NILE VALLEY REGIONAL PROGRAM
PHASE II

Resource Management Series

Volume 18

MULTIDISCIPLINARY SURVEYS

Rainfed Areas of Egypt

Editors
Nicholas Garrigue, Rashad Abo Elenein, Mahmoud B. Solh,
Mohamed Abdel Monem and Hamdy Khalifa

Volume 18

Resource Management in the Rainfed Areas of Egypt: Multidisciplinary Surveys

Technical Input

Team Coordinator: **Nicholas Garrigue**

Consultant

Team Members: **Dr Mohamed Abdel Monem**

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

Dr Hamdy Khalifa

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

Language Editor: **Dr Hala Hafez**

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Table of Contents

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.

Rashad Abo Elenein
National Program Coordinator, NVRP
Agricultural Research Center, Egypt

Mahmoud B. Solh
Director of International Cooperation and
Former Regional Coordinator NVRP/ICARDA

Weights and Measures

1 feddan (fed) = 0.42 hectare = 1.037 acres

1 hectare (ha) = 2.38 feddans

Acronyms

ARC = Agricultural Research Center

CA = Cultivated Area

EU = European Union

HCU = Human Consumptive Unit

HLU = Human Labor Unit

ICARDA = International Center for Agricultural Research in the Dry Areas

LU = Livestock Unit

NVRP = Nile Valley Regional Program

Results of the Multidisciplinary Survey in the Rainfed Areas: El Barth, North Sinai

Methodology Used in the Multidisciplinary Surveys

Conducting the Surveys

A specific questionnaire was designed for each site surveyed, each questionnaire comprising four parts:

(i) Structural information (description of the household, land area, livestock, etc.).

(ii) Crop rotations recorded by plot over four to five years. In Beni Suef and North Sinai, the whole farm was not recorded systematically if the farmers had too many plots. In these two sites, the first plots to be recorded were those located in the area of interest, according to the sampling method.

(iii) Crop-related information. For at least four crops/farmers, all relevant information on cropping practices and yields was recorded on standard "crop sheets." All this detailed information always referred to the previous season (summer or winter) and to a specific plot so as to record the exact data in relation to the preceding crop.

(iv) Soil and water management aspects. All questions related to fertility, soil degradation, and water availability were recorded.

In each site, a different sampling strategy was devised according to the local specificities and available information. Sampling was always done with the help of a local informant. Farmers' names were randomly selected within each defined category, usually according to the position of their plot. In the New Lands, farmers were selected from detailed maps where all plots were recorded. In Beni Suef, selection was done by visiting each selected area and randomly selecting plots or farmers.

All surveys were conducted in the farmer's field.

Method of Analysis

Structural information

Family size was measured by using the human consumption unit (HCU) concept, with the following scale:

Adult man 15–60 = 1 HCU

Adult woman 15–60 = 0.8 HCU

Child less than 15 = 0.5 HCU

Old person over 60 = 0.5 HCU

Only family members who permanently resided with the farmer were recorded.

Available family labor was measured using the human labor unit (HLU) concept, which was calculated using the same scale as for HCU but multiplying by the rate of presence of the person, as given by the farmer. For example, an adult farmer spending all his time on his farm = 1 HLU; his adult wife who would spend only half of her time on farm work = 0.8 × 50% = 0.4 HLU.

Livestock holding was measure in livestock units (LU). 1 LU = one cow of 250 kg. The value in LU of other animals is as follows:

Young cow = 0.7

Adult buffalo = 1.2; Young = 0.8

Adult sheep or goat = 0.2; Young = 0.15

Donkey = 0.4

Horse = 1.2

Camel = 2

Poultry was not included in this livestock inventory.

Structural ratios were calculated. The cultivated area divided by family size (CA/HCU) gives the average land area available to the farmer to sustain one member of his family (in HCU). The family labor by cultivated area (HLU/CA) gives the area that each labor unit in the family has to work on.

Cropping patterns and rotations

All the crop sequences were recorded with the specific area for each crop each year. This allowed calculating the percentage of land cultivated by each crop on each farm (or field, in the case of Beni Suef and North Sinai) and to recreate the trend at the farm level. By adding all the crop areas for each farmer and dividing the result by the total cultivated area in our sample, we obtained the estimated share of land devoted to each crop on the same total sampled area.

Fertility management and soil degradation

All information included in this analysis came from two sources:

- General information (qualitative data) obtained from the farmer at the end of the survey.
- Crop-specific information recorded on the crop sheets.

The two were combined in the synthesis and were almost always in agreement.

Values for yield and fertilizer application were always recorded for at least two dates: the previous season and five years ago (or less if the farmer started cultivating less than five years ago, as found in the New Lands).

<u>All the information reported in the synthesis came from the farmers' interviews. No modifications were made to what the farmers told us, whether we agreed with it or not.</u>

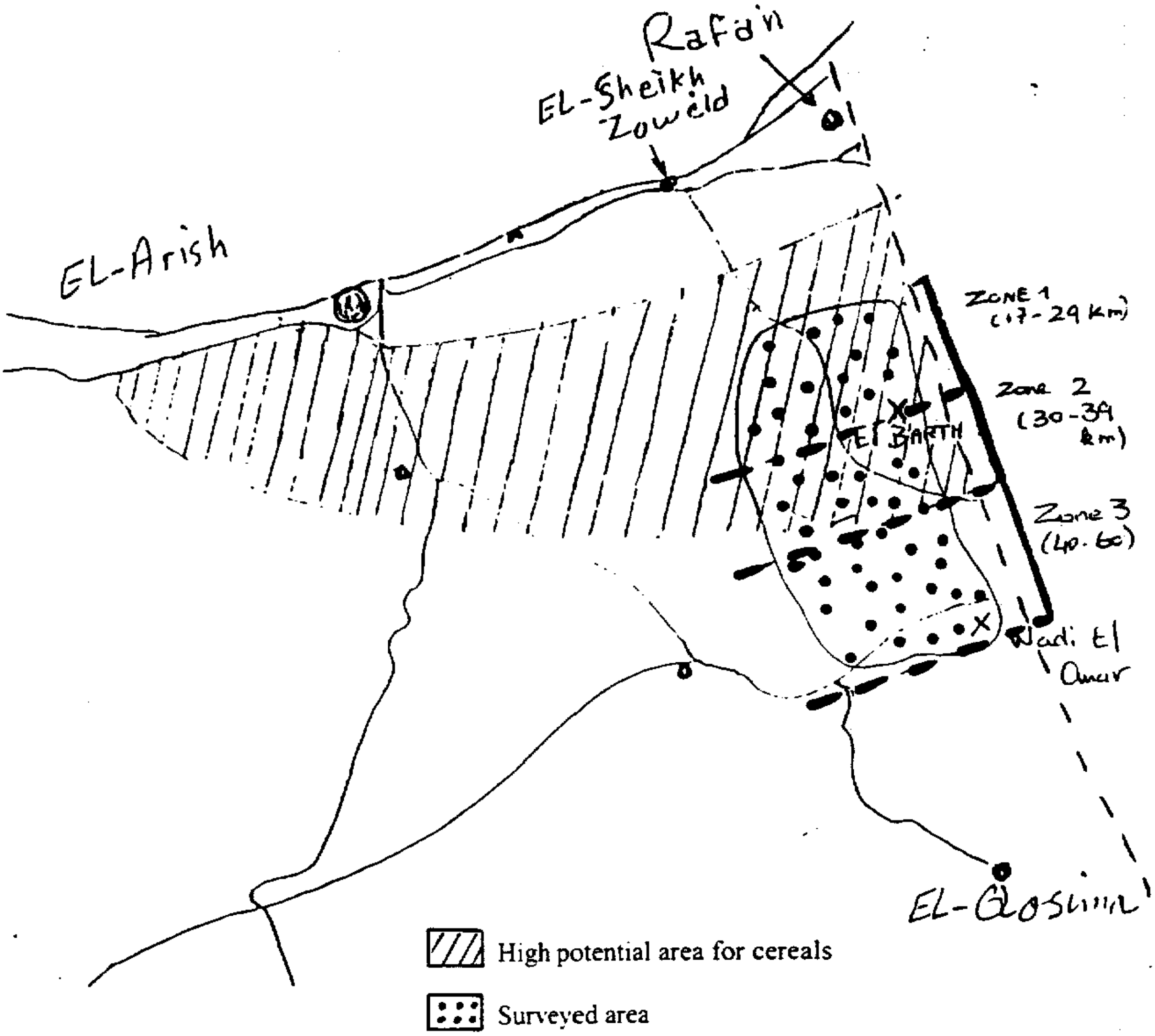
Introduction

The survey was conducted in El Barth area in North Sinai, which extends from 17 to 37 km to the south of El-Sheikh Zoweid area (see Map 1).

The multidisciplinary survey (MDS) team interviewed 15 farmers geographically distributed as follows:

- 5 farmers living between km 0 and km 5.
- 5 farmers living between km 5 and km 20.
- 5 farmers living further than km 20.

The farmers were asked about the fields they cultivate within selected areas as well as any other areas. This allowed the MDS team to collect data representing an area extending from km 0 to km 35.



Map 1. Location of surveyed areas.

Farm and Farmers' Characteristics

Table 1 gives an overview of the main descriptors used in characterizing our sample.

Table 1. Average value and range of structural variables of the surveyed farmers in Rafah area.

Criterion	Total sample	
Age (median)	47	
Family size (HCU)†	5.5	
Family workforce (HLU)‡	3.1	
% farmers own animals	92	
Average livestock holding (in LU)§	3.3 (= 17 small ruminants)	
% farmers owning tractor	8	
Average area owned (fed)	25.5	
Farm land use:		
Trees	20% (65% of farmers grow trees on 30% of their land)	
Crops	70% (100% of farmers grow crops on 70% of their land)	
Rangeland	10% (31% of farmers have rangeland in 40% of their land)	
Structural ratios		
CA/HCU	4.2	
HLU/CA¶	0.2	
Livestock importance for family subsistence compared to crops	more important	8%
	equal importance	24%
	less important	67%

† HCU = Human consumptive unit.
‡ HLU = Human labor unit.
§ LU = Livestock unit.
¶ CA = Cultivated area.
1 fed = 0.42 ha.

The main points are:

Family Size and Workforce

The family size at El Barth area, expressed in human consumptive units (HCU), is 5.5, while family workforce, expressed in human labor units (HLU), is 3.1.

Farm Area and Farm Land Use

The average farm area is 25.5 fed. All farmers cultivate field crops, 65% grow trees, and only one-third keep part of their own land as permanent rangeland. However, communal land for grazing is still present and used by all farmers.

Livestock Holdings

Ninety-two percent of the farmers own animals and the average livestock holding, expressed in livestock units (LU), is about 3.3 (16 sheep and/or goats), which is rather low in this area. Farmers mentioned that due to the shortage of rainfall for the last two years, they sold much of their animals but we also suspect that many of them understated their real livestock size.

The average feeding regime (based on survey results) is as follows:

Crop	Barley grain	Cereal straw	Acacia	Concentrates	Berseem	Range-land	Watermelon residues
Winter	31%	29%	12%	12%	8%	8%	0%
Summer	14%	7%	9%	11%	3%	27%	29%

Structural Ratios

The average land size available by family member (CA/HCU) is about 4.2/fed, while family labor available per feddan (HLU/CA) is only 0.2. Farmers need to hire additional labor at peak labor periods, i.e. crop and tree harvests.

Motorized Equipment

The results revealed that only 8% of the surveyed farmers own tractors, but all farmers use tractors (rented) to cover the cereal seeds after broadcasting or to plow the land before planting watermelon.

Cropping Patterns and Rotations

The cropping patterns and rotations practiced in the surveyed area have been derived from the crop sequences recorded by the multidisciplinary survey team. In most cases the whole farmland (made of several scattered plots) was comprehensively surveyed with each farmer. The data obtained represent the cropping patterns and rotations practiced on 1438 fed of El Barth region.

Evolution of Cropping Patterns

We will first look at the land-use pattern of the region (Table 2).

Table 2. Land-use patterns in % of the total surveyed area (private land only).

Zone	Crops	Trees	Rangeland
17–29 km	58	20	27
30–39 km	77	16	7
40–60 km	84	2	14
Total area	65	16	20

It is obvious from this data that the tree planting limit is within zone 2, around 35 km from the sea. Private rangeland is rather high in zone 1, due to the high occurrence of sand dunes in this area.

Past trend

The crop sequences by plot were recorded for the last three years and the present year.

The cropping pattern in North Sinai depends mainly on three factors:

- Annual rainfall (amount and timing).
- Distance from the sea (related rainfall and humidity distribution).
- Type of soil and topography.

Rainfall effect

If we first look at the trend for crop areas in the whole region (Fig. 1), we can have an idea of the effect of rainfall on the annual cropping pattern.

- 1991 and 1992 were considered as average years in terms of rainfall but with some non-negligible late rains in 1991.
- 1993 was a very bad year.
- 1994 is almost exceptional.

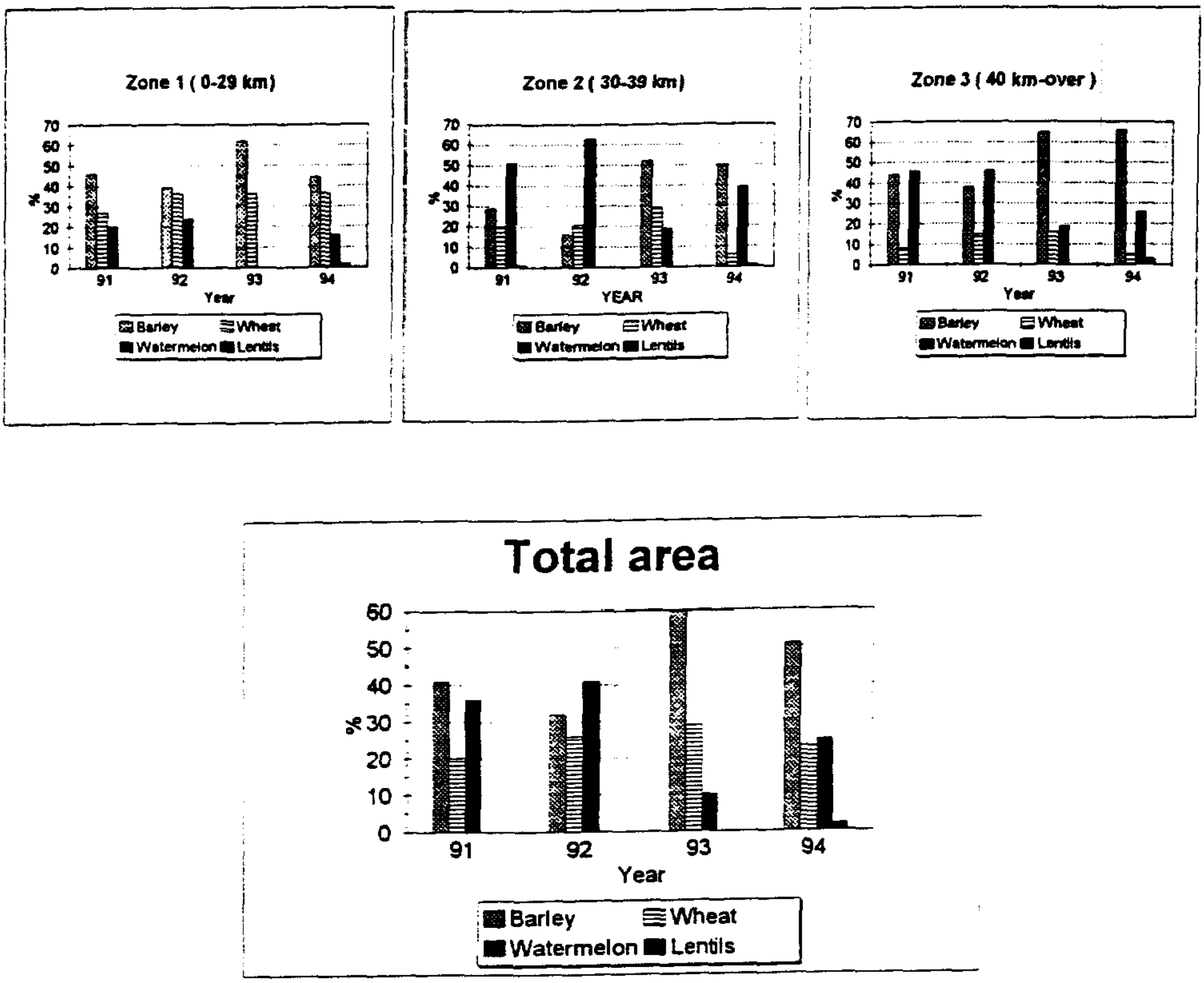


Fig. 1. Trend of cropping pattern over 4 years in El Barth, North Sinai (% of total sampled area for each crop).

Fig. 1 shows that:

- In a bad year, barley is by far the major crop. It is more drought resistant than wheat so farmers will plant it first. If some more rain comes later then they will also plant wheat. This, however, did not take place. This is also why the area planted with watermelon was very low in 1993 (watermelon is planted in April on plots not cultivated with cereals and develops itself on the moisture brought by late rains).
- In a good year, like this year, barley and wheat areas should be more balanced. However, this year, a non-climatic factor played very much in favor of barley: this is the late delivery of wheat seeds by government services. Watermelon comes back to a higher level, but since this year rain came early in large amounts, most of the land was planted immediately to cereals and the area left for watermelon was less than in the average years (see below).
- In an average year, the gap between barley and wheat is reduced and watermelon comes to the same level as barley (or even overpasses it), especially if some late rain comes (January–February), as was the case in 1991 and 1992.
- It is difficult to see from this 4-year record if there is a trend in favor of one or the other of the crops. Rainfall factor is overwhelming and certainly overruns in bad years such economic factors as government subsidies or price fluctuations. Only in good years could these factors have a marked influence on cropping patterns, but in 1994, the wheat seed delivery issue did not permit us to draw any conclusion on the overall trend for this crop.

Distance to the sea

To find out the effect of rainfall distribution on the cropping patterns, we observed the cropping patterns for the three areas surveyed (A = 15–29 km, B = 30–39 km, C = 40 km and above) in Fig. 1, which showed that:

- Barley and wheat areas are almost balanced in zone A (except in 1993), and the watermelon area always remains minor. Even this year, in spite of the seed issue, wheat was sown practically as much as barley. This, of course, was due to higher rainfall close to the sea. Most of the farmers in El Barth were anxious to sow as soon as the rain came to take minimum risk in waiting for later rains to plant wheat (after the seeds are delivered), in case another bad year would repeat itself like in 1993. Only in areas closer to the sea, rainfall was enough from the beginning to reserve some fields for planting wheat later in the season.
- In zone B, watermelon is a major crop in average years and almost equal to barley in good years. This is actually due mainly to the soil types and topography in this area. Watermelon is mostly planted on sandy sloping plots which abound in this zone. However, even in 1994 (plenty of early rainfall), in mixed soil areas where cereals could be planted, farmers reserved a sizeable part of the area for watermelon cultivation.
- In zone C, wheat becomes almost a marginal crop, which is normal given the lower rainfall and higher climatic uncertainty prevailing there. Watermelon and barley are equal in average years with late rain, but in bad years, the gap between the two is more pronounced compared to other zones because the chance of occurrence of late rains is smaller in the south.

Effect of soil type and topography

Fig. 2 shows the cropping patterns in 1993 and 1994 according to the soil types (usually sandy soils are located on small sand dunes and sandy loamy soils in the flat bottom of the wadi).

- On sandy soils in a bad year, even barley is preferred to watermelon, but in a good year (i.e. when soil effect is not overshadowed by rainfall effect), watermelon regains its normal position of a favored crop for sandy soils.
- On loamy sandy soils, cereals are also dominant crops. Watermelon can be cultivated there also, but will remain minor. Lentils are planted on loamy sandy soils only.

Summary

Rainfall amount and timing are the most influencing factors on the local cropping patterns. Distance to the sea (= level of climatic uncertainty) and soil type will add two supplementary spatial dimensions of cropping pattern differentiation. Thus, we could summarize the above as follows:

- In a good year with early rain, barley and wheat will occupy most of the flat areas and watermelon the sandy sloping fields. The proportions of barley and wheat will depend on other factors as seed availability and livestock needs.
- In an average year with early rain only, barley will expand at the expense of wheat and watermelon.
- In an average year with late rains, watermelon can become the major crop, especially in zones further from the sea.
- In a bad year, barley will cover most of the area, wheat being sown only in the regions closer to the sea. Watermelon will be at its all-time low if no late rains come.

Future expected trends

We asked the farmers which crops they were likely to increase in the future and which ones they would rather decrease. This, of course, refers to good rainfall years, since in bad years, barley will always be the only alternative.

The answers are given in Table 3.

Table 3. Percent of farmers willing to increase or decrease specific crops in the near future.

Trend	Barley	Wheat	Watermelon	Lentil	Trees
Up	31	88	25	31	69
Down	50	0	43	0	7
Balance	–19	+88	–8	+31	+62

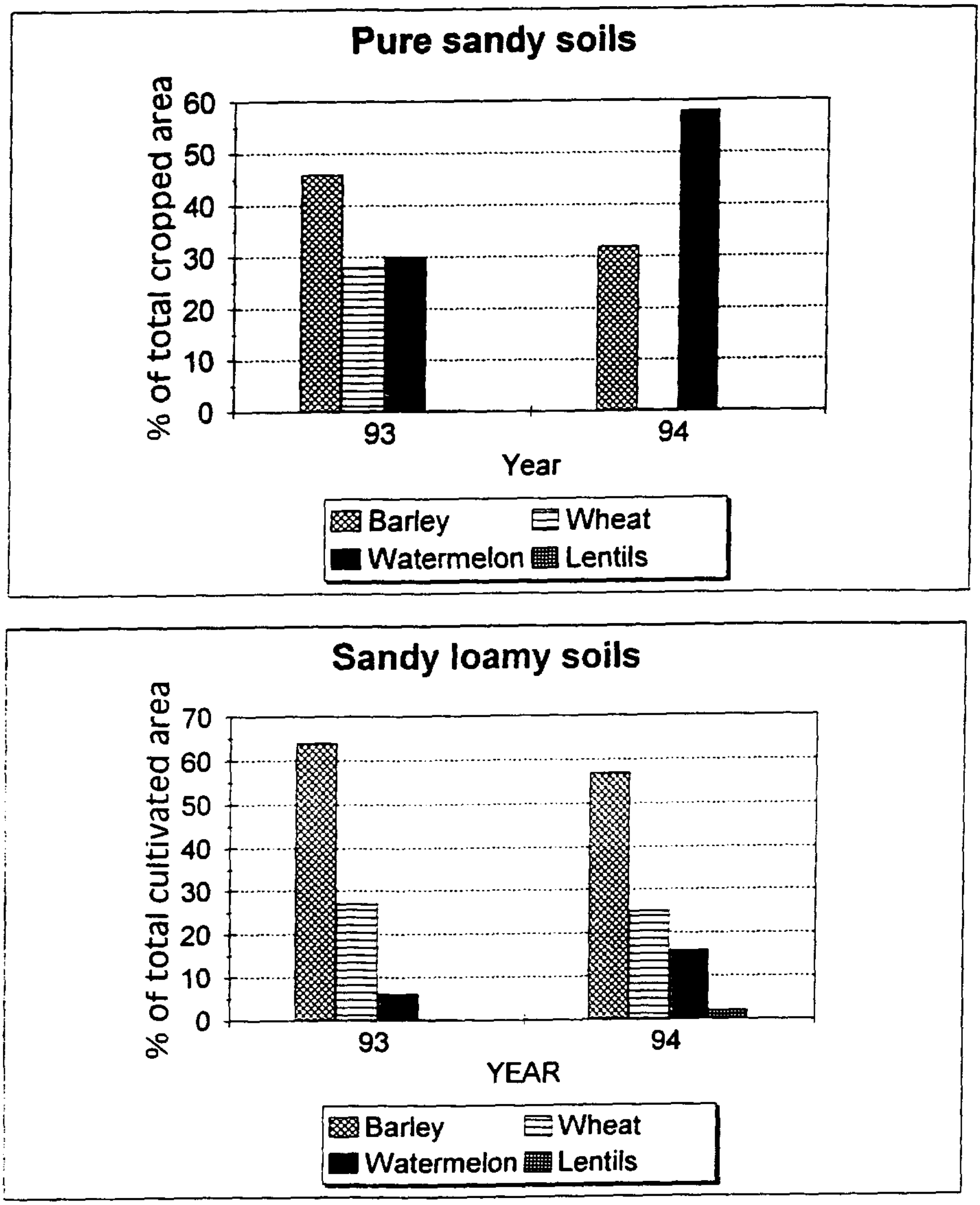


Fig. 2. Cropping pattern according to soil type in El Barth, North Sinai (% of total sampled area for each crop).

This data shows an overwhelming trend towards wheat cultivation. This, of course, remains theoretical as long as more drought-resistant varieties of wheat, showing the same adaptation to low-rainfall years than local barley varieties, have been introduced in North Sinai. But in normal to good years—and if wheat seeds are readily available—we can expect to see the wheat area expand. Apart from incentives given by different kind of subsidies on wheat, there could be a clear long-term trend towards a reduction of barley in favor of wheat explained maybe by the simultaneous expansion of trees and horticultural crops. Indeed, areas planted to trees have been steadily increasing over the last few years. Although we did not obtain figures concerning this expansion, in 1994, fruit trees occupied 16% of the total cultivated area from km 17 to km 60 and 20% in the first strip. To finance this tree-planting move, farmers have to sell animals, and, therefore, the need for barley—and its market value—diminishes. In these conditions, wheat becomes definitely more economically interesting than barley.

In addition to this, the last two years were disastrous in terms of cereal production. Animals suffered a lot as well as farmers who had to sell them to make a living. This just added to the trend of shifting from a livestock-based farming system to a more crop-based system in which trees and wheat become economically more important than barley. Of course, this move will never affect zones further than, say, 35–40 km.

To finish with, lentil has a good potential for the future in terms of farmers' readiness to cultivate it. Already this year in El Barth area, four farmers cultivated it on 23 fed, and the results were quite encouraging (certainly due to high rainfall). This helped spread the idea among farmers that lentil has a good potential for their area.

Prevailing Crop Rotations

The crop rotations have been studied on a sample of 77 crop sequences over 4 years (8 seasons). The total area concerned is 1438 fed.

It is in fact difficult to speak of crop rotations in North Sinai because the choice of crops first depends on the rainfall amount each year and is not really guided by a fertility maintenance logic that could be found in the Old Lands. Soil type and topography also direct crop choice. On sandy sloping plots, monocropping of watermelon will be the most common "rotation." On flat deep sandy loamy soils, cereals monocropping is the rule.

We classified the crop sequences recorded according to the number of crops present in the rotation. The results are shown in Table 4.

Table 4. Tentative classification of prevailing crop rotations in El Barth area (North Sinai).

Number of crops in the rotation	Area	No.	Type of crop(s)	Area	No.	Crop sequences	Area	No.	Example	Rotation years
Monocropping	43	40	Barley	16	18	Barley–Barley–Barley......	16	18	Barley–Barley–Barley...	1
			Wheat	11	6	Wheat–Wheat–...	11	6	Wheat–Wheat–Wheat...	1
			Watermelon	16	16	Watermelon–Watermelon–Watermelon–	16	16	Watermelon–Watermelon...	1
Two crops	43	51	Wheat + Barley	25	29	Wheat–Barley in alternation	5	5	Wheat–Barley–Wheat–Barley	2
						Not fixed	20	24	Barley–Wheat–Barley–Barley	
			Watermelon + Cereal			Not fixed	17	19	Barley–Watermelon–Barley–Barley	
			Lentil + Barley or Watermelon			Not fixed	1	4	Barley–Barley–Barley–Lentils	
Three crops	9	7	Wheat + Barley + Watermelon (Lentils)	9	7	Not fixed (but cereals dominant)	9	7	Barley–Watermelon–Wheat–Barley Watermelon–Barley–Barley–Wheat Barley–Watermelon–Barley–Lentils	

Based on this classification, the three more frequent rotations—called hereafter prevailing rotations—are:

1. Two Cereals Rotation

Area = 25% Number = 29%

Type = Wheat and barley either in alternation or open rotation

Most often wheat will be sown the years of good rainfall and barley the years of average and low rainfall. There is no indication that farmers try to respect a certain sequence between the two cereals.

2. Barley Monocropping

Area = 16% Number = 18%

Type = Barley every year

This kind of monocropping is found mainly in the southernmost areas and sometimes on mixed soil plots (sand + loamy sands) in areas closer to the sea. Wheat can still be sown only during years with exceptional rainfall.

3. Three Crops Rotation

Area = 9% Number = 7%

Type = Cereals + watermelon or lentils

This is the most diversified type of rotation and takes place on mixed-soil plots also. Usually (but not as a rule), cereals are sown two years in a row and then watermelon for one year. However, depending on the rainfall and date, and the soil type, all kinds of other combinations are possible.

Example = Barley–Watermelon–Wheat –Barley

= Barley–Watermelon–Barley–Lentils

Fertility Management

Crop Yield

Seed yields of barley, wheat, lentil and watermelon in good, average and low rainy seasons as a function of distance are given in Tables 5 to 11 and Figs 3 and 4. Also, yields per kg of seed are presented.

Table 5. Seed rate (kg/fed) in El Barth area.

Crop	17–29 km	30–39 km	40–46 km	Total
Barley	20.4 (50)	14.6 (12.4)	13.0† (–)	18.6 (48)
Wheat	26.3 (28)	18.9 (47)	NA	24.6 (31)
Lentil			NA	16.1 (19.4)
Watermelon seed	1.6 (32.8)	1.55 (26.6)	1.58 (47.14)	1.58 (29.11)

NA = Data not available; † One value only.
Values between parentheses represent the coefficient of variation (CV).
No data is given for lentil by zone because we collected only 4 yield figures for lentil in three different zones.

The variation in seed rates between farmers tends to be high for barley and wheat. Also, seed rates decrease from north to south, except for watermelon.

Table 6. Good yield (kg/fed) in El Barth.

Crop	17–29 km	30–39 km	40–46 km	Total
Barley	378 (53)	329 (40)	500† (–)	373 (48)
Wheat	342 (49)	420 (71)	NA	362 (51)
Lentil				278 (72)
Watermelon seed	65 (37)	92 (34)	158 (47)	97 (50)

NA = Data not available; † One value only.

Table 7. Good yield/kg of seed (kg/fed) in El Barth.

Crop	17–29 km	30–39 km	40–46 km	Total
Barley	26 (62.3)	23 (51)	37 (28)	26 (53)
Wheat	23 (73)	29 (101)	38 (–)	26 (69)
Lentil				18 (61)
Watermelon seed	38 (19.9)	60 (32.5)	125 (85)	67 (78)

Watermelon yields increase from north to south, which would mean that rainfall is not the main factor in watermelon yield (land type more important). For cereals, there is no marked difference between zones 1 and 2. Too little data is available for zone 3 to draw any conclusion. Also, like in other surveyed sites, yield data is not reliable enough (due to farmers' mistrust) to allow us going into further analysis.

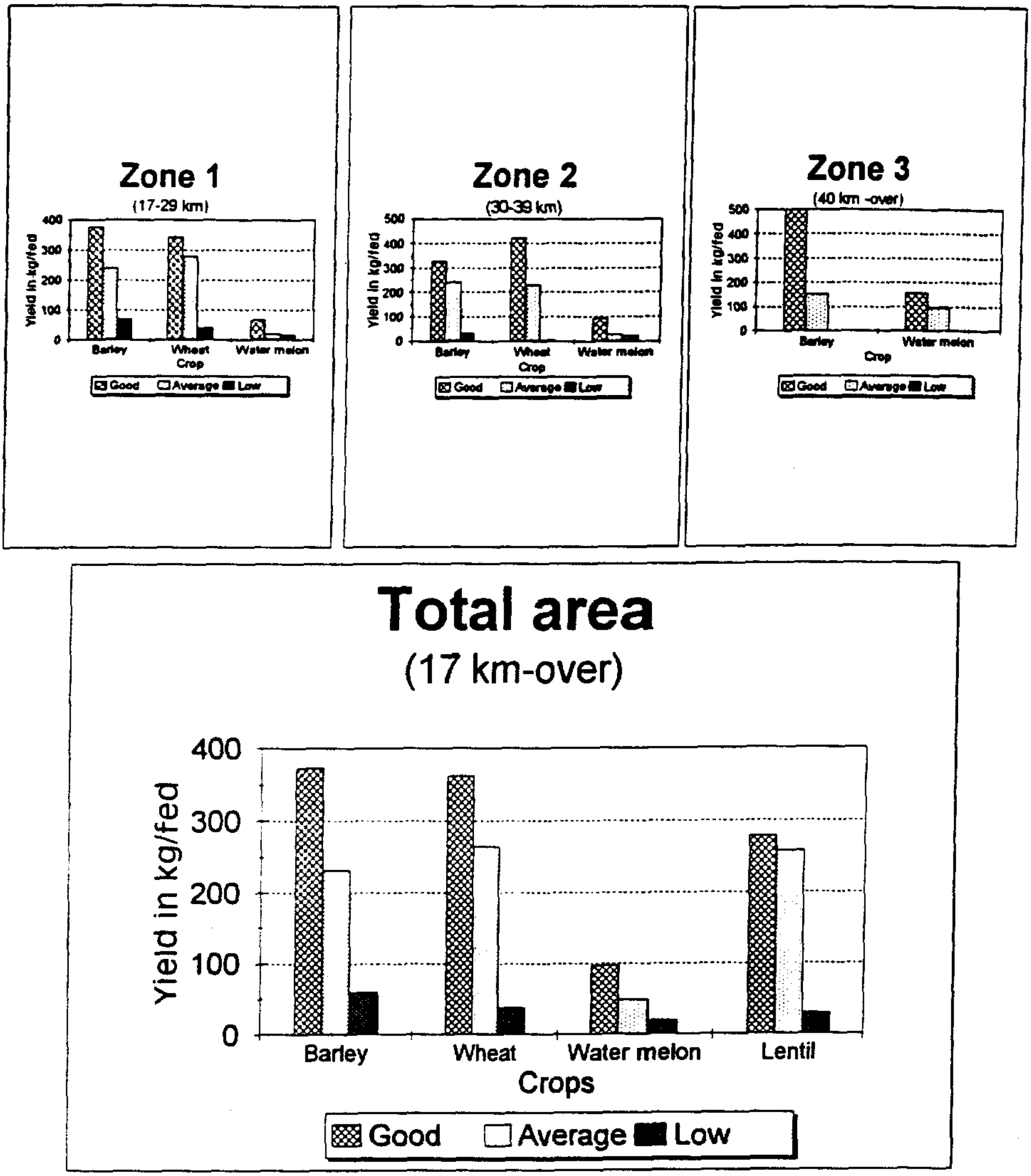


Fig. 3. Crop yield (kg/fed) according to field location in El Barth, North Sinai.

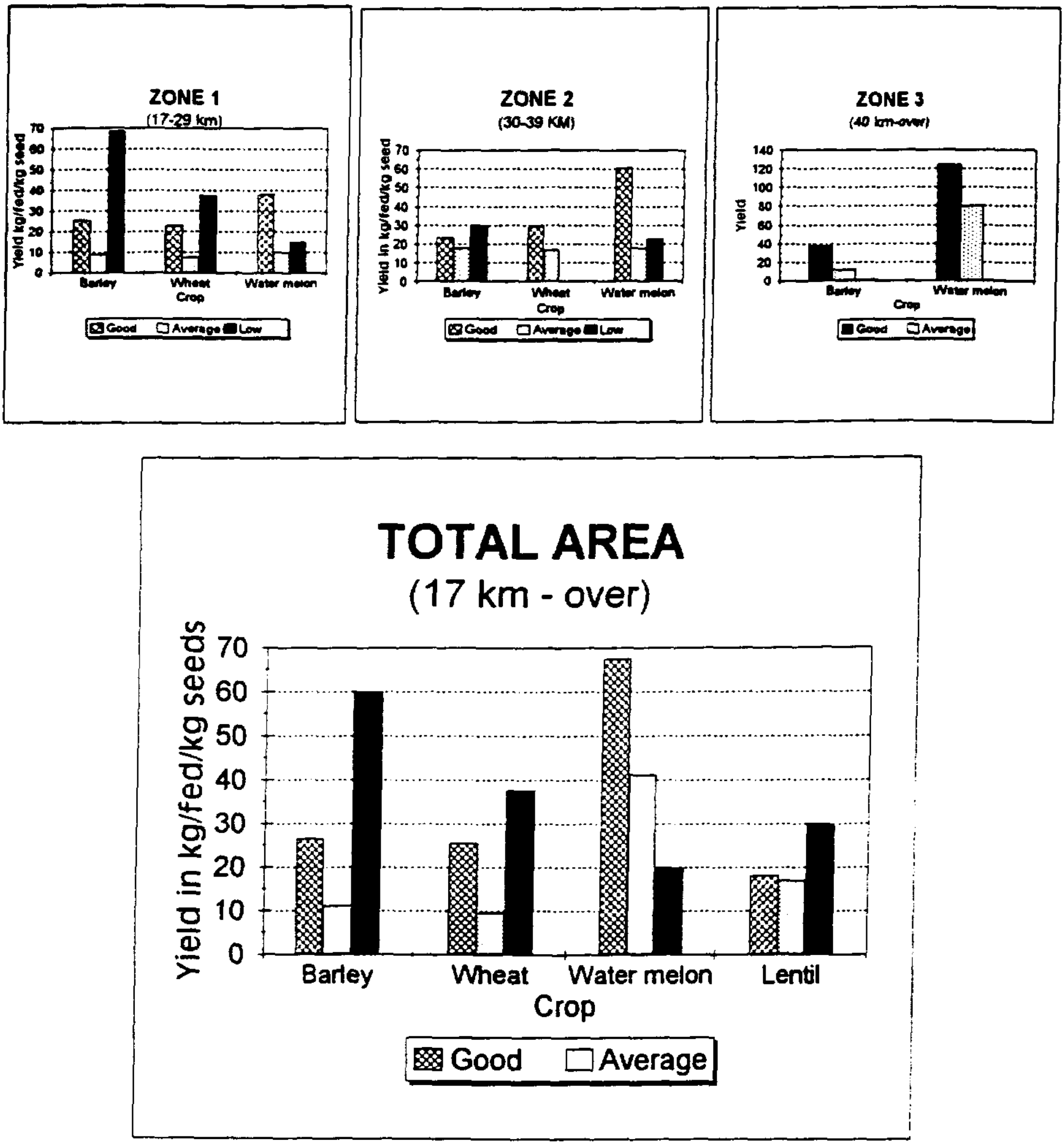


Fig. 4. Crop yield (kg/fed) by kg of seeds in El Barth, North Sinai.

Table 8. Average yield (kg/fed) in El Barth.

Crop	17–29 km	30–39 km	40–46 km	Total
Barley	240 (83)	242 (80)	150† (–)	231 (76)
Wheat	278 (99)	231 (90)	NA	265 (91)
Lentil				258 (55)
Watermelon seed	21 (–)	28 (46)	95 (79)	49 (100)

NA = Data not available; † One value only.

Table 9. Average yield/kg seeds (kg/fed) in El Barth.

Crop	17–29 km	30–39 km	40–46 km	Total
Barley	8.9 (70)	18.1 (93)	11.5† (–)	11.2 (18)
Wheat	7.7 (142)	16.7 (113)	NA	9.5 (127)
Lentil				16.9 (37)
Watermelon seed	10.0 (–)	17.6 (19)	80.0 (106)	41.1 (135)

NA = Data not available; † One value only.

Table 10. Low yield/(kg/fed) in El Barth.

Crop	17–29 km	30–39 km	40–46 km	Total
Barley	69 (50)	30 (–)	0	60 (57)
Wheat	38 (47)	0	0	38 (47)
Lentil				30 (–)
Watermelon seed	15 (–)	23 (47)	0	20 (43)

Table 11. Low yield/kg seeds (kg/fed) in El Barth.

Crop	17–29 km	30–39 km	40–46 km	Total
Barley	3.4 (1.0)	2.1 (0)	0	3.2 (1.2)
Wheat	0.67 (122)	0	0	0.53 (144)
Lentil				1.9 (–)
Watermelon seed	7.8 (5)	15.0 (47)	–	11.4 (51)

The average number of harvests for each crop over the last 5 years is given in the Table 12.

Table 12. Average number of harvests per crop.

Crop	17–29 km	30–39 km	40–46 km	Total
Barley	3	2	2	3
Wheat	3	2	1	2
Watermelon seed	3	2	4	3

Fertility Management Methods

The farmers were asked in the survey to describe the factors that make one field more fertile than the other. The results of their opinions are presented in Table 13.

Table 13. Farmers opinions on what makes a field more fertile than the other.

Reason	% of farmers mentioning it
1. Manure and fertilizer application	69
2. Amount of rain (plot location)	42
3. Soil type	42
4. Land topography	23
5. Leaving land fallow between two successive crops	19
6. Regular cultivation	15
7. Crop rotation (avoiding monocropping)	12
8. Additional water from run-off	4

These data show that uncontrollable factors such as rainfall, land topography and soil type are seen as major land fertility factors in these marginal areas. It also shows that farmers do not really have any established methods for fertility build-up (apart from manure and fertilizers which in fact few of them use). There is also some contradiction between reasons No. 5 and 6 (fallow or no fallow), which is certainly related to the kind of soil considered and whether there is a real crop rotation practiced or not.

The farmers were also asked about the trend of their field productivity with time. Their answers are summarized in Table 14.

Table 14. Farmers' opinions of farm productivity trend.

Productivity trend	Farmers' opinion (%)
Up	36
Equal	50
Less	14

The majority of farmers did not notice any change in their field productivity with time. In fact, most of them related productivity to rainfall amount only, therefore no trend is perceivable.

The farmers were also asked about the effects of harvesting[1] the same area two years in a row on its fertility. Their answers are given in Table 15.

[1] Harvesting and not cultivating, because farmers almost always broadcast seeds when the rain comes, but not always harvest the crop afterwards if the rain is scarce.

Table 15. Effect of harvesting a field two years in a row on its fertility status.

Farmers' opinion	%
- Yes, will increase fertility	93
- due to crop residue and crop rotation	78
- due to manure application	22
- No, will not increase fertility	39
- if same crop is grown	78
- better to leave the land fallow	22
- Rainfall dependent	22

The methods dealing with fertility management will be discussed in the following sections.

Manure

Table 16 presents the general data on manure use by the sampled farmers.

Table 16. General data on the use of manure in El Barth.

Criterion	%
1. % farmers not using manure at all	28
2. % farmers using manure to:	72
Trees only	16
Crops only	28
Trees + Crops	28
- Manure type:	
% farmers using different types:	
- pure manure (not mixed)	50
- manure mixed with crop residue	12
- manure mixed with sand	19
- manure mixed with crop residue and sand	19
Manure self-sufficiency	
100%	32
50–100%	37
< 50%	31

The results indicated that the majority of farmers apply manure to their fields but at very low rates (see below). Altogether, 56% of the surveyed farmers give manure to field crops. Also, the results showed that 50% of the farmers use pure manure and only 32% of them are self-sufficient in the manure they use for their crops and trees.

However, farmers will apply manure to crops only if rainfall is considered good, and it is usually confined to the best part of the field. The use of manure is not regular in terms of time nor space.

Table 17 presents the percentage of farmers applying manure to different crops as a function of the distance from the sea.

Table 17. Percent of farmers applying manure to crops with distance from sea (El Barth).

Crop	% of farmers using manure			
	17–29 km	30–39 km	40–60 km	Total
Barley	46	50	0	42
Wheat	38	0	0	27
Lentil	25	0	0	25
Watermelon seed	50	20	0	27

The more risky the area in terms of rainfall, the less manure is used. Also, applying manure on fields further south means longer and more difficult transport for unpredictable results.

Finally, the effect of applying manure on the yield of wheat, barley and watermelon for seed is given in Table 18.

Table 18. Effect of applying manure on the yield of wheat, barley and watermelon for seed.

Crop	With manure				Without manure				Range of manure applied (m^3/fed)
	Yield (kg/fed)		Yield (kg/fed)		Yield (kg/fed)		Yield (kg/fed)		
	Good	Range	Average	Range	Good	Range	Average	Range	
Wheat	524	(294–1050)	399	(126–672)	370	(130–630)	211	(40–462)	1.7–6.3
Barley	319	(170–840)	127	(68–210)	421	(294–504)	234	(150–378)	0.7–12.6
Water-melon seed	105	(90–120)	NA	NA	95	(42–210)	43	(20–140)	1.7–3.0

NA = Data not available.

The results presented in this table indicate an increase in wheat and in watermelon for seed with manure application and a decrease in barley. However, the yield data given by farmers must be taken cautiously (as for livestock). Moreover, we do not have enough replications of farmers applying manure in our sample, and the yield variability is very high in North Sinai for various reasons (mainly rainfall distribution), making a single-factor correlation hardly representative. Also, the range of manure rate is wide, and since manure is not applied uniformly all over the field, the yield data collected is not precise and specific enough to be analyzed.

Fertilizer use

The majority of farmers (77%) do not use fertilizers. The rest apply fertilizers as follows:

- To trees only (12%).
- To trees and crops (7%).
- To crops only (4%).

Altogether, 11% of the farmers surveyed use fertilizers for field crops.

When farmers were asked why they do not use chemical fertilizers, their answers were as follows:

- High cost (64%).
- High risk related to rainfall (50%).
- Damage to the plant if rainfall is not enough (14%)[2].

The percentages of farmers applying P_2O_5 and N-fertilizer to field crops as a function of the distance from the sea are given in Table 19.

Table 19. Percent of farmers using chemical fertilizers for different crops as a function of distance (El Barth).

Crop	% of farmers using P_2O_5†				% of farmers using N-fertilizers			
	17–29 km	30–39 km	40–60 km	Total	17–29 km	30–39 km	40–60 km	Total
Barley	8	0	0	5	15	0	0	11
Wheat	25	0	0	18	–	0	0	0
Lentil	0	0	0	0	25	0	0	25
Watermelon seed	0	0	0	0	0	0	0	0

† % calculated from the total number of farmers surveyed who are cultivating such crop in such area.

The results showed that only farmers close to the sea, where there is a better chance of rain, apply the chemical fertilizer.

The rates applied are, in general, very low. However, they are presented thereunder just as an indication, because in many cases, we found only one farmer adding fertilizers for a certain crop.

[2] Farmers mean that if fertilizer is applied, the crop will shoot out more rapidly and also develop more stems. However, there might be short drought periods after the first rains and the plant, with accrued needs, will not resist it.

- P_2O_5: Barley = 11 kg/fed (11)

  Wheat = 5.5 kg/fed (4–7)
- N: Barley = 5.3 kg/fed (4.3–6.3)

  Lentil = 16.5 kg/fed (16.5)

Use of legume crops

Lentil is the only legume crop cultivated in the area. Its trend of cultivation is presented in Table 20.

Table 20. Lentil cultivation in El Barth area (in percent).

	Distance (km)	1991	1992	1993	1994
Farmers	17–29	0	0	0	4
	30–39	6	0	0	5
	40–60	0	0	0	12
Total cultivated area	17–29	0	0	0	2
	30–39	1	0	0	1
	40–60	0	0	0	3

The results show that the number of farmers cultivating lentil and the total area devoted to lentil are increasing with time. The major part of this increase is concentrated in the southern strip (40–60 km). Also, the results showed that more farmers are willing to cultivate lentil in the future.

Crop residues

Cereal and watermelon crop residues are fed to animals. Since animal manure is usually applied to fields, there is a partial restitution of the exported nutrients, but manure is not applied every year (which means that a lot is wasted away) and not all the field will be manured. Therefore, restitution of nutrients can be considered as marginal.

Also, since farmers pull out the whole plant at harvest, there is almost no plant residue (roots, stem bases) left in the fields and we could actually speak of total nutrient export. This also means that by increasing plant biomass (higher density, fertilizers, manure), restitution to the soil will not be increased, but only nutrient export will. Harvest methods would have to be changed to see a positive effect on fertility build-up of increasing the fertilization package in this area. Only in case that the crop is not harvested, the farmer will leave his animal to graze the field and the restitution through animal droppings will be more direct.

We also did not find any marked correlation (either positive or negative) between the number of years that a plot had been cultivated and harvested over the last 10 years, and the crop yield obtained from this specific plot in good years.

Water and Soil Management Aspects

Wind Erosion

Seventy-five percent of the farmers said that wind erosion had a non-negligible effect on their land and crops. According to them, the factors favoring wind erosion (expressed in % of farmers mentioning the factor) are:

- Sandy soil: 35%
- Flat land: 30%
- No windbreaks: 25%
- Slopes: 20%

It is not contradictory to find flat land and sloping land both mentioned as factors contributing to wind erosion. Indeed, sand dunes move under the effect of wind and cover fields; on flat areas, wind is stronger and blows away the topsoil as well as seeds. Farmers indicated that the most current damage is on seeds after broadcasting, on young plants, and on flowers of fruit trees. The intensity of damage ranges between 5% of the field destroyed to 100% in some cases and for very exposed plots.

Finally, 66% of the farmers admitted not doing anything special to limit wind erosion. The other 34% mentioned:

- Windbreaks (mainly Acacia trees): 29%
- Tutors (for young trees): 5%

Field Moisture Conservation

Farmers were asked what they thought were the practices that could help increase and conserve the field moisture for a longer time. The results are as follows:

- Plowing the soil before the rain[3] = 46%
- Manure applied before rainfall (and plowed in) = 23%
- Covering the silty-clay soils (flat areas) with sand = 8%
- No techniques available = 42%

The most efficient technique therefore seems to be the combination of manure application with early plowing. It is indeed important that the manure be well mixed with the topsoil to create a kind of mulch that will prevent rapid evaporation afterwards.

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[3] This is a common practice for watermelon. Plowing with tractor is carried out in January and seeds are planted only in April.