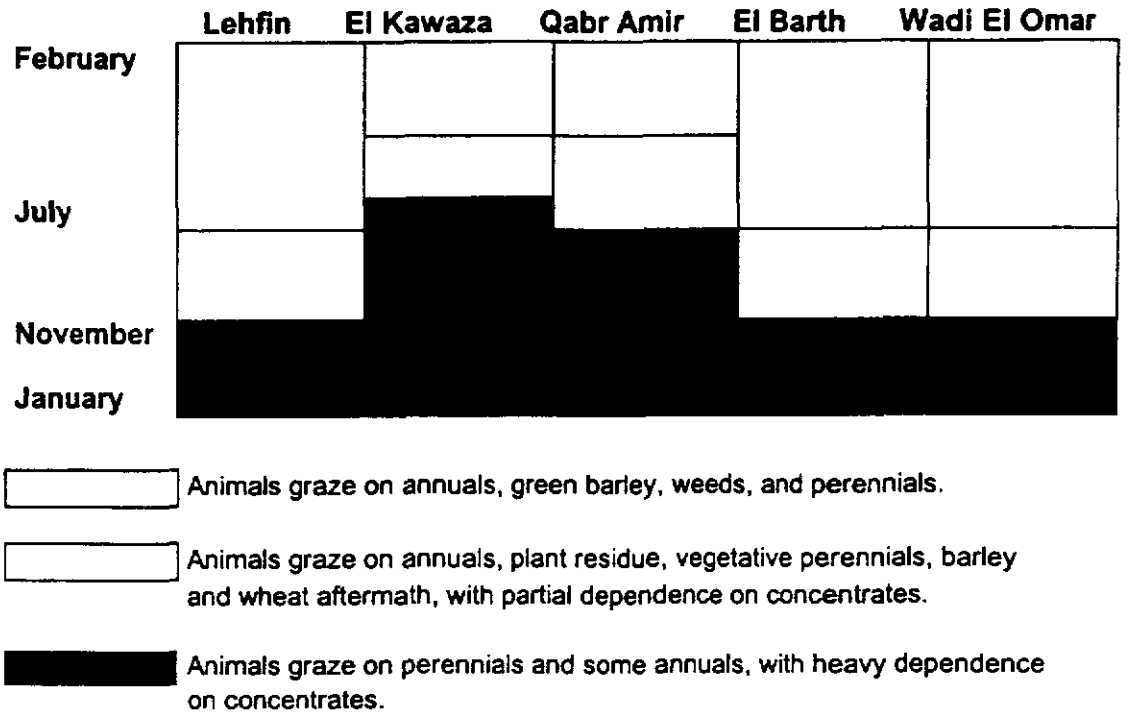

Fig. 7. Typical annual feeding regime in North Sinai.

Bedouins in the study area depend on two grazing sources for their livestock, natural vegetation, and barley and wheat stubble.

Natural grazing occurs in the uncultivated areas in the *wadis* and depressions where the dense or very dense vegetative cover allows everyone to graze his sheep and goats. Some of the Bedouins migrate annually with their flocks of sheep and goats, moving each spring to the coastal areas and Wadi El Arish or to other *wadis* bisecting the high mountains in the southern zone, looking for natural pasture. Where there are palm trees the Bedouins let their animals graze on fallen dates at different stages of maturation all year-round.

In areas cultivated with wheat and barley the Bedouins let their sheep and goats graze on the stubble immediately after harvest. In areas cultivated with trees and vegetables, weed control is practiced and the grasses and weeds collected are used to feed the animals. After the harvest of vegetables the farmers use plant residue for animal fodder.

The movement of the flock to the rangeland starts at sunrise, with the flock returning at sunset. Lambs and kids usually graze separately, closer to the settlements. After weaning they join their dams in the pasture. When animals return from the range, they are fed roughage (hay) or concentrates, depending on the type of pasture they roamed. Animals are generally herded by boys and girls, but sometimes a shepherd is hired to take the animals to pasture.

Farmers use large amount of concentrates in the study area. The major sources of supplemental feed are cotton seed cake, grains and barley and legume straw.

Carrying capacity

Carrying capacity in the study area depends on many factors and varies from one location to another depending on differences in the amount and distribution of rainfall and consequently on plant growth and land cover. In the areas with ground cover ranging between 20 and 30%, the carrying capacity is estimated at 31 feddans (13 ha) per head. In other areas, where ground cover reaches 70%, the carrying capacity increases to about 17 feddans (7.1 ha) per head.

Socioeconomic Considerations

Land tenure

Historically, every tribe on the Sinai Peninsula established itself in an expanse of the desert, where it maintained exclusive rights. Territorial conflicts among tribes were settled by *El Qadaa*, the tribal arbitration committee made up of the *omdas*, which adjudicated according to Arab norms and customs. Nowadays, the tribes have their own traditional documents which specify ownership of their lands. Although they are not recorded in any land register, all boundaries between different tribal areas are well known. Land is inherited by descendants without conflict.

Within the tribal areas, land has been distributed down to the family level, especially in the northern areas. Cultivated land is distributed among the Bedouins, and each knows the shape and boundary of his plots.

In the communal rangeland of the mountains and El Teh plateau, some problems arise due to the mobility of the Bedouins. But the *Qadaa* tribal council is there to resolve these problems.

Farm size

The results of the Rapid Rural Appraisal, supported by the secondary data, show that the total number of farm households in the study area is 14,655. Farms can be categorized into three groups as follows:

- Small farms (less than 10 feddans, or 4.2 ha, less than 20 head) represent about 78.2% of the total farming households.
- Medium farms (10-20 feddans, or 4.2-8.4 ha, 20 to 100 head) represent 17.6%.
- Large farms (over 50 feddans, or 21 ha, over 100 head) represent 4.2% of the total farmers in the study areas.

Labor

The main factors affecting family labor for agricultural production in North Sinai are family size, off-farm employment, landholding and number of livestock. The majority of the farmers rely mainly on family labor. Only large farmers hire labor to harvest cereals and tree crops, and for threshing and herding livestock.

The average family size is 5.5 with approximately 2.0 labor units available (one adult = one labor unit).

The tasks of land preparation, planting of cereals, irrigating, pruning fruit trees, cereal and horticulture crop harvesting, transport and livestock herding (when animals are grazing away from the home compound) are all undertaken by adults. Boys assist in these activities,

especially in herding animals. Adult males do all the purchasing of inputs and handle the sale of surplus farm products.

Women help the men with cereal and horticulture crop harvesting and cereal threshing, and tend to have primary responsibility for weeding of horticulture and vegetable crops. Women and girls water the animals when herds are in or close to the home compound. They are also responsible for milking goats and gathering manure for application to field crops, vegetables and trees. The calculated manpower requirements are:

- 2.1 men per feddan (5 men/ha) of vegetables.
- 0.42 man per feddan (1 man/ha) of fruit trees.
- 0.05 man per feddan (0.1 man/ha) of barley and wheat.
- 1 man per flock of 100 head.

Although labor is easily available in the area, when peak demand occurs during the cereal harvest in May and June the farmers may have to hire laborers to help the family.

Farm income

Fruit trees and vegetable production are the important economic activities in the northern strip of North Sinai. The importance of animal husbandry and barley production increase southwards. In Qabr Amir, tree production accounts for 60% of the agricultural activities, while in El Kawaza, vegetable production accounts for 50% (Table 7). The production of cereals contributes 10 to 20% of the total farm income in the coastal strip, increasing to 30% in Wadi El Omar to the south.

In the main areas of vegetable and tree production, which are located in El Kawaza and Qabr Amir, people depending exclusively on the breeding and herding of flocks are becoming fewer and fewer. Consequently, the contribution of livestock production to the household income is decreasing (about 10% in El Kawaza and 20% in Qabr Amir).

In general, farm income varies from one year to another and from one family to another.

Estimates of the output and income for the main crops for different farm sizes in the study area are summarized in Table 9.

Non-agricultural income

An additional 1 to 10% of the household income comes from non-agricultural sources. Such activities are considered an exclusive source of income for about 5% of the total households in the area, concentrated close to the main towns. The Rapid Rural Appraisal has identified this non-agricultural income as follows:

- 24% commerce
- 14% vocational jobs
- 13% transport
- 21% employees
- 13.5% traditional handicrafts
- 13% agro-processing
- 1.5% real estate

Table 9. Output for main crops in North Sinai.

	Lehfin			El Kawaza			Qabr Amir			El Barth			Wadi El Omar		
	L	M	S	L	M	S	L	M	S	L	M	S	L	M	S
Area (fed)															
Wheat	-	4	2	5	2	-	40	20	1	-	-	1	10	10	3
Barley	-	-	1	3	3	-	21	5	1	-	5	3	15	15	4
Watermelon	-	40	-	20	10	-	10	-	-	-	10	3	25	5	2
Melon	-	-	-	10	3	-	-	-	-	-	-	-	-	-	-
Lentil	-	-	-	-	-	-	10	-	2	-	-	-	-	-	-
Tomato	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
Olive	-	-	-	1	1	-	50	-	-	5	-	-	-	2	-
Peach	-	-	-	-	-	-	10	-	3	35	-	-	-	-	-
Average income (LE/fed)															
Wheat	-	369	371	396	394	-	415	415	415	-	-	413	401	400	391
Barley	-	413	317	402	402	-	274	274	275	-		325.6	390	390	393
Water-melon	-	-	-	695	695	-	393	-	-	-	633.0	593	795	795	795
Melon	-	-	-	743	743	-	-	-	-	-	-	-	-	-	-
Lentil	-	-	-	-		-	325	-	325	-	-	-	-	-	-
Tomato	-	-	-	2725	-	-	3704	-	-	-	-	-	-	-	-
Olive	-	-	-	3254	2725	-	1480	-	-	2941	-	-	4954	4954	-
Peach	-	-	-	-	3254	-	-	-	1480	1540	-	-	-	-	-

1 hectare = 2.38 feddans.

L= Large; M = Medium; S = Small.

The role of women

The Bedouin society in North Sinai is similar to that in the Northwest Coast in its patriarchal and hierarchical structure in terms of the privileges granted for age and position in the family. Adult male decisions supersede those of women. In some cases older women may have some say in specific matters after the approval of men, especially those related to activities within the households.

Women in North Sinai are responsible for the daily running of the household, including food preparation, the making of carpets, the cultivation of small vegetable plots close to the house compound, and the breeding of poultry. Women are indirectly responsible for significant portions of the in-kind household income, but their contribution is minimal. The older women have privileges in mobility and decision making that are not normally given to younger women or girls. They can travel from their villages to El Arish, Ismailia, El Qantara and Cairo to buy household supplies. They are also allowed to converse with men and can participate in some decision making. Older women may become fully responsible for the household, especially after the death of the household head.

The older women are responsible for distributing domestic tasks among the daughters and daughters-in-law. They also assist the older children in overseeing the younger children. Older women also have a say regarding household purchases such as furniture, type of oven, food, clothing, etc.

Women in North Sinai may own sheep and goats and other small animals such as chickens, pigeons, and rabbits. They are also given some of the wool for spinning and weaving carpets and blankets, which then become their property. They produce head covers, necklaces, and embroidered pillow cases. While such items are normally produced for self consumption, women can keep the cash if they are sold. This cash is spent on clothes, jewelry, furniture, and gifts, or saved. In many cases women give the money to their husbands to buy fodder and feed concentrates for their flocks.

Agricultural Support Services

Credit and financial services

There are two main sources of financing for agricultural activities in North Sinai. They are:

- Principal Bank for Development and Agricultural Credit, or PBDAC (El Arish branch).
- Informal sources.

The PBDAC branch located in El Arish loans money directly to producers at competitive interest rates. Recipients must produce standard guarantees, such as collateral, to secure loans. Loans are made for vegetable marketing, water pumps, tractors, agricultural machinery, egg production and poultry farms, olive salting, etc.

Informal loan sources include relatives, traders, wholesalers, and agro-processing plants. This financing tends to be an advance against delivery of the crop or livestock.

Marketing and markets

The markets in North Sinai are dominated by private traders, wholesalers and cooperatives.

The marketing of livestock does not present a problem, due to the fact that the strong local market demand for sheep and goats guarantees a better than average market price. Market prices for fruits and vegetables tend to be low, due to inconsistencies in quality.

The principle markets of North Sinai are at El Arish, El Sheikh Zoweid and Rafah. Wool is sold to private traders, while goat hair is used locally to make tents. Sheep and goat milk, and homemade butter and cheese are not produced for sale, but are consumed by the family.

Projects

International projects

There are a number of international projects in the study area, including WFP, UNESCO, JICA and GTZ.

WFP

The World Food Program is active in the Sinai as well as in the Northwest Coast, working to increase Bedouin sedentarization, decrease erosion, improve soil resources and enhance socioeconomic conditions.

UNESCO

The project aims to improve socioeconomic conditions and drill wells to increase and sustain agricultural production.

JICA

Japan International Cooperation Agency (JICA) has funded two projects to study the soil of the northwestern Sinai, as well as groundwater resources.

GTZ

The German Agency for Technical Cooperation is funding a rural development project in a pilot area in North Sinai.

The Italian project

This project is developing agricultural production in some *wadis* in the southern part of the study area.

National projects

Many national projects are being carried out by agencies such as the Academy of Scientific Research and Technology, the National Research Center, the Agricultural Research Center, and the universities. All of the these activities are research projects aiming to collect data on available resources.

Problems and Constraints

Rainfed areas in North Sinai have good potential for improved agricultural production, but there are many problems that affect resource management, production levels and sustainability.

Natural resources

- The climate is hot and arid, particularly during the summer. This aridity is increasingly severe in the southern parts of the study area.
- There is a lack of information on the climate, especially with respect to the distribution and expectancy of rainfall and rainfall/runoff correlation.
- Half the year is completely dry with no rainfall at all, leading to water shortages in summer and early fall. This causes an increase in the exploitation of groundwater and leads to rapid deterioration of groundwater quality.
- There is a lack of information on the conservation and development of groundwater resources.
- North winds cause movement of the coastal sand dunes which affects agricultural areas and vegetables, especially watermelon cultivation. Sand-carrying south winds in the spring also affect vegetation, especially in the rangelands of the southern regions. Wind erosion affects the sides of Wadi El Arish and its tributaries and causes damage to fields and orchards in the south.
- Flood waters cause erosion of the *wadis* and soil.
- There is a lack of catchment areas, and this causes extended areas of bare and dry soils in the cereal/livestock production zone.
- Information on soil characteristics, such as infiltration rates and moisture storage capacity, is lacking. This greatly affects the development of the region in terms of improved productivity and water harvesting.
- Changes in soil salinity have resulted from over-pumping of groundwater, especially in El Kawaza.
- Water harvesting in the cereal/livestock and inland zones, particularly storage of surface runoff water in currently existing cisterns, does not sufficiently cover water needs in the summer. Cisterns also have low efficiency.
- Dam and dike systems are not used often enough and well enough for the purpose of developing and intensifying agriculture.
- There is an absence of research activity on integrated resource management at the farm level. Research programs and extension efforts will improve and sustain the resource management and enhance agricultural productivity. The Bedouins are more than willing to participate in these research activities.
- The present resource use does not take into consideration the sustainability of these resources.

Crop production

- The lack of water is considered the main constraint to increasing agricultural production.
- There is an inadequate distribution of water in the fields.
- Soil fertility is declining.

- Crop management systems are inadequate, including land preparation, crop management, harvest and post harvest practices.
- There is only poor potential for crop production in the southern parts of the study area.
- Agricultural products are of low quality.
- There is water erosion of soils due to inadequate land leveling and terracing.
- There is a lack of research, extension and training programs due to low staffing levels, limited information and limited facilities.
- There is a lack of formal follow-up for newly introduced improved varieties.
- Coordination between research and extension services is weak.
- Interaction between research and extension organizations and the Bedouin community is weak.
- Crop rotation, which is needed to maintain soil fertility, is not practiced.
- Water-use efficiency is low.

Animal husbandry

- Rangelands are destroyed by overgrazing, shrubs are used for fuel, and expansion of agriculture into rangeland areas is unchecked.
- There is a lack of information on the carrying capacity of the rangelands, the size of the flocks, and the pattern of seasonal flock migration, all of which affect grazing management.
- Reproduction rates for small ruminants are low due to inadequate feeding and health care conditions and the absence of genetic selection.
- Agricultural products are of low quality.
- There is a lack of rural extension and veterinary services, especially in the southern parts of the study area.
- There is not enough water for the animals in the rangeland.

Rural support services

- Access to rural services is difficult.
- Existing facilities are poorly staffed and poorly equipped.
- There is an absence of skilled professionals to serve in the area.
- Road networks are inefficient.
- There is a lack of postal and telecommunication facilities.

Development Potential

Although North Sinai had the potential to play an important role in the economic security of the country, it was left to benign neglect until the occupation of 1967. Following liberation in the early Eighties and the peace agreements, these areas have acquired political,

economic, social and security significance to the country, and their development is a top priority for the Government of Egypt. Systematic efforts are now being made to develop these economic and human potentials. This requires the adoption of resource management programs that would lead to sustainable agricultural development and improved productivity.

In the two northern zones, due to soil characteristics and water availability, there is a high potential for intensification, either by intercropping with trees or with field crops. This can be accomplished by:

- Raising productivity per unit area.
- Improving soil and water management systems.
- Improving crop production systems.
- Developing productive wind breaks on the coastal dunes, on sloping soil surfaces and around orchards.
- Adoption of better pruning practices for fruit trees.

In the cereal/livestock and inland zones, which are considered the principle zones for the production of field crops, there is a higher potential for an absolute increase in agriculture productivity and therefore in the total value of crop yields. This could be achieved by:

- Increasing the productivity per unit area and the density of field crops (barley and wheat) by improving water harvesting techniques and farming systems.
- Intensification and stabilization of the production of field crops on terraces and retention basins by introducing high-yield varieties and cultivars, fertilization schemes and plant protection.
- Improving the productivity of winter and summer vegetables by improving water-use efficiency.
- Improving rangeland and rangeland management by introducing proper range rotations, proper water harvesting techniques for rangeland management, re-seeding of local range plants, introducing new species and varieties, and fodder afforestation.
- Introduction of productive wind breaks.

The Bedouins in North Sinai are willing to participate in research programs to sustain their resources and improve their production levels.