FARMING SYSTEMS PROGRAM RESEARCH REPORT 1982

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

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FARMING SYSTEMS PROGRAM

INTRODUCTION

ICARDA's research was set-up to have a farming systems orientation. The major aim was to develop appropriate technologies that could be easily integrated into the existing farming systems in the region. This should increase the quality and quantity of food, and in turn, improve the well-being of the population, particularly the small-holder and resource-poor farmers. Initially, the Farming Systems Program (FSP) was expected to help set research priorities for the Center and assure that research findings of the commodity programs were suitable for and acceptable to these farmers.

At first, the program was hesistant to accept this responsibilty; we began with no theoretical basis on which to build and with few staff trained in Farming Systems Research (FSR). In the past five years, we have made progress clarifying our focus, developing an approach to FSR, gaining experience in the region and doing systems research. The benefits of this research structure are becoming clear and this is illustrated by research findings and results from the 1981/82 cropping season. The approach that the program is taking to FSR is described in the introduction; the results of recent research activities are then presented by projects in the subsequent sections.

Farming Systems Research

First, we define Farming Systems Research as it is perceived within the program. FSR is a process that identifies problems limiting agricultural productivity and then searches for solutions to these problems. FSR is comprehensive in that an effort is made to evaluate new technologies in the light of all the components of the system including the complex interdependencies of these components. This process recognizes the resources and constraints of the farming families (who are both producers and consumers), and seeks solutions that are relevant, useful and acceptable to these families. Research is undertaken by multidisciplinary teams of scientists that interact continually with the farmers for whom the research is intended. This approach should ensure that the research produces appropriate technologies and, therefore, will be more easily and quickly adopted.

The FSP percieves its research as a process that passes through four stages. These stages are: (1) diagnostic, (2) design or experimental, (3) testing, and (4) extension. FSR is problem oriented ; a clear diagnosis and definition of the problem are of paramount importance if the effort to find appropriate solutions is to succeed. This will determine the make-up of the team and the allocation of research effort to the various stages. Indeed, problem-oriented research acts to keep the team together, the effort focused and on-schedule.

This process is dynamic and iterative since we frequently return to previous stages to clarify points as we gain knowledge, confront problems and consider research alternatives. In addition, the distribution between stages is not sharply defined as there is much overlap,and we work at several stages simultaneously. Finally, it is flexible and adaptable to many circumstances and different problems. By visualizing the research process this way, we keep our work in perspective vis-a-vis other scientists and the farmer as well.

Program Goal and Long Range Objectives

The program seeks to find strategies that will add stability and improve the farming systems in the region by increasing the technical and economic efficiency of limited resources. Particular emphasis will be placed on soil and water resources, combined with improvements in crop and livestock husbandry. To achieve this goal, the program has two over-riding objectives which will allow the design of strategies for increasing agricultural production.

The first objective is to develop methods and tools that are required to conduct FSR. An agricultural system is determined by its natural resources, human resources, historical development and the current social and economic environment. Because the ICARDA region is large and diverse, these factors are found in many combinations, and consequently, the systems in our region are numerous. Therefore, we do not aim to develop a new system or technology that has wide applicability or adaptability, but rather a process that can be used to improve a particular system and then be repeated elsewhere.

The second objective is to promote the use of FSR as an efficient approach to solving agricultural problems. FSR is a new approach to agricultural research, and few people are familiar with it. Thus, exposing scientists in the region to this approach, and training them to use it, is a high program priority and will take a long time to achieve satisfactorily. A first step is to test the efficacy of the approach outside of Syria (We have chosen Tunisia for this test.) and then adopt a training strategy to broaden the geographical base to include other countries. We believe that a creative approach will have to be taken towards FSR training. Developing a regional FSR network is an idea that merits consideration.

Research Projects, 1981/82

The program has a number of immediate objectives that guide specific research activities. The main thrust of the program in 1981/82 was to concentrate on basic research (at the design stage) in search of an understanding of the simple as well as complex interrelations between plants, animals and human beings. Thus, an important objective was to assess the potential for increases in productivity and find the means by which these can be achieved.

The research was conducted in five project areas. They are:

Project I

The Productivity of Cereal Crops under Rainfed Mediterranean Environmental Conditions.

Project II

Nitrogen Fixation, Productivity and Water Use of Grain and Forage Legumes under Rainfed Mediterranean Environmental Conditions.

Project III

Crop Rotations and Cropping Systems.

Project IV

The Role of Animals in the Farming Systems of the ICARDA Region.

Project V

Environmental Zoning.

A large effort was allocated to research on cereals (Project I). We have completed three cropping years and have experienced a range of environmental conditions. Thus, we have a considerable quantity of research findings that cover a diverse number of topics relating to this commodity group. While this research is not yet complete, we now have a good understanding of the factors affecting crop growth, and recommendations to farmers on agronomic practices are now possible. This research has lead us directly into other activities such as (a) on-farm joint-managed (farmer and scientist) trials, (b) complementary research on legumes and crop rotations, (c) studies on grain and straw use for animal feed and (d) research on economic problems related to the availability of purchased inputs.

A major effort on the subject of biological nitrogen fixation (Project II) indicates a large potential for legumes to produce nitrogen particularly when good management practices are used. The potential decreases as the availability of water decreases but even in the dry areas significant amounts of BNF have been measured. The research on crop rotations (Project III) is concentrating on the barley/fallow rotation in search of a forage or cereal-forage mixture that would replace the fallow: results are promising.

The livestock research (Project IV) has shown that sheep performance can be increased through improved feeding using home grown feeds and pasture/forage crops. We now have a better measure of how the presence of animals influence the cropping decisions of farmers. Finally, the recognition of environmental zones (Project V) has been useful in planning outreach activities. While agro-climatic zones overlap with economic zones, this research shows that basing research allocation decisions solely on agro-climatic zones will not be very effective.

The details of these results follow.

HIGHLIGHTS OF METEOROLOGICAL CONDITIONS 1981/82

In Northern Syria physical environmental conditions at the beginning of the cropping season were generally favorable (Table 1). Precipitation events were well distributed in time and the first rains capable of causing germination were recorded in early November, approximately five weeks earlier than in 1980/81. Seasonally low temperatures with some frost were observed in December and January (Table 2). However, in February a substantial period of anti-cyclonic conditions resulted in continuous sub-zero minimum temperatures for a three week period. The effect of these low night temperatures was exacerbated by generally inadequate precipitation. Most crops showed some damage ranging in extent from minor loss in leaf area to the more rare extreme of complete crop loss at certain sites. However, growth was retarded badly at all sites for most of February, and thus the development of yield potential was effected particularly in early maturing cultivars.

Late maturing cultivars were also favored this season by the highly atypical temporal distribution of precipitation. Large amounts of rain were recorded in the late April-mid May period expecially at drier sites. These occurred in the mid-late grain filling period for early cereal cultivars and considerably reduced moisture stress effects.

In consequence, the seasonal precipitation totals given in Table 3 show the odd situation in which the wetter areas (Zone 1A and B, see Table 4) had a drier than average season; intermediate areas (Zone 2) had a normal season and dry areas (Zones 3 and 4) had a wetter than average season.

Finally, it may be seen in Figure 1 that in the previous three seasons ICARDA's research center, Tel Hadya, has received average or better than average precipitation. The effects of very dry years such as 1958/59, 1972/73 have yet to be experienced.

Table 1

ICARDA RESEARCH CENTER - TEL HADYA

(Met. Data Summary 1981-82 Season)

LAT 35°55'N
LONG 36°55'N
ALTITUDE 362 m

Weekly Period	Daily Air Temperature			RH	SR	E_o	Rain	Wind Run
	Max T°C	Min T°C	Mean T°C	%	MJ m^2/d	mm/d	mm	km/d
1/10/81- 7/10/81	33.0	15.1	24.1	46.6	16.7	9.2	-	266.0
8/10/81-14/10/81	29.3	12.9	21.1	42.0	14.5	7.8	-	201.7
15/10/81-21/10/81	27.7	9.8	18.8	42.0	13.7	5.5	4.6	155.4
22/10/81-28/10/81	28.5	11.1	19.8	41.4	13.1	6.6	-	156.9
29/10/81- 4/11/81	25.2	11.3	18.3	51.6	9.4	4.7	3.6	194.8
5/11/81-11/11/81	18.7	3.8	11.3	52.0	11.3	4.6	43.2	240.1
12/11/81-18/11/81	15.5	6.4	11.0	66.4	8.3	2.5	13.6	226.3
19/11/81-25/11/81	14.4	2.4	8.4	71.5	8.0	1.4	9.0	165.2
26/11/81- 2/12/81	15.3	5.0	10.2	76.1	7.7	1.5	2.7	186.1
3/12/81- 9/12/81	14.8	5.6	10.2	78.1	7.2	1.6	15.0	159.2
10/12/81-16/12/81	14.8	4.1	9.5	76.5	6.5	1.4	3.1	171.8
17/12/81-23/12/81	14.9	4.6	9.8	71.7	7.6	1.9	5.9	259.7
24/12/81-31/12/81	13.3	6.4	9.8	82.8	4.7	0.7	28.9	161.7
1/ 1/82- 7/ 1/82	10.9	6.1	8.5	88.5	3.7	0.8	15.1	234.3
8/ 1/82-14/ 1/82	11.4	5.4	8.4	76.4	5.3	1.5	6.0	241.6
15/ 1/82-21/ 1/82	12.0	-3.3	4.3	56.9	11.1	3.0	-	179.0
22/ 1/82-28/ 1/82	11.3	0.2	5.8	64.6	7.9	2.3	23.4	275.3
29/ 1/82- 4/ 2/82	11.2	3.9	7.6	76.9	6.7	1.3	39.1	228.1
5/ 2/82-11/ 2/82	9.6	-1.9	3.8	67.2	9.7	1.8	3.7	229.5
12/ 2/82-18/ 2/82	10.7	-4.1	3.3	53.6	13.2	2.6	-	172.1
19/ 2/82-25/ 2/82	12.5	0.1	6.3	64.0	11.4	2.6	11.8	331.7
26/ 2/82- 4/ 3/82	15.2	3.6	9.4	68.8	10.5	3.0	10.4	261.7
5/ 3/82-11/ 3/82	15.7	3.1	9.5	68.9	13.0	3.0	6.9	228.8
12/ 3/82-18/ 3/82	15.7	4.2	9.9	63.9	13.9	3.8	10.0	248.6
19/ 3/82-25/ 3/82	17.9	1.8	9.9	61.1	17.6	4.3	4.1	210.7
26/ 3/82- 1/ 4/82	19.1	0	9.6	51.8	18.9	5.7	-	177.6
2/ 4/82- 8/ 4/82	20.3	8.6	14.5	66.0	13.7	4.5	9.2	270.4
9/ 4/82-15/ 4/82	24.1	9.8	17.0	65.7	16.8	5.9	2.0	232.3
16/ 4/82-22/ 4/82	27.7	10.5	19.1	56.6	20.5	9.3	-	261.9
23/ 4/82-29/ 4/82	23.1	10.2	16.7	66.1	15.2	5.7	7.7	272.7
30/ 4/82- 6/ 5/82	24.1	8.9	16.5	70.1	17.9	5.5	40.8	217.3
7/ 5/82-13/ 5/82	29.6	12.0	20.8	57.1	19.2	7.6	9.4	193.5
14/ 5/82-20/ 5/82	28.0	13.3	20.7	61.8	20.5	8.8	6.2	308.2
21/ 5/82-27/ 5/82	29.3	13.3	21.3	55.6	21.2	10.5	0.2	288.1
28/ 5/82- 3/ 6/82	29.9	13.1	21.5	56.0	22.3	11.4	-	352.5
4/ 6/82-10/ 6/82	30.1	13.4	21.8	57.5	22.3	11.4	2.0	326.3
11/ 6/82-17/ 6/82	33.7	17.3	25.5	43.5	23.7	17.0	-	499.0
18/ 6/82-24/ 6/82	35.7	17.2	26.5	37.8	24.9	15.7	-	300.3
25/ 6/82- 1/ 7/82	38.1	17.9	28.0	32.7	23.3	17.8	-	362.8

Table 2. FROST EVENTS IN 1980/81, 81/82 SEASONS AT THE FSP PRINCIPAL RESEARCH SITES.

	JINDIRESS		KAFR ANTOON		TEL HADYA		BRIDA		KHANASSER	
	Nr.of Frost Days	Min Abs. T°C	Nr.of Frost Days	Min Abs. T°C	Nr.of Frost Days	Min Abs. T°C	Nr.of Frost Days	Min Abs. T°C	Nr.of Frost Days	Min Abs. T°C
OCTOBER										
1980	-		-		-		-		2	-3.0
1981	-		-		-		-		-	
NOVEMBER										
1980	3	-2.5	10	-5.5	2	-4.0	8	-6.5	8	-7.5
1981	4	-2.8	10	-4.0	4	-4.2	4	-3.0	5	-6.0
DECEMBER										
1980	7	-4.0	15	-7.0	6	-3.6	14	-4.5	17	-5.0
1981	-		1	0.0	-		-		-	
JANUARY										
1981	2	-2.5	11	-7.0	3	-2.4	6	-5.0	7	-3.0
1982	9	-5.0	13	-6.0	11	-6.0	9	-6.0	8	-4.0
FEBRUARY										
1981	6	-2.0	13	-4.0	7	-3.0	6	-2.0	10	-3.0
1982	16	-7.0	21	-11.0	17	-7.8	17	-8.0	18	-6.0
MARCH										
1981	-		2	-3.0	2	-0.4	-		1	0.0
1982	10	-5.0	18	-7.0	7	-4.2	9	-4.8	16	-7.0
APRIL										
1981	1	-1.5	5	-3.1	3	-2.5	3	-2.2	2	-2.0
1982	-		-		-		1	-1.2	-	
SEASONAL TOTAL										
1980-81	19	-4.0	56	-7.0	23	-4.0	37	-6.5	47	-7.5
1981-82	39	-7.0	63	-11.0	39	-7.8	40	-8.0	47	-7.0

Table 3. Seasonal precipitation (mm) in Northern Syria in 1980/81 and 1981/82.

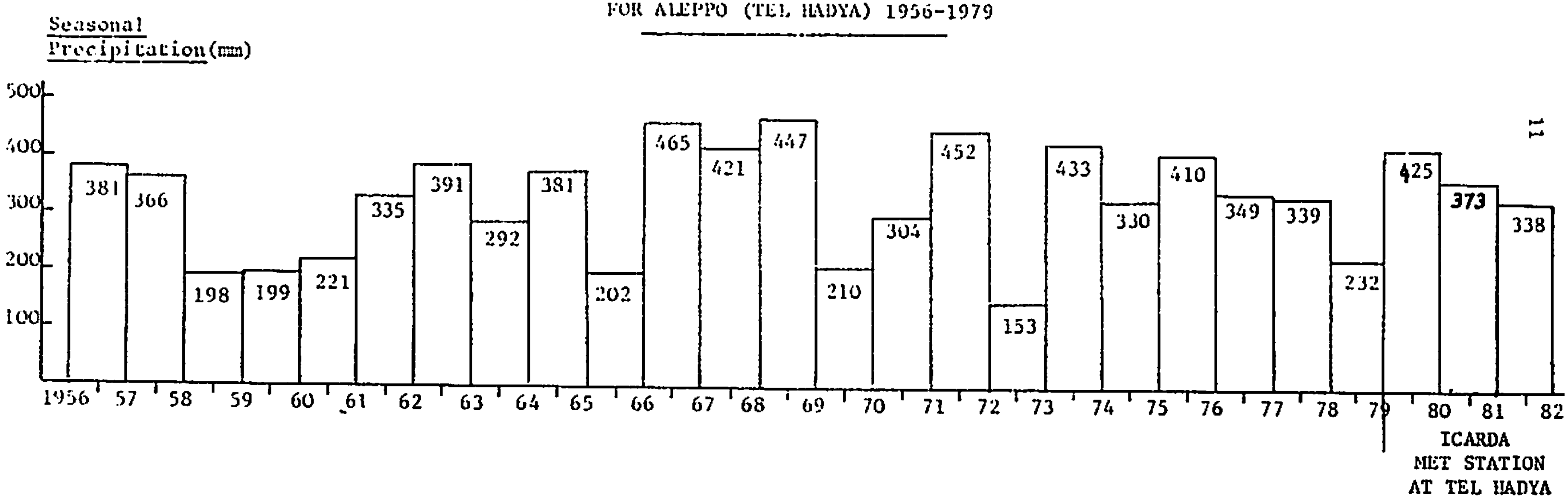
			1980/81	1981/82	Longterm average
Jindiress	- 36°23'N	36°41'E	527	350	477
Kafr Antoon	- 36°32'N	37°02'E	467	397	436
Tal Hadya	- 35°55'N	36°55'E	333	338	333
Breda	- 35°55'N	37°10'E	292	324	261
Khanasser	- 35°47'N	37°30'E	246	263	219

Table 4. Agro-ecological zonation of Syria.

Zone 1a	Average rainfall over 600 mm. A wide range of crops can be grown. Fallowing is not necessary.
Zone 1b	Average rainfall between 350 and 600 mm and not less than 300 mm in two thirds of the years surveyed. At least two crops can be grown every three years. The main crops are wheat, pulses and summer crops.
Zone 2	Average rainfall between 250 and 350 mm and not less than 250 mm in two thirds of the years surveyed. Two crops are normally planted every three years. Barley, wheat, pulses and summer crops are grown.
Zone 3	Average rainfall over 250 mm and not less than this in half the years surveyed. One or two crops will yield in every three years. Barley is the principal crop but some pulses can be grown.
Zone 4	Average rainfall between 200 and 250 mm and not less than 200 mm during half the years surveyed. Barley is grown. The area is also used as grazing land.

In more general terms zones 1a and 1b can be referred to as zone A, zone 2 as zone B and zones 3 and 4 as zone C.

Figure 2. SEASONAL VARIATION IN PRECIPITATION FOR ALEPPO (TEL HADYA) 1956-1979



PROJECT I

PRODUCTIVITY OF CEREAL CROPS UNDER RAINFED MEDITERRANEAN ENVIRONMENTAL CONDITIONS

In extensive areas of West Asia and North Africa, where the winter rainfall is both limited and erratic, barley, and to a lesser extent wheat, are the principle crops. In such dry environments, both yield level and stability of yield are fundamentally important factors in determining the standard of living of the agricultural community. Crop yields are affected by a broad spectrum of environmental, management and socio-economic factors. Consequently, studies designed to improve cereal productivity must be conducted by a multidisciplinary team to ensure that the results will be useful to the farmers for whom they are intended.

Within the framework of established crop rotations, traditional and new management practices are studied to determine their effects on:

a) The underlying processes and rates of crop growth as they are regulated by the physical and nutritional environment.

b) Cereal productivity within the limits of economic profitability and social acceptability.

Greater understanding in these areas will be helpful as agronomic recommendations for cereal production are developed. These must circumvent or alleviate the constraints inherent to agricultural production in the ICARDA region, and thereby, help to improve the living standards for the rural population.

This project has the following four components:

1. Socio-economic Management. The principal part of this component is a survey of barley production in Syria. The survey aims to gather information about current practices and farming conditions with a view to determining the constraints of increasing production.

2. Cereal Agronomy. This component aims to identify and analyse limitations to cereal productivity under environmental conditions that are typical of the ICARDA region. The effects of seed rates, nitrogen and phosphorus fertilizer on various yield parameters for wheat and barley varieties have been studied for three years.

3. Physical Environment. This component focuses on the interactions between the physical environment with factors under the farmers control and the consequent effects on plant growth and productivity of wheat and barley.

4. Nutritional Environment. This component emphasizes factors influencing soil fertility with particular focus on nitrogen.

Each of these components comprises one or more studies, and the following presentation emphasizes the main findings of each one.

Component 1. Socio-Economic Management: Survey of Barley Production in Syria.

Introduction

Research at ICARDA indicates that it is possible to increase the productivity and the profitability of farming systems by increasing barley production. These research results are:

1. Promising developments of higher yielding cultivars and dual-purpose cultivars of barley.

2. Consistent, positive and significant response of barley to the application of phosphorus fertilizer.

3. Significant effects of seed drills on yields.

The relevance and viability of these findings need to be analysed and assessed at the farm level. Consequently, a survey was initiated in Syria in 1981 to better understand the environment and the way in which barley is produced.

The survey has followed 168 barley producers through the 1981/82 season by visiting each of them three times.

1. The first visit was in November and December 1981, at planting time. In this visit socio-economic information as well data on production practices were collected.

2. The second visit was in April 1982. This visit emphasized field observations on agronomy, plant physiology, pathology, entomology. Also plant and soil samples were taken and information on socio-economic variables and production practices was collected.

3. The third visit is currently underway (October 1982) and information on yields, production, utilization, storage and marketing of barley is being gathered.

These visits are conducted by multidisciplinary teams that involve social and biological scientists.

Preliminary Results

1. The differences in farming practices between Western (Aleppo, Idlib, Hama and Homs Provinces) and Northeastern (Hassakeh, Raqqa and Deir-ez-Zor Provinces) Syria were found to be greater and more complex than the simple agro-climatic differences would suggest. (See Table 1.1).

Table 1.1. Some practices in barley production (percent of farmers)

	West	Northeast
Planting by broadcasting	80	7
Planting by drills[a]	20	93
Fertilizer use: P_2O_5	28	1
Nitrogen	26	0
Barley grazed during the year[b] (80/81) (prior to anthesis)	13	64
Crop grazed instead of harvesting (80/81)	51	17

[a] Some of these 'drills' are essentially sophisticated mechanical means of broadcasting, e.g., a drill box plus disc, without shoes or, a fertilizer hopper (spinner) for distributing seed on the soil which is subsequently disced to cover the seeds.

[b] The nature of grazing during the year is different between the West and the Northeast. In the Northeast most grazing is completed between emergence and mid-February. In the West grazing takes place later in the year and in good years to prevent lodging.

(a) Even though the Northeast appears more mechanized, the level of technology is drastically low in comparison to the West. This arises because of the differences in prevailing tenurial arrangements between the two regimes. In the West, land is typically owned or rented from other farmers. In the Northeast, land is predominantly rented from the State. When the tenant is a resource-poor peasant, he often re-rents his land to large and mechanized share cropping operators who usually live in towns. Legally, the share cropping contracts cannot be longer than a year; thus, there are no incentives to employ anything more than a minimum technology. The result is that the land is essentially being "mined".

(b) Another significant difference between the West and the Northeast is that in the West fallow is often used in barley rotations whereas in the Northeast barley is grown continuously (Table 1.2). This situation in the Northeast may be due to two interrelated reasons:

i. At low levels of rainfall, fallowing and expensive land preparation to conserve moisture may not be worthwhile from a technical viewpoint.

ii. The resource-poor peasant may not be able to afford to give up a year's crop, and the contractor farmer has no interest in fallowing land that he can share crop with annual contracts.

These result in the predominance of continuous barley - again "mining" the land.

Table 1.2. Usual crop rotations on the largest barley plot (% of farms in each region x zone).

	Zone 2		Zone 3		Zone 4	
	West	NE	West	NE	West	NE
Barley-fallow	67	33	50	19	63	8
Barley-fallow	13	29	29	41	20	83
Barley-barley-fallow	-	19	-	33	-	8
Barley-legume-fallow	10	-	-	-	-	-
Other	10	19	21	7	17	-

(c) In the Northeast there are important interactions between the cultivated areas, livestock and the steppe. In some areas, there are no qualitative environmental differences between the steppe and cultivated areas. They are contiguous with an arbitrary border separating the two areas.

The barley planted in the cultivated areas is grazed between plant emergence and the beginning of February. This is not part of the contractual arrangement between the peasant and the contract farmer share cropper. However, the absentee contractor farmer tolerates this, because he cannot control it, and because he does not want to jeopardize the tenurial relationship. About the beginning of February, by law and with the enforcement of the security authorities, flocks are removed from cultivated areas and sent to the steppe for grazing. Shepherds whose flocks remain in cultivated areas face the penalty of having their sheep confiscated.

Therefore, in the Northeastern provinces, not only is there "mining" or over-exploitation of the cultivated areas, but also increased pressure on the remaining marginal lands in the steppe.

2. Some technical observations from the barley survey are given in Table 1.3. Analyses indicate that the soils are deficient in phosphorus and nitrogen.

3. Barley production in Syria is particularly influenced by climatic variables. One hundred percent of the sample ranked rainfall as the primary constraint limiting their barley yields on their fields. Yields in 1981/82 were low due to the severe adverse weather conditions, particularly the repeated incidence of frost.

Table 1.3. Some summary physical information from the second visit of the barley survey.

	Zone 2		Zone 3		Zone 4	
	West	NE	West	NE	West	NE
Average P-Olsen (ppm)	6.4 (60)[a]	4.9 (69)	7.3 (78)	4.3 (29)	7.5 (76)	5.3 (51)
Average plant N (%)	1.56	1.45	1.56	1.7	2.1	1.6
Average plant population per m^2	431 (43)	349 (29)	242 (48)	320 (35)	217 (50)	331 (31)
Average plant height (cm)	36 (28)	41 (25)	26 (27)	34 (23)	21 (34)	32 (16)

[a] The figures in parentheses are the C.V. in percentage.

Farmers' expected yields in the long term and expectations for a poor year like 1981/82, are given in Tables 1.4 and 1.5. Two conclusions can be drawn from this information.

(a) Yield expectations seem low; however they appear to be realistic when compared with actual performance within the region. Under these circumstances there is great potential for technical development provided it is gradual and recognizes constraints of the farmer. Neither the system (infrastructure, markets, policies, etc.) nor the farmers appear to be ready for changes which may produce yields of 4-6 tons/ha. Research geared to more realistic targets will have a higher chance of success.

(b) Farmers expect "poor" years to occur in at least 20 percent of the time. The expected gross returns from a "poor" year as 1981/82 are extremely low (Table 1.5). A 20 percent probability of a year with such low gross returns imparts a significant degree of risk to barley production. Therefore, farmers are reluctant to invest in costly technologies. If research is focused on increasing the stability of yields as well as increasing the yields it is highly probable that the perceived risks of poor years will become less significant. This will increase the chances of adoption and diffusion of technology.

Table 1.4. Long-run expected barley yields.

	Zone 2		Zone 3		Zone 4	
	West	NE	West	NE	West	NE
Average yield (kg/ha)	867	997	967	778	573	557
C.V. (%)	81	40	52	33	55	42

Table 1.5. Expected barley yields and gross returns for 1981/82[a]

	Zone 2		Zone 3		Zone 4	
	West	NE	West	NE	West	NE
Expected yields (kg/ha)	687	289	298	180	272	254
Expected gross returns (SL/ha) based on expected market prices	756	312	355	189	313	274
Expected gross returns (SL/ha) based on expected government prices	632	243	277	153	253	216

[a] These are based on products of averages and relate solely to grain yields. When gross returns fall below a threshold level, the fields will be grazed.

Component 2. Agronomic Management

Seed Rate, Nitrogen, Phosphorus (SNP) Trial

This research component was designed to investigate the interaction between crop management and environment (principally rainfall). Field trials were established at five sites spanning the steep precipitation gradient (600 to 200 mm p.a.) found in Aleppo Province. At these sites a range of agronomic management practices was examined to estimate responses associated with environmental variations. This work intends to determine the most suitable agronomic management packages for specific environmental conditions.

The volume and complexity of results produced in the past three years makes a comprehensive summary extremely difficult so soon after the 1982 harvest. A more detailed analysis will be performed during the coming year. Nevertheless, some general points can be made, and some results are presented in Table 1.6.

1. In 1981/82 Beecher Barley again yielded well at all sites and surpassed Durum Wheat Sahl and Bread Wheat S 311 x Norteno at the wetter sites (Jindiress, Kafr Antoon and Tel Hadya) by a good margin. In the dry areas, it yielded more than the local Arabic Aswad and Martin barleys. At the driest site, Khanasser, it yielded nearly one ton per hectare, whereas Martin virtually failed, and the farmers' crops in the surrounding area were also very poor in comparison. Thus, an improved variety appears to be a valuable agronomic input, particularly in drier areas.

Table 1.6. Effects of seed rates, nitrogen and phosphate on grain yields - Beecher Barley - tones/ha.[a]

Regression Coeffts.	Individual sites: Jindiress	Kafr Antoon	Tel Hadya	Breda	Khanasser
	---------- Beecher Barley ----------				
Adj. Mean	3.09	3.68	3.34	1.74	0.95
S	0.02	0.02	-0.15xxx	0.04xxx	0.25xxx
N	0.42xxx	0.25xxx	-0.06xxx	0.08xx	0.04xxx
P	0.15xxx	0.10xxx	0.01	0.09xxx	0.13xxx
SN	-0.02	0.03	0.00	0.00	0.12xxx
SP	-0.00	0.08x	-0.08x	0.01	0.05x
NP	-0.01	-0.15	0.08x	0.02	0.04x
S^2	0.00	-0.10	-0.07xx	-0.01	0.01
N^2	-0.14xxx	-0.02	-0.21xxx	0.01	0.03x
P^2	-0.04	-0.09	-0.12xxx	-0.01	0.04xx

[a] xxx = significantly different from zero at 1%.

xx = significantly different from zero at 5%.

x = significantly different fron zero at 10%.

Regression equation: $Y = a+b_1S+b_2N+b_3P+b_4SN+b_5SP+b_6NP+b_7S^2+b_8N^2+b_9P^2$

where S = seed rate,
P = P_2O_5, and
N = Nitrogen.

For these regressions the data was transformed for each input according to the following schedule.

		Independent variables: -2	-1	0	1	2
Level of input	S	30	60	90	120	150
	N	0	30	60	90	120
	P	0	30	60	90	120

2. Seed rates for Beecher Barley has had no effect on yields at the wetter sites, which implies that the high seed rates normally applied in zones 1 and 2 in Syria could be reduced (providing weed control is not a problem). At the drier sites, a high seed rate seems to be more effective.

3. At the two wettest sites, Jindiress and Kafr Antoon, nitrogen application increased yields for the third successive year. At the two driest sites, the responses to nitrogen in 1981/82 were generally positive, although small, whereas in the previous two years they were mainly negative.

   The positive responses to phosphorus were similar to previous years at the two wettest sites. At the two driest sites they were also positive, but, due to the poorer growing conditions in the early part of the season, were not so large as the previous two years. The positive response to phosphorus is particularly noticeable in a barley crop after a fallow season. The responses of grain at Tel Hadya to nitrogen and phosphorus were generally negative which is the reverse of the general trends at the other sites. However, this site is probably a special case as it possesses a high level of natural fertility.

The Economic Implications of the SNP Trial Results

The increased economic return due to fertilizer application, particularly phosphorus, makes it very profitable to use. In Table 1.7, a partial budget is shown which compares two barley plots at Breda: one with no phosphate and another with an application of 60 kg of P_2O_5/ha. The increase in the net benefit, derived from adding this amount of fertilizer, is 959 SL. Thus, the benefit-cost ratio is more than 4.5, i.e. for every Syrian lira spent, four and a half Syrian liras were earned, which makes this is an attractive economic investment.

Table 1.7. Partial budget for Beecher barley at Breda.

	No P_2O_5		60 kg P_2O_5/ha	
INCOME				
Grain yield	tons 1.52		tons 1.74	
Grain revenue	1,444	SL	1,653	SL
Straw yield	tons 1.07		tons 2.81	
Straw revenue	588	SL	1,545	SL
GROSS REVENUE	2,032	SL	3,198	SL
INCREASE IN EXPENSES				
Fertilizer				
P_2O_5 x price	-		144	SL
Labor for application	-		10	SL
Credit	-		15	SL
Harvesting				
Labor, equipment, transport, bags, etc.	-		38	SL
TOTAL CHANGE IN EXPENSE			207	SL
NET BENEFIT	2,032	SL	2,991	SL

Notes: 1) Cost of P_2O_5 = 2.4 SL per kg

2) Price of barley grain = 0.95 SL per kg

3) Price of barley straw = 0.55 SL per kg

4) Labor for broadcasting = 10.00 SL per 120 kg of TSP fertilizer

5) Both trials received 60 kg of N/ha, at a seed rate of 90 kg/ha.

Figure 1.1 illustrates the increase in net benefits at Breda at different levels of phosphorus application. The most profitable level is 60 kg of P_2O_5/ha. In Table 1.8, the increases in net benefits at all five sites and at five different levels of P_2O_5 are given. At three sites 60 kg of P_2O_5/ha was the optimum use. At Kafr Antoon and Khanasser, the farmer would probably also choose to apply 60 kg/ha; at higher levels of phosphorus use, he would increase his net revenue but only by a very small amount, and it is unlikely that he would wish to accept the greater risks involved.

Residual Effects of Phosphate

At the two drier sites, Khanasser and Breda, the rotation practiced on the experimental plots is two crops of barley after the year in which barley experiments are grown. Therefore, it is possible to measure the residual effects of phosphorus for the two years after application. At the two wetter sites, Jindiress and Kafr Antoon, there is one barley crop after the cereal experiments, hence one year's residual effect can be measured.

There is a steep decline in barley yields after a barley crop the previous year. (See Table 1.9.) The yields of the second barley crop were generally about half of those obtained by the first crop (after fallow in the dry areas and after a summer crop of sesame at the two wetter sites). The yield of the third successive barley crop, at Breda and Khanasser, was extremely poor.

In the 1981/82 season significant positive responses to residual phosphorus were obtained, again at the two drier sites, but not at the two wettest sites. In previous seasons responses had been found at all sites except Tel Hadya. The effects of residual phosphorus ate generally observable and add significantly to potential profitability of phosphate application over the range of environments.

Figure 1.1 Increase in Net Benefit of P_2O_5 applied to Beecher Barley at Breda, 1981/82. (In Syrian Lira)

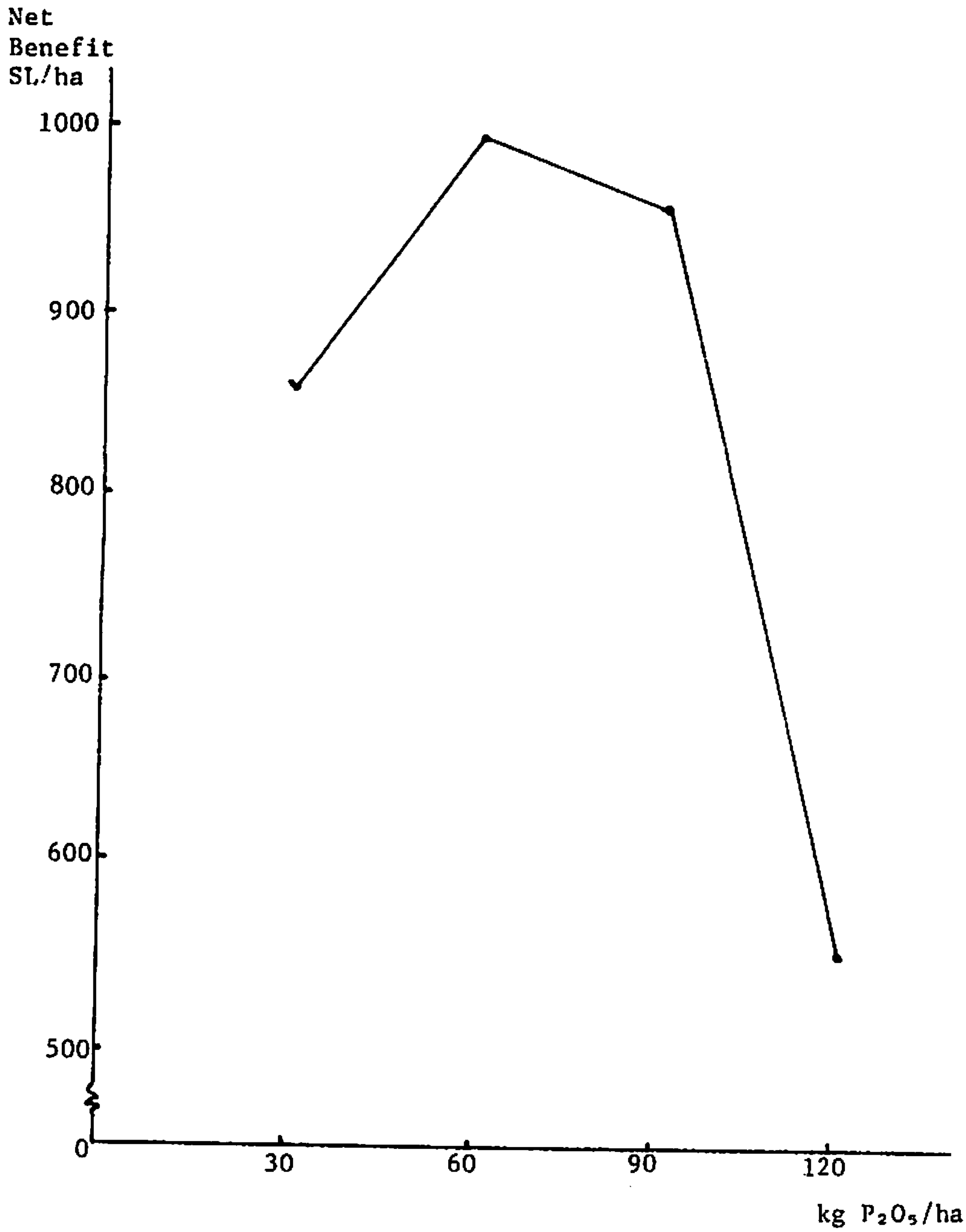


Table 1.8. Increases in net benefit from using P_2O_5 on Beecher Barley in 1981/82. (In Syrian Liras.)

	kg of P_2O_5/ha			
Site	30	60	90	120
Jindiress	689	1005[a]	935	482
Kafr Antoon[b]	293	359	405	418
Tel Hadya	557	757[a]	591	53
Breda	851	996[a]	951	548
Khanasser[b]	284	567	569	657

These calculations follow the same procedure used in Table 1.7. The level of Nitrogen was held at 60 kg/ha and the seeding rate was 90 t/ha for all the calculations. Since both straw and grain were included, the computations tend to refute the previous statement that there was no response to fertilizer application at same sites.

[a] denotes highest increase in net benefit at that site.

[b] denotes no clear, best choice as net benefits for applications of 90 and 120 kg/ha of P_2O_5 are only slightly above the net benefit of 60 kg/ha.

Table 1.9. The direct and residual effects of 60 kg P_2O_5/ha on Beecher barley yields, t/ha.[a]

	Year when P was applied	Year when response was measured						Total Response over (n) years
		1st year		2nd year		3rd year		
		$\bar{x}$	P.A.	$\bar{x}$	P.1.	$\bar{x}$	P.2.	
Khanasser	1979/80	1.88	0.84[xxx]	0.51	0.44[xx]	0.16	0.16[xxx]	1.44 (3)
	1980/81	1.28	0.44[xxx]	0.45	0.06[x]	-	-	0.50 (2)
	1981/82	0.88	0.26[xxx]	-	-	-	-	0.26 (1)
Breda	1979/80	1.76	0.32[xxx]	0.64	0.24[xx]	0.15	0.21[xxx]	0.77 (3)
	1980/81	2.03	0.54[xxx]	0.42	0.23[xxx]	-	-	0.77 (2)
	1981/82	1.52	0.18[xxx]	-	-	-	-	0.18 (1)
Kafr Antoon	1979/80	3.31	0.32[xx]	2.18	0.30[x]	-	-	0.62 (2)
	1980/81	3.77	0.32[xx]	1.66	-0.10	-	-	0.22 (2)
	1981/82	2.51	0.20[xxx]	-	-	-	-	0.20 (1)
Jindiress	1979/80	2.78	0.20	1.65	0.28[xx]	-	-	0.48 (2)
	1980/81	3.08	0.30[xxx]	1.50	-0.04	-	-	0.26 (2)
	1981/82	1.90	0.30[xxx]	-	-	-	-	0.30 (1)

Notes: 1) $\bar{x}$ is the mean yield obtained without phosphate, and with 20 kg N/ha.

2) P.A. is the direct yield increase over $\bar{x}$ obtained by applying 60 kg P_2O_5/ha at planting.

3) P.1. is the residual response to 60 kg P_2O_5/ha one year after application.

4) P.2. is the residual response to 60 kg P_2O_5/ha two years after application.

[a] xxx = significantly different from zero at 1%.

xx = significantly different from zero at 5%.

x = significantly different from zero at 10%.

Research Proposal 1982/83

As a result of research into important farmer controlled management practices, we are now in a position to make "best bet" recommendations regarding these management factors for specific environmental zones. Many years of cereal breeding (at ICARDA and elsewhere) have made improved wheat and barley varieties available. These have been extensively tested (under high levels of management), and as a result the breeders are in a position to recommend improved varieties for the different zones.

However, because a vast majority of the farmers in the region have limited resources, it is extremely unlikely that many could afford to adopt a complete "improved cereal farming package". ICARDA and the national programs should, therefore, be in a position to recommend a clear order of economic priorities to the farmers in different zones. ICARDA is already cooperating closely with both the Syrian and Jordanian Ministries of Agriculture, and this project could be linked with these cooperative efforts.

A 2^n factorial design which incorporates the major practices at a zero and "best bet" level is one way to establish these priorities where both first and second order interactions could be identified. It is proposed that the FSP and the Cereal Program would jointly run the trial at the five principal FSP research sites on 15 to 20 farmers fields across the rainfall gradient in Northern Syria. Factors to be examined will include variety, nitrogen, phosphorus, weed control and seed rate. Although the levels of these factors would vary from zone to zone, the treatments will be kept constant across locations within zones. Treatments are listed in Table 1.10. These experiments will then form part of the testing stage in FSP research strategy prior to the eventual development of an extension effort to be conducted in conjunction with national programs.

Table 1.10. Management practices in FSP-Cereal experiments for the 1982/83 season.

	Zone 1	Zone 2	Zones 3-4
Variety			
Local	Mexipak	Horani	Arabic Aswad
Improved	Nortino	Sahl	Beecher
Nitrogen (kg/ha)			
Low level	0	0	0
High level	100	60	20
P_2O_5 (kg/ha)			
Low	0	0	0
High	60	45	45
Weed control			
Low	none	none	none
High	+ Bromonil	+ Bromonil	+ Bromonil
Seed rate[a]			
Local	100	100	100
Improved	60	60	60

[a] Seed rate on farmer field locations will be kept at 100 kg/ha.

Component 3. Physical Environment

Introduction

This study was initiated in the 1979/80 season in order to complement the agronomic trials reported in component 2. It was designed to examine the influence of physical and nutritional environment on the crop growth and productivity of barley and wheat. Particular attention is paid to five overlapping areas namely: (a) to understand the effect of environmental factors on crop phenology and the development of a yield structure; (b) to study the crops' ability to maximise their interception of incident radiant energy and the subsequent efficiency of its conversion to dry matters; (c) to study the crops' response to the rapidity of exposure to and degree of drought stress experienced under Mediterranean environmental conditions; (d) to determine the interactive effects of nutrition and environment on phenology and crop productivity; and (e) to quantify the findings of items a-d to permit the development of a crop model driven by meteorological parameters which will be able to predict ctop maturity date and potential productivity.

Research highlights from two sub-components of this study (c and d) are reported in the following sections.

Barley: The effects of the physical environment and nutritional factors on growth, phenology and productivity.

Key fertilizer treatments were selected from the SNP agronomic trial which would produce different patterns of barley growth and yield (c.v. Beecher). In the 1981/82 season three levels of fertilizer were studied at three sites (Jindiress, Breda and Khanasser). Treatments selected were: (1) zero fertilizer, (2) phosphorus at 60 kg P_2O_5/ha , (3) phosphorus at 60 kg P_2O_5/ha plus nitrogen at 60 kg N per hectare.

Analysis of the results is still at an early stage but generalizations can be made on some aspects of the data from the 1980/81 and 1981/82 seasons. The conclusions below are based on comparisons between unfertilized and fertilized crops.

1. The large yield responses to fertilizer application, observed across all rainfall zones, were associated with large increases in water use efficiency (see Table 1.11). Similar trends were reported in the 1979/80 season.

2. Fertilizer application, principally phosphorus, had the effect of advancing phenological development; the effect began at early stages of growth. This has important implications for the analysis of crop growth and water use for different crop development phases.

3. Increased grain yield due to fertilizer application was associated with increased total dry matter yield. The differences in dry matter production between fertilizer and unfertilized barley occurred during the early stages of growth; thereafter crops had generally similar relative growth rates.

4. Fertilizer application resulted in increased levels of dry matter production at anthesis, but this did not result in an increase in the fraction of the total water supply used by anthesis. This suggests that further increases in early growth could lead to further field increases.

Table 1.11. Grain yield and crop water use efficiencies.[a]

Site	Treatment	Crop yield t/ha	Cumulative crop water use (mm)	WUE in grain production kg/ha/mm	WUE in Total DM production kg/ha/mm
1980/81					
Jindiress	No F.[b]	2.2	311	7	16
	N+P[c]	5.0	352	14	34
Breda	No F.	1.6	224	7	16
	N+P	2.6	214	12	33
Khanasser	No F	1.4	226	6	14
	N+P	2.2	220	10	25
1981/82					
Jindiress	No F	1.4	323	4	14
	N+P	2.9	315	9	28
Breda	No F.	1.3	218	6	18
	N+P	2.2	218	10	28
Khanasser	No F.	0.4	210	2	6
	N+P	0.9	210	4	12

[a] Water use efficiencies are based on crop water use (evapotranspiration) from germination until maturity. Yields are expressed on a dry weight basis.

[b] No fertilizer was applied.

[c] 60 kg of P_2O_5 and 60 kg of N/ha.

5. In the results of the two seasons reported here, yield increases were obtained, in many cases, with no additional crop water use (Table 1.11). The depth of water extraction was not affected by fertilizer application and generally coincided with the depth of the wetting front. Increased growth of fertilized crops appears to be associated with a greater proportion of the total water supply passing through the crop in transpiration, water which would otherwise be lost by evaporation from the soil surface.

Wheat: Plant water status studies

In previous seasons it has been observed that management practices, particularly the application of nitrogen and phosphorus fertilizer, can change the pattern of crop moisture use. This is caused by an increase in and earlier development of crop green area in response to improved fertility. As a result, significant levels of moisture stress can be experienced in the later growth stages, particularly at grain filling. Such stresses were recorded in the 1980/81 season and as a consequence 1000 grain weights of fertilized crops were significantly reduced. In the current season this problem was studied in greater detail. Plant water potential and diffusive resistance profiles were measured on a wheat crop with variable fertility treatments. These measurements were made bi-hourly from pre-dawn (3:30 hr) to late evening (22:00 hr) at weekly intervals from pre-anthesis to maturity at Tel Hadya.

In Figure 1.2, it can be seen that the wheat treatments at Tel Hadya, which received additional nitrogen (90 kg/ha) as a topdressing, was developing severely decreased plant water potentials (more negative) from pre-anthesis (5 April, 1982) to early grain filling (20 April, 1982).

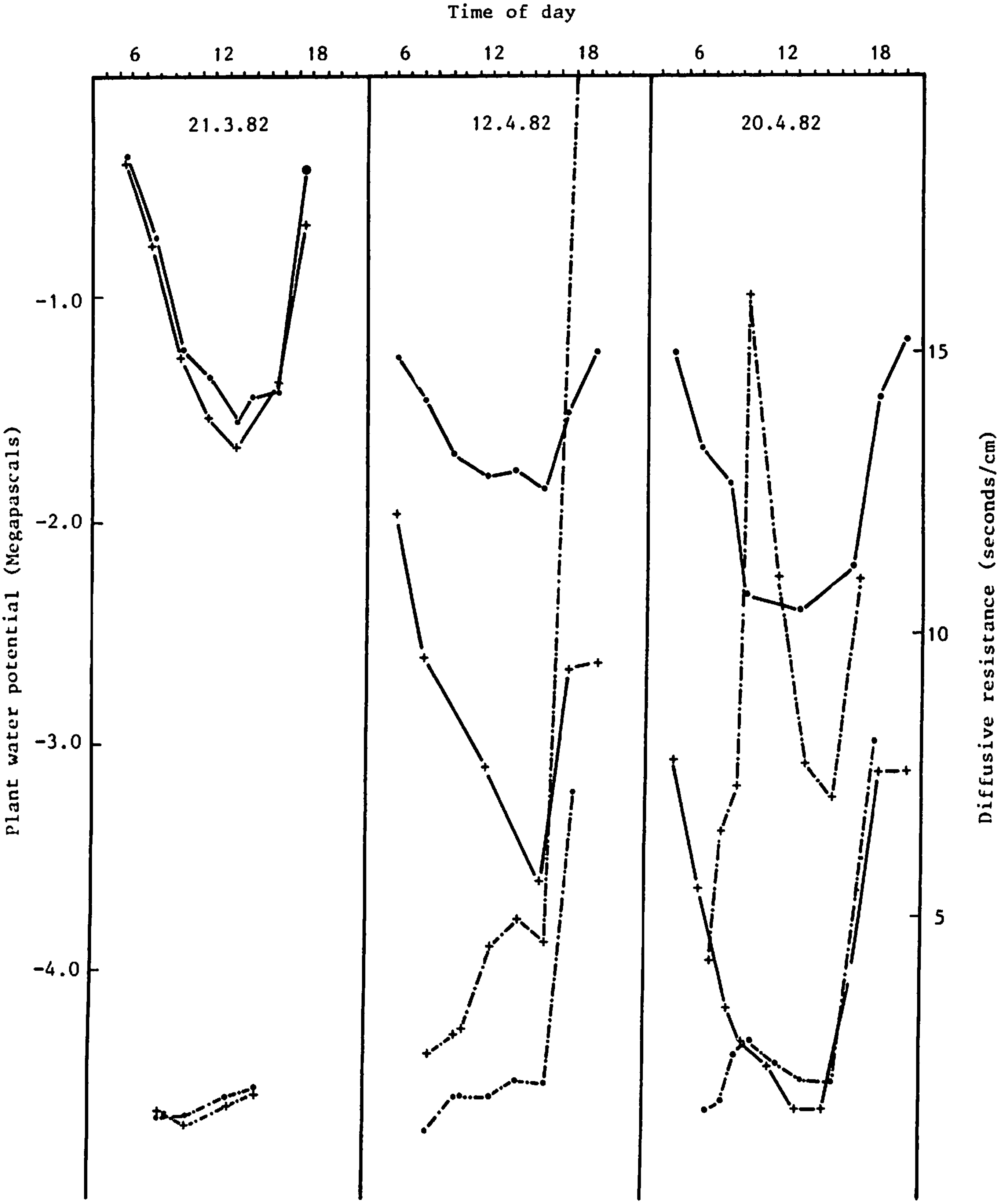


Figure 1.2. Diurnal variation in plant water potential and Leaf Diffusive Resistance on three dates for Mexipak Wheat.

——x——x—— = Plant water potential with top dressed Nitrogen.
——•——•—— = Plant water potential without top dressed Nitrogen.
—·—x—·—x = Leaf diffusive resistance with top dressed Nitrogen.
—·—•—·—• = Leaf diffusive resistance without top dressed Nitrogen.

This plant water stress was sufficiently severe by 20 April 1982 to cause a considerable increase in diffusive resistance by mid-morning and thus was reducing current production of photosynthate. Had this situation been unrelieved until harvest, it is highly likely that 1000 grain weights in the treatment with additional nitrogen would have been significantly reduced. However, in the next week 41 mm of precipitation were received which was followed by an additional 24 mm in the next two weeks. This amount of precipitation is highly atypical and resulted in a large reduction in the level of moisture stress on the crop: hence, no reduction in 1000 grain weight in the high nitrogen treatment was recorded. This experiment indicates that the higher yields obtained from improved nutrition in the seasons to date (1979 to 1980) are not achieved without a consequent increase in the risk of having a reduced kernel size at harvest or ultimately severely reduced grain yields.

Component 4. Nutritional Environment

Nitrogen dynamics in soils in Aleppo Province

During the 1980/81 growing season the mineral-nitrogen status of soils was monitored at five sites in Aleppo Province: Khanasser, Breda, Tel Hadya, Kafr Antoon and Jindiress.

Mineral nitrogen is defined as the sum of ammonium and nitrate nitrogen. The ratio of ammonium-nitrogen to nitrate-nitrogen in soils at all sites tends to increase with increasing annual rainfall. At harvest time, fallow plots at all sites contained more mineral nitrogen (mainly in the form of nitrates) than plots cropped with cereals: an excess of 50 to 80 kg of nitrogen per hectare. The nitrate contents of soils in fallow plots at all sites tend to fluctuate less during the season than the ammonium contents. At most sites, in particular Breda and Tel Hadya, the onset of the rains is followed by an increase in ammonium-nitrogen, presumably as a result of mineralization of easily decomposable organic matter. This is illustrated in Fig. 1.3 for Tel Hadya. The decrease in ammonium-nitrogen in February and March is not accompanied by an increase in nitrate-nitrogen and therefore is due probably to immobilization of ammonium-nitrogen in the biomass of the soil rather than to nitrification.

Nitrogen fertilization

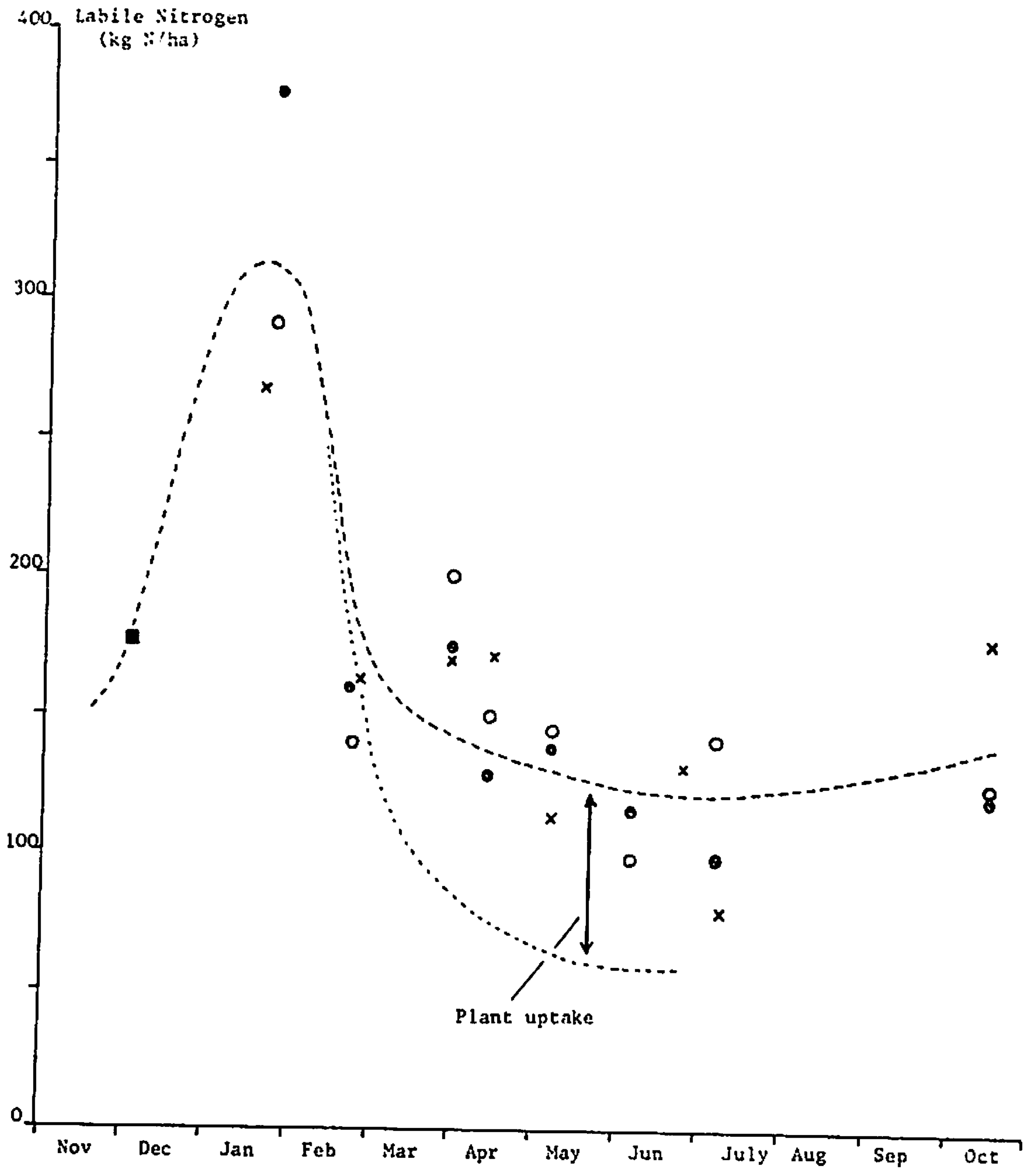
Soils at most sites (with the notable exception of Khanasser) are low to medium in plant-available nitrogen. Therefore, cereal crops at most sites responded to application of nitrogen fertilizer. The nitrogen uptake efficiency (defined as the difference in nitrogen-uptake between a fertilized and an unfertilized crop divided by the amount of nitrogen applied) tends to increase with increasing annual rainfall, from 30 to 40 percent at the drier sites (Khanasser and Breda) to 70 to 80 percent at the wetter sites (Kafr Antoon and Jindiress). (See Fig. 1.4.) A similar trend was observed at Tel Hadya, where the nitrogen uptake efficiency increased from 59 percent under rainfed conditions to 72 percent (157 mm) and 84 percent (236 mm) under irrigated conditions.

Nitrogen balance

In a number of experiments at Breda and Tel Hadya, ^{15}N-labeled nitrogen fertilizers were used to make up a mass balance for nitrogen in soils at these sites and to investigate whether losses of nitrogen occurred from the soil-plant system at these sites. At Tel Hadya, ^{15}N-recoveries were high: about 95 percent of the labeled material was recovered in the crop (Mexipak Wheat) and the soil at harvest. This suggests that no significant losses occurred at Tel Hadya during the growing season. At Breda about 80 percent of the applied ^{15}N-enriched

Fig. 1.3 Dynamics of labile nitrogen in fallowed and cropped plots at Tel Hadya.

(Labile nitrogen is defined as the sum of mineral nitrogen in the soil (0-120 cm depth) and total nitrogen in the plant (cropped plots only). Fallowed plots are denoted by crosses. Plots cropped with wheat are denoted by open circles (unfertilized) and heavy dots (fertilized). Applied nitrogen fertilizer is not included in the labile nitrogen. At planting a composited soil sample representative for the whole field was analysed (solid square). The broken line visualizes the dynamics of labile nitrogen, and the dotted line the dynamics of mineral nitrogen in soils in cropped plots. Thus, distance between the two lines is a measure for plant uptake of nitrogen.)



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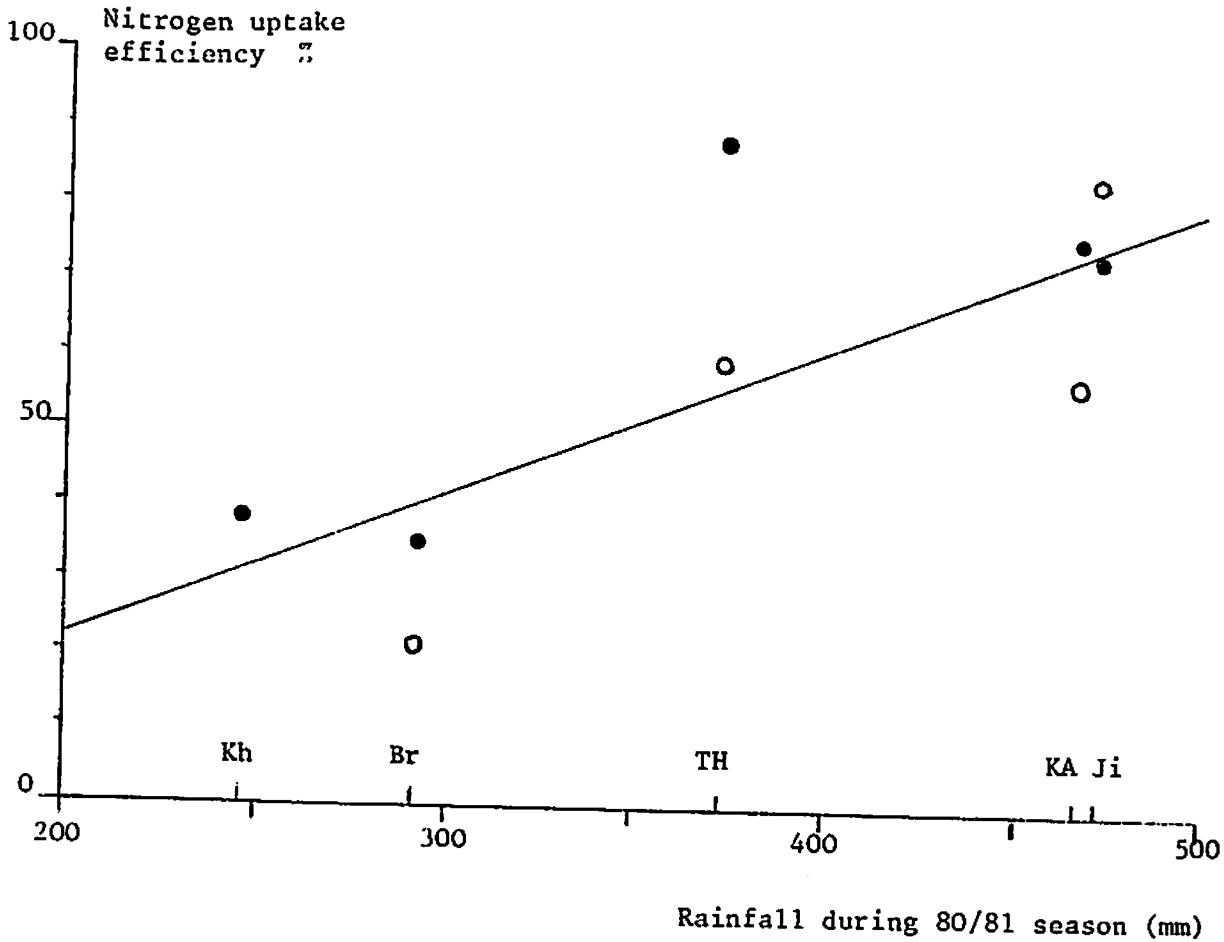

Fig. 1.4 Relation between nitrogen uptake efficiency of barley (heavy dots) and wheat (open circles) and rainfall during the 80/81 growing season at Khanasser (Kh), Breda (Br), Tel Hadya (TH), Kafr Antoon (KA) and Jindiress (Ji). The simple correlation coefficient of r=0.75 is significant at the one percent level.

material was recovered in the crop (Beecher Barley) and in the soil at harvest. This suggests that losses may have occurred at Breda during the growing season. At both sites about equal amounts of ^{15}N-enriched material were recovered in soil and plant materials. Most of the ^{15}N-enriched material in the soil (60 to 70 percent) was recovered in the top 20 cm of the soils at both sites. (See Fig. 1.5.) Nitrogen losses may occur as a result of ammonia volatilization (The conversion of NH_4^+ into NH_3) or denitrification (conversion of NO_3^- into N_2 or N_2O). Information available to date suggests that ammonia volatilization is the more likely loss mechanism involved. Immobilization of mineral nitrogen in the biomass of the soil at both sites occurred mainly during February and March.

CONCLUSION

In Project I, components 1 and 2 are efforts to understand and analyse socio-economic and biological constraints that farmers in the region face. It is hoped that adaptable research based on these results will allow us to formulate viable and effective recommendations for improved cereal production. Components 3 and 4 go deeper into the dynamics of crop growth and seek an understanding of the complex interactions between nutrients, the physical environment and other factors that we can manipulate. Interaction between the four components is expected to increase the fine tuning of our research efforts.

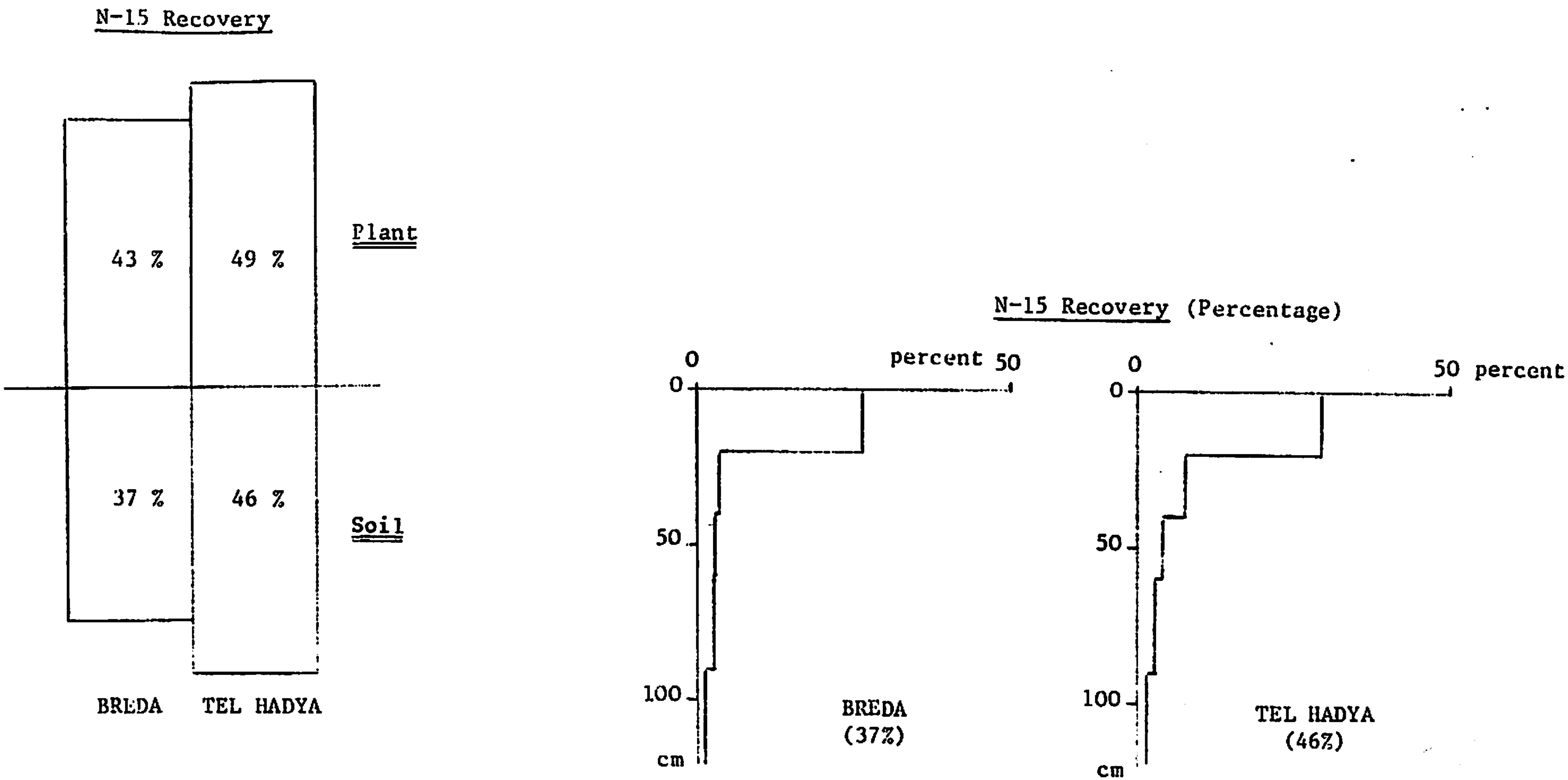

Fig. 1.5 Schematic presentation of ^{15}N recoveries in soil and plant materials, and the depth distribution of ^{15}N-enriched nitrogen soils at Breda and Tel Hadya.

PROJECT II

NITROGEN FIXATION, PRODUCTIVITY AND WATER USE OF GRAIN AND FORAGE LEGUMES

INTRODUCTION

Research conducted by national programs and ICARDA has indicated that nitrogen deficiency is widespread within the region, and large responses to nitrogen fertilizer have been obtained by both farmers and researchers on a variety of crops. However, many farmers can ill afford the ever increasing cost of fertilizer, and thus the importance of nitrogen biologically fixed in the soil in association with the grain and forage legume components of the cropping system is very apparent.

There is considerable scope for the improvement of nitrogen fixation by manipulation of the two partners of symbiosis, the crop and *Rhizobium*, and by appropriate crop management practices. In order to obtain more information on the potential for increased nitrogen fixation within cropping systems, a collaborative project between the Farming Systems Program and the Food Legumes Improvement Program was conducted during the 1981/82 growing season. The main focus of this project was nitrogen fixation by grain and forage legumes at eight locations spanning the 250-550 mm/annum rainfall transect in Aleppo Province. Crops were selected for each location depending on their agronomic suitability (see Table 2.1) and were grown at two levels of management to represent (a) farmers' current practice and (b) what at present is thought to be optimum management (see Table 2.2).

Table 2.1. Selected crops and levels of management (H=high, L=low) for three zones.

Zone < 350 mm	350-450 mm	> 450 mm
Lentil (L)	Lentil (L)	Faba bean (L)
Lentil (H)	Lentil (H)	Faba bean (H)
Chickpea (H)	Chickpea (L)	Chickpea (L)
Vicia (H)	Chickpea (H)	Chickpea (H)
Pisum (H)	Pisum (H)	Pisum (H)
Fallow plot	Fallow	Fallow
Non-nod. (Barley)	Non-nod. (Wheat)	Non-nod. (Wheat)
Sites: Nasrieh, Breda Ghrerife	Tel Hadjar Hayyan Tel Hadya	Jindiress Segeraz

Table 2.2. Mangement of grain and forage legumes.

Crop		Seeding date	Seeding Rate	Row Width (cm)	kg/ha P-Fertilizer (1)	kg/ha N-Fertilizer (1)	Incoluation	Sitona Control	Weeding (2)
Lentil	(L)	Late winter	100 kg/ha	45	-	20	-	-	(a)
Lentil	(H)	Early winter	100 kg/ha	22.5	50	20	+	+	(b)+(a)
Chickpea	(L)	Spring	10 plants/m row length	45	-	20	-	-	(a)
Chickpea	(H)	Early winter	10 plants/m row length	22.5	50	20	+	-	(b)+(a)
Faba bean	(L)	Early winter	10 plants/m row length	45	-	20	-	-	(a)
Faba bean	(H)	Early winter	10 plants/m row length	45	50	20	+	-	(b)+(a)
Vicia/Barley	(H)	Early winter	90/20 kg/ha	22.5	50	20	+	+	(b)+(a)
Pisum	(H)	Early winter	10 plants/m	22.5	50	20	+	+	(b)+(c)
Barley		Early winter	80 kg/ha	22.5	50	20	-	-	(c)
Wheat		Early winter	80 kg/ha	22.5	50	20	-	-	(c)

L = Farmer's management H = Optimum management

(1) Fertilizer will be placed with the seed. All treatments hand planted.

(2) (a) = hand weeding; (b) = pre-emergence spray; (c) = post-emergence spray.

At the completion of one year of this research, there are few firm conclusions that can be drawn. Nevertheless, we now have data which are being analyzed, and the results are interesting and will guide the continuation of this research. These are presented and discussed in the subsequent six, separate but interrelated, sections.

Component 1. Soils and Soil Fertility at Biological Nitrogen Fixation (BNF) Experimental Sites

Soil texture. The texture of the soils at the BNF sites (plus Khanasser and Kafr Antoon) are all in the shaded area indicated in Fig. 2.1. Soils at Breda and Khanasser are loam to clay loams in the surface horizon, merging into silty clay and silty clay loam at depth. The texture of the soils at Chrerife and the wetter sites is clay throughout the profile. Soils at Kafr Antoon merge into the calcareous substratum below 120 cm depth. Soils at Tel Hadya have a heavy layer at 90-120 cm depth, possibly kaolinitic clay, which probably impedes root development.

The clay contents (averaged over the top 90 cm) of the soils at the different sites tend to increase with increasing annual rainfall (r=0.78 **).[a/] (See Fig. 2.2). Soils at Hayyan, Jindiress and Kafr Antoon are deep-cracking, heavy clays (Vertisols).

Lime content. Soils at all sites are calcareous; lime contents range from 10 percent (Hayyan) to more than 40 percent (Breda and Khanasser). At most sites lime contents are quite constant with depth. Only at Breda and Khanasser are there clear calcic horizons. At higher-rainfall sites there are no horizons with lime accumulation, although there is redistribution of lime in the profile (soft lime spots).

The lime contents (top 20 cm) of the soils at different sites tend to increase with decreasing annual rainfall (r=0.79 **). (See Fig. 2.2).

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a/ Means significant at the 95 percent level of confidence.

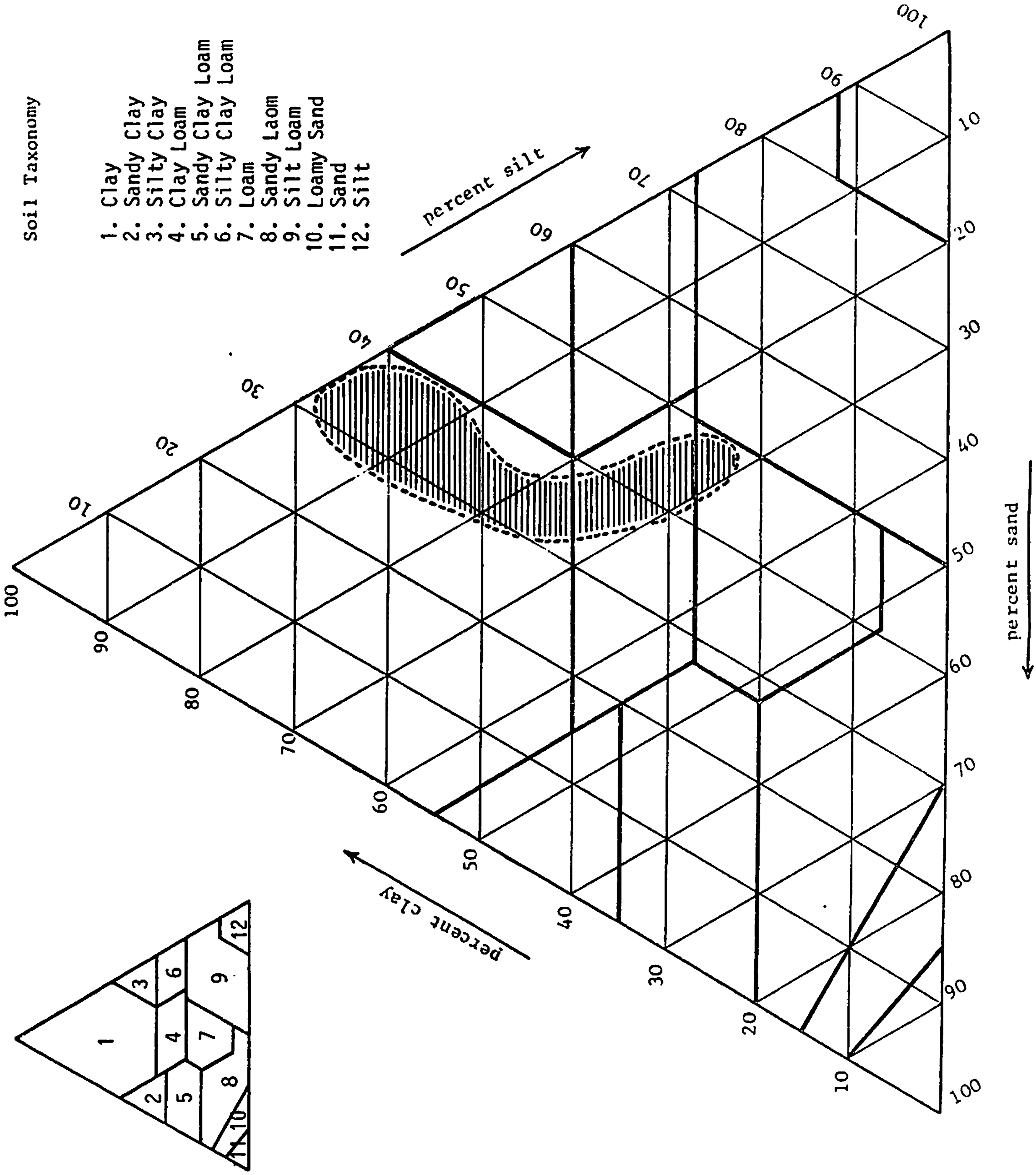

Figure 2.1. Texture of surface horizons (0-20 cm depth) of soils at BNF sites. All soils are in the shaded area. Textures range from clay to clay loam and loam.

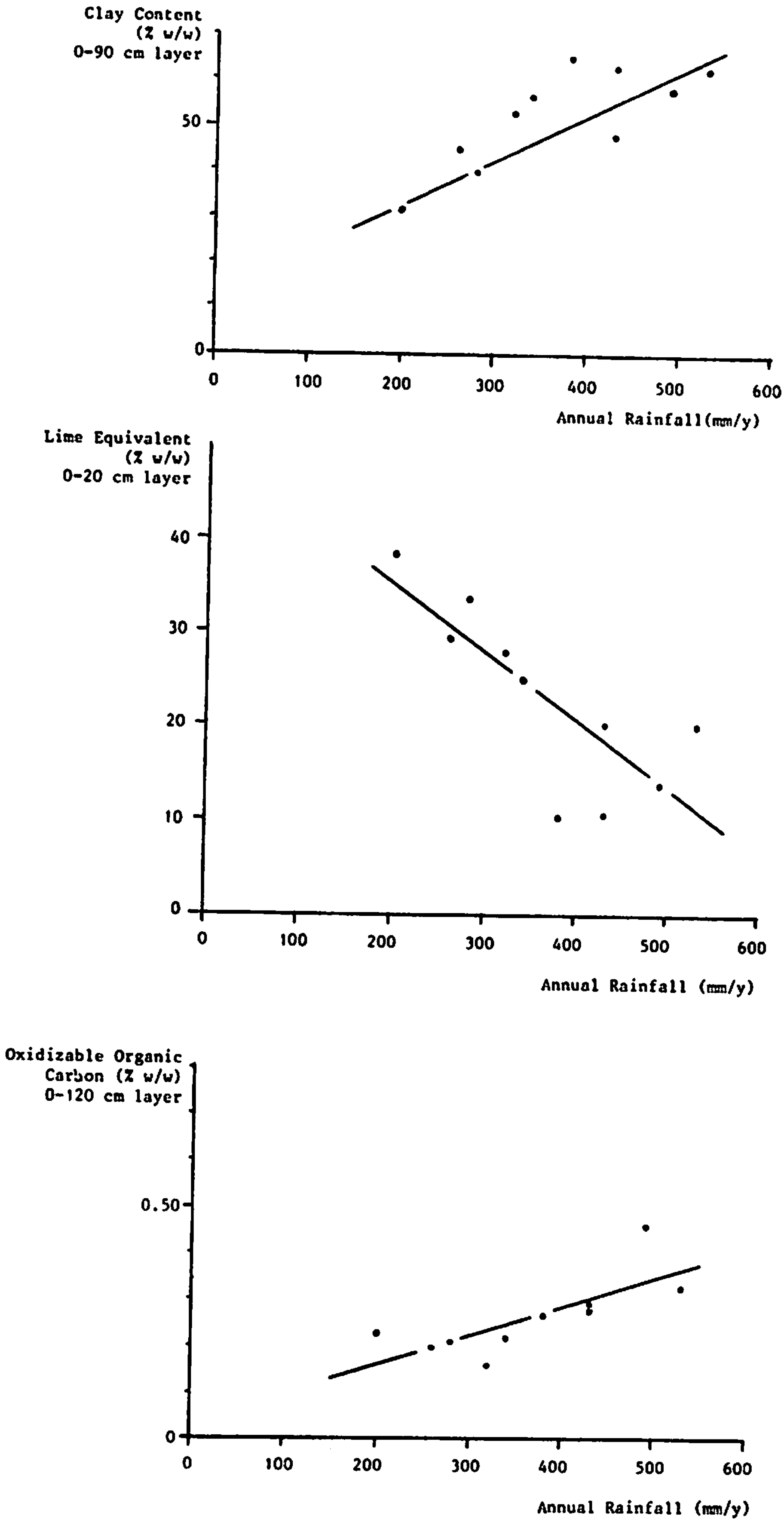

Figure 2.2. Relation between soil characteristics and estimated annual rainfall at BNF sites.

Organic matter. Organic matter contents of soils at all sites are in low range: from 1.6 percent (Segeraz) to 0.5 percent (Nasrieh). Organic-carbon contents in soils at Breda and Khanasser decrease more steeply with depth than at other sites. Carbon to nitrogen ratios of soils at all sites are around 9, i.e., rather low.

Organic-carbon contents (0-20 cm) of the soils tend to increase with increasing rainfall (r=0.32 not significant). The correlation between organic-carbon and annual rainfall becomes highly significant (r= 0.75 **) if the average contents of the top 120 cm are taken as the basis for comparison between sites. (See Fig. 2.2).

pH and EC. Soils at all sites have quite similar pH values (1:1 soil-water suspension): ranging from 8.0 (Jindiress, Segeraz and Kafr Antoon) to 8.4 (Nasrieh).

Electrical conductivity of 1:1 soil-water extracts are low at Tel Hadya and wetter sites and quite constant with depth. At the drier sites, EC_1 increases with depth due to the presence of soluble salts such as gypsum. Salinity is not expected to impede plant growth at any of the sites, because values of EC_{sat} are below 4.0 mS/cm in the rooting zone.

Available phosphorus. Available phosphorus contents (extraction with sodium bicarbonate) are medium to high in the top 20 cm of soils at Segeraz and Tel Hadjar and low at all other sites. The higher contents at Segeraz and Tel Hadjar may be due to the use of phosphorus fertilizers in previous years. Available phosphorus contents of soils are low below the top layer (0-20 cm) at all sites. (See Fig. 2.3).

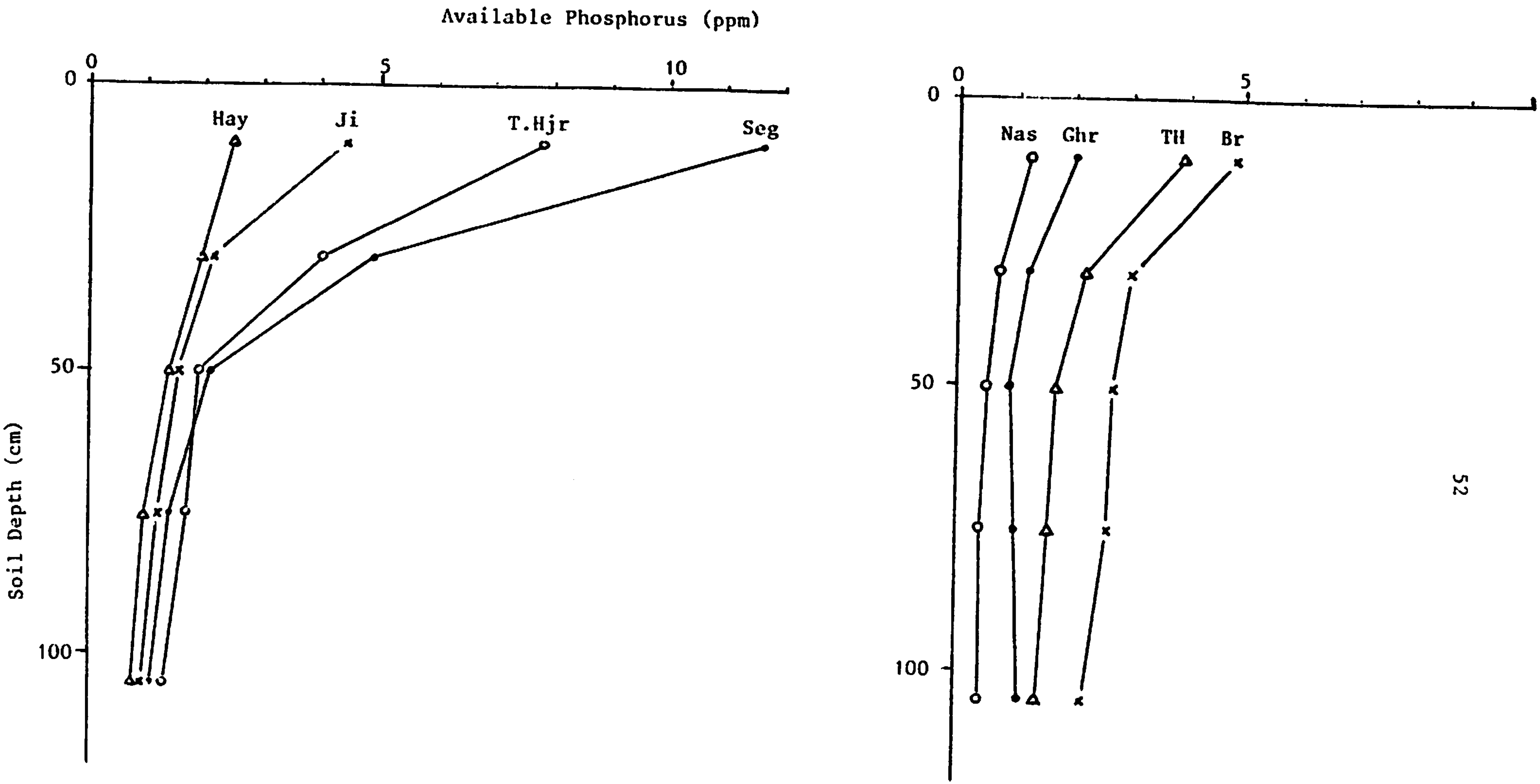

Figure 2.3. Distribution of available phosphorus (P-Olsen) with depth in soils at BNF sites.

Mineral nitrogen. Mineral nitrogen contents of soils at planting are in the low range, except at Segeraz, which seems to be quite high in mineral nitrogen. However, without knowledge of the nitrogen dynamics in these soils throughout the growing season, it is difficult to predict the availability of nitrogen to the crop.

Component 2. Nitrogen Fixation and Micro-Biological Studies

Native Rhizobium population. Composite soil samples were collected from the different sites before planting the trials. Estimation of the Most Probable Number (MNP) of *Rhizobia* present in those soils were made with a plant infection technique using a specific host crop which was inoculated with a series of soil dilutions. As lentil, faba bean and pisum sp. are all nodulated by *Rhizobium leguminosarum*, counts were made for convenience on lentil alone. The same method was used for vetch and chickpeas. Unfortunately, none of the soil dilutions resulted in nodulation on chickpeas. This may have been due to inadequate environmental conditions in the growth room. Thus, we have used the nodulation status of the uninoculated plants at the early vegetative stage to provide a measure of the native chickpea *Rhizobium* population.

Table 2.3 gives the Most Probable Number of *Rhizobia* present in the different locations for the range of crops investigated in this trial. There was a native *Rhizobium* population for vetch, lentil, faba bean and pisum sp. present at all sites, but population numbers were quite variable. Only two out of the eight sites (Jindiress and Tel Hadya) has a native *Rhizobium* population compatible to chickpeas. Plants from Jindiress had more nodules than those obtained from Tel Hadya.

Table 2.3. Most probable number (MPN) of *Rhizobia* present in the different locations (per gram dry soil) in Syria.

	Lentil/ Faba bean/ Pisum	Vicia	Chickpea
Jindiress	1.7×10^3	5.9×10^3	$0.0_{(16.4)}$
Segeraz	n.a.	1.8×10^4	$0.0_{(0.0)}$
Tel Hadjar	1.0×10^5	n.a.	$0.0_{(0.0)}$
Hayyan	5.5×10^3	3.1×10^4	$0.0_{(0.0)}$
Tel Hadya	1.0×10^5	n.a.	$0.0_{(6.0)}$
Nasrieh	1.7×10^4	3.4×10^4	$0.0_{(0.0)}$
Ghrerife	5.5×10^3	1.1×10^4	$0.0_{(0.0)}$

The number in parentheses represent the number of nodules/plant formed during vegetative stage on the un-inoculated treatment.

Nodulation and nitrogenase activity. Nodulation assays were made at the early vegetative and early pod filling growth stages. Nitrogenase activity of the nodules was measured by acetylene reduction at early pod filling. In the early vegetative stage there were few differences between treatments in nodule status; however, by early pod filling differences were apparent as is indicated in Table 2.4 . These are discussed on a crop by crop basis.

In all locations, faba beans with a high level of management had a greater nodule mass than found in the low management treatment. The difference between the high and low levels of management was much greater at Jindiress than at Segeraz and Tel Hadya. This suggests that the introduced strains performed better in the presence of a low native Rhizobium population. The plants grown with improved management had higher nitrogenase activities, both in terms of ethylene production and of nodule efficiencies, than those plants grown with low levels of management. This was reflected in dry matter productivity.

With improved management lentil crops had a higher nodule mass and dry matter production than with the lower level of management. Most nodule mass was produced at Tel Hadjar whether the crops were inoculated or not. This reflects the high status of the native Rhizobium population. Nitrogenase assays were made at the pod filling stage, but as this was rather late for lentils,there was very little difference in ethylene production between the two levels of management. Nodules produced at low levels of management were more efficient at this stage possibly because nodule formation was delayed in the low management treatment and the nodules were younger. In most locations, chickpea crops fixed more nitrogen under high than low level of management practice. This difference was greater where native Rhizobium population for chickpeas was absent. Pisum crops were well nodulated at all locations although the degree of nodulation varied between sites. The highest

Table 2.4. Nodule mass, nitrogenase activity and total dry matter production in different location in Syria under low and high levels of crop management.

Crop	Location	Nodule dry wt. (mg/plant)		MC_2H_4/Plant/hr		MC_2H_4/gm. nod/hour		Total dry wt. (g/plant)	
		Low	High	Low	High	Low	High	Low	High
Faba bean	Jindiress	141.0	486.0	0.30	3.24	2.08	6.47	10.42	23.74
	Segeraz	396.1	550.9	0.77	1.74	2.04	3.14	16.02	23.21
	Tel Hadya	209.2	280.1	0.77	1.01	2.80	4.10	12.11	14.23
Lentil	Tel Hadjar	5.8	10.8	0.013	0.004	2.64	0.39	0.34	1.47
	Hayyan	1.9	6.6	0.005	0.005	2.38	0.82	0.22	1.15
	Nasrieh	1.3	3.8	0.004	0.004	3.17	1.11	0.14	1.00
	Breda	1.3	2.8	0.002	0.003	2.25	1.07	0.24	1.07
	Ghrerife	1.0	4.2	0.003	0.017	1.68	4.41	0.22	0.80
Chickpea	Jindiress	21.2	145.2	0.09	0.65	4.11	4.53	0.32	4.44
	Segeraz	8.5	73.1	0.001	1.10	0.12	1.40	0.19	0.72
	Tel Hadjar	11.0	287.6	0.002	0.99	0.16	3.36	0.29	2.89
	Hayyan	13.8	12.2	0.012	0.014	0.91	1.13	0.25	0.24
	Nasrieh		319.3		0.313		0.97		2.67
	Breda		54.4		0.35		0.63		1.26
	Ghrerife		38.9		0.061		1.65		0.95
Pisum	Jindiress		30.6		0.07		2.07		11.66
	Segeraz		35.1		0.02		0.86		7.84
	Tel Hadjar		78.1		0.26		3.29		10.93
	Hayyan		23.0		0.02		0.94		3.64
	Nasrieh		12.9		0.010		0.82		5.28
	Breda		13.7		0.010		0.69		4.77
	Ghrerife		9.2		0.51		5.60		1.82
Vetch	Nasrieh		3.7		0.10		2.81		2.47
	Breda		5.6		0.003		0.61		1.12
	Ghrerife		2.4		0.006		1.30		0.70

nodule mass was obtained at Tel Hadjar and the lowest at Ghrerife. Nodules showed their maximum activity at Tel Hadjar. In contrast, nodules were most efficient at Chrerife. This may have been the result of significant precipitation at this site two days before the assay was made. For vetch, nodule weights were highest at Breda but higher fixation efficiencies were recorded at Nasrieh. This latter factor may have contributed to the maximum dry matter production value being obtained at Nasrieh.

Nitrogen fixation. Total dry matter production, seed yields and estimated nitrogen fixation are presented in Table 2.5. Since the ^{15}N analyses has not yet been completed, computation of nitrogen fixation is yet to be done. Nevertheless, at all locations the trial followed a cereal crop in 1980/81, and the growth and N-uptake of the non-nodulating crop indicated severe N deficiency. An exception was at Segeraz where the farmer had applied a heavy dressing of N fertilizer to his wheat in the preceding season. Because these sites were so N deficient, a reasonable estimate can be made of N-fixation by simply calculating the difference in N-uptake between the nodulating and non-nodulating crop.

As would be expected, there is a close relationship between the total dry matter produced and nitrogen fixation; it follows that a relationship also exists between the levels of nitrogen fixation and the potential productivity at the different sites depending on moisture availability. This is illustrated in Fig. 2.4 where nitrogen fixation by three legume crops under optimum management is related to rainfall. However, when the low level of management data is considered, it would appear that other constraints such as phosphate deficiency, weeds and inefficient root nodulation combine to reduce the overriding effect of moisture availability.

Table 2.5. Dry matter, seed yield and nitrogen fixation of grain and forage legumes at 8 locations in N. Syria, 1981/82.

Site	Crops		Total dry matter (kg/ha)	Seed yield (kg/ha)	N-Fixation[a] (kg/ha)
Jindiress	Faba bean	H	4980	2380	108 (3)[b]
		L	3040	1540	54 (19)
	Chickpea	H	6510	3440	94 (12)
		L	1740	990	9 (3)
	Pisum	H	5380	--	127 (15)
Segeraz	Faba bean	H	6590	3420	146 (13)
		L	7090	3270	168 (11)
	Chickpea	H	4480	2920	60 (21)
		L	3590	2150	26 (11)
	Pisum	H	4470	--	83 (33)
Tel Hadjar	Chickpea	H	6330	3230	114 (5)
		L	2880	1640	31 (11)
	Lentil	H	6440	1900	110 (17)
		L	4110	1230	79 (7)
	Pisum	H	5720	--	175 (8)
Hayyan[c]	Lentil	H	4280	1570	72 (6)
		L	2210	880	25 (8)
Tel Hadya	Chickpea	H[d]	2940	1170	32 (10)
		L	1850	960	16 (3)
	Lentil	H	3450	1280	54 (12)
		L	2920	1260	43 (5)
	Pisum	H	4430	--	89 (15)
Nasrieh	Lentil	H	4130	1590	66 (4)
		L	1400	540	8 (6)
	Chickpea	H[d]	2000	880	12 (2)
	Barley/Vicia	H	2580	--	40 (11)
Breda	Lentil	H	2140	720	29 (2)
		L	1000	390	4 (2)
	Chickpea	H[d]	790	450	4 (5)
	Barley/Vicia	H	2080	--	21 (8)
	Pisum	H	2120	--	34 (14)
Ghrerife	Lentil	H	1230	340	12 (8)
		L	790	190	0 (1)
	Chickpea	H[d]	850	100	1 (1)
	Barley/Vicia	H	1500	--	15 (5)
	Pisum	H	1200	--	17 (8)

a ^{15}N analyses not yet completed at IAEA. N-fixation estimated as difference between N-uptake of nodulating and non-nodulating crops. (See text for further explanation).

b Figures in parentheses are standard errors.

c All crops except lentils destroyed by children or frost.

d Severe Aschochyta Blight during pod filling.

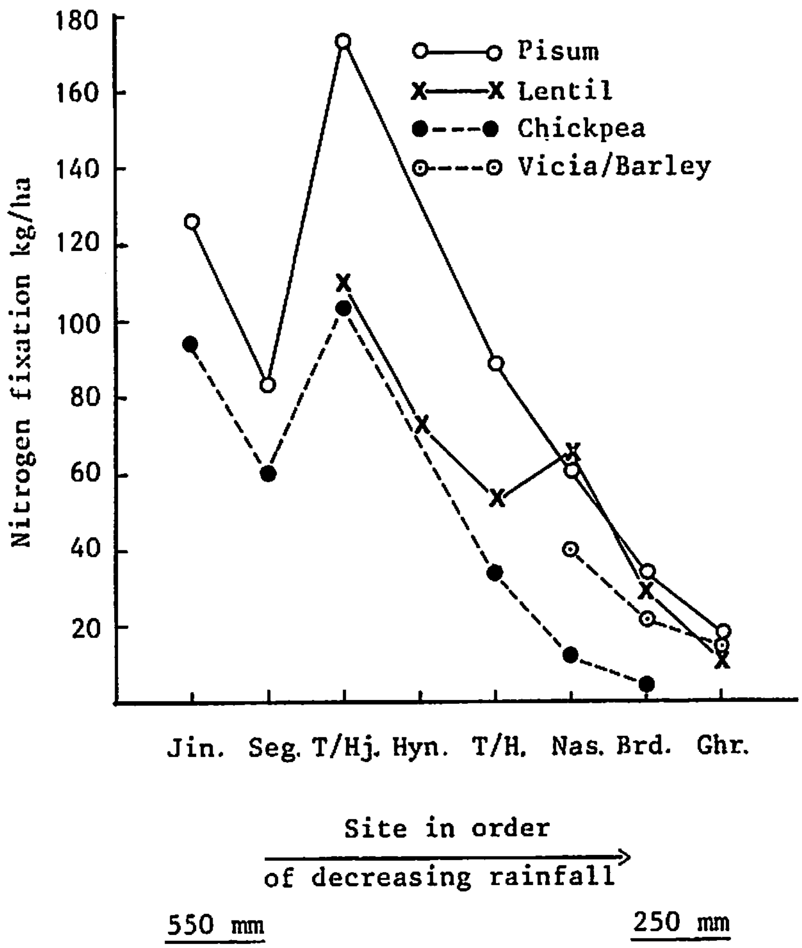

Figure 2.4. Nitrogen fixation by Pisum, Lentil, Vicia/Barley and Chickpea under optimum management as related to rainfall.

The results in Table 2.5 also indicate that there is great variation in the potential increase in nitrogen fixation resulting from improved management in all the grain legume crops. In faba beans, the potential increase ranged from 54 kg/ha at Jindiress to 0 kg/ha at Segeraz. In chickpeas, a maximum increase in N-fixation of 85 kg/ha was found at Jindiress, but only 16 kg/ha was found at Tel Hadya. In lentils, a 58 kg/ha increase occurred at Nasrieh compared with 12 kg/ha at Chrerife. This large variation in the response of nitrogen fixation to improved management is, of course, due to a whole range of soil and environmental factors, not all of which will have been investigated in this trial. Nevertheless, when all the recorded data have been more fully analyzed, it is hoped that a clearer picture will emerge.

While any conclusion is still tentative, the data from the first year of this trial show that in spite of differences between crops and between sites there is considerable potential for improving biological nitrogen fixation. In general, this potential decreases as one moves from the wetter to the drier zones. In 1982/83 potential fixation rates will be measured in greater detail at three sites representative of wet (475 mm p.a.), intermediate (350 mm p.a.) and dry (275 mm p.a.) conditions. These measurements will include additional treatments particularly forage legume crops and forage legume/cereal mixtures.

Component 3. Soil Moisture Studies

Introduction

This project had trials at locations that covers a wide range of levels of average annual precipitation. This enables us to investigate the interaction between moisture supply and use of a grain legume (chickpea) and a forage legume (pisum). In both crops, the high level of management was selected in order to minimize the variation among sites of factors other than moisture supply. In addition to these two crops, fallow plots were included at each location, and moisture storage under fallow was investigated. These results have been reported in Project III.

Results

Total dry matter production, total water use, estimated nitrogen fixation and water-use efficiency data for Pisum are presented in Table 2.6. In general, dry matter production and water-use declined with declining seasonal precipitation. At the four wettest locations a substantial water-use efficiency value of around 20 kg/ha/mm was measured. However, this value decreased considerably at the three driest sites. Water-use efficiency (WUE) values are derived from evapotranspiration data which includes both soil evaporation and crop transpiration. Large variations in WUE's (as indicated in Table 2.6) are mainly due to variation in the percentage of radiant energy intercepted by the crop canopy and its resultant effect on the variable partitioning of evapotranspiration into its two components. Thus, at locations such as Jindiress (where the maximum green area index of pisum is 6.0), much less radiant energy reaches the soil surface than, for example, at Breda (where the maximum green area index is 1.7). Therefore, at Jindiress a greater proportion of evapotranspiration is being actively used by the crop as transpiration rather than evaporation from the soil. This is reflected in the higher WUE value obtained at this site.

WUE can also be considered in terms of nitrogen fixed (see Table 2.6). It is apparent that, because of a general relationship between total dry matter and nitrogen fixation, the same trends are observed. However, there is much greater variation of the WUE of nitrogen fixation compared with that of dry matter production at the wetter locations. The low value obtained at Segeraz may well be associated with the high soil nitrogen status. (See Component 1.)

Table 2.6. Dry matter, water use, nitrogen fixation and water use efficiency of forage pisum at 7 locations in N. Syria.

Site	Rainfall Germ. to Harvest (mm)	T.D.M. kg/ha	Water Use (mm)	N-Fixation kg/ha	WUE (1)	WUE (2)
Jindiress	308	5380	252	127	21.3	0.50
Segeraz	322	4470	228	83	19.6	0.36
Tel Hadjar	285	5720	250	175	22.9	0.70
Tel Hadya	263	4430	214	89	20.7	0.41
Nasrieh	250	2700	210	61	12.9	0.29
Breda	245	2120	185	34	11.4	0.18
Ghrerife	217	1200	151	17	7.9	0.11

WUE (1) = kg T.D.M./ha/mm   WUE (2) = kg N fixed/ha/mm

Extractable soil moisture is the difference between the maximum moisture observed in a discrete soil depth interval and that at harvest. These measurements are presented in Table 2.7. Because pisum followed a cereal crop in 1980/81, extractable soil moisture levels were zero at the start of the season. Thus, only depth intervals recharged by the rainfall in the current season contained moisture available for the pisum crop. The extractable soil moisture data in Table 2.7 reflect both the depth of penetration of the current season rainfall, and the depth of extraction of moisture by the crop. These data emphasize the very restricted rooting depth of the crop at the drier locations.

There is, at present, much interest in the role that a forage legume could play in replacing the fallow year in the barley/fallow rotation practiced by many farmers. There is strong evidence to suggest that a barley/forage rotation will be much more productive and maintain greater yield stability over the long-term (See Project III). Thus, as well as fixing appreciable nitrogen, the pisum crop also leaves some residual soil moisture from the current seasons rainfall which, with timely post harvest cultivation, can be stored. This is illustrated in Fig. 2.5, where the moisture distribution under pisum at three dates is presented for two locations. The dotted line represents the distribution at the start of the season, and the other two dates represent respectively the distribution at maximum profile recharge and at harvest. The shaded area thus represents moisture potentially available for next year's barley crop. Research in Project III indicated that the same holds true under a vetch forage crop in long-term rotation trials at Breda and Khanasser.

Table 2.7. Extractable soil moisture (cm/15cm depth interval) under forage pisum at 7 locations in N. Syria.

Depth Interval	Jindiress	Seregaz	Tel Hadjar	Tel Hadya	Nasrieh	Breda	Ghrerife
	High rainfall site						Low rainfall site
15-30	1.7	1.7	2.3	2.4	2.1	1.5	1.4
30-45	1.3	1.3	2.1	2.1	2.0	1.3	0.8
45-60	1.2	1.3	1.8	2.0	1.7	1.0	0.1
60-75	1.1	1.2	1.4	1.0	1.5	0.4	-
75-90	1.0	1.0	0.8	0.1	0.9	-	-
90-105	0.7	0.3	0.3	-	-	-	-
105-120	0.4	-	0.2	-	-	-	-
120-135	0.1	-	-	-	-	-	-
135-150	-	-	-	-	-	-	-
Total	7.5	6.8	8.9	7.6	8.2	4.2	2.3

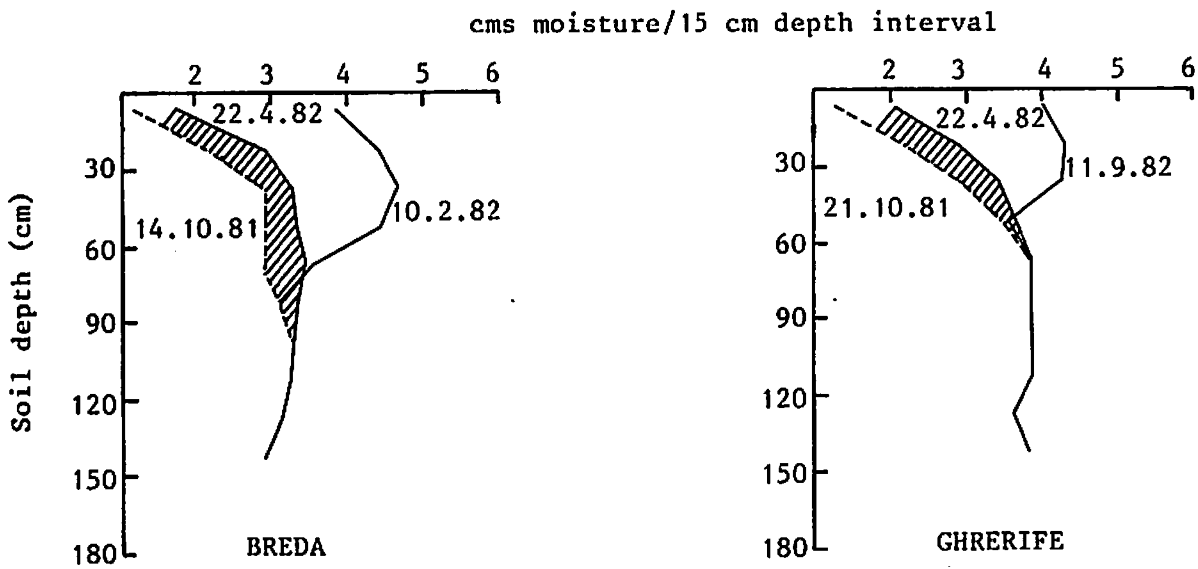

Figure 2.5. Moisture distribution under Pisum at 2 locations (≤ 275 mm) in N. Syria.

Component 4. Crop Physiology

Introduction

This study was initiated in the 1980/81 season to consider problems arising from the introduction of winter planting for chickpea crops as a potentially more productive management practice than the traditional farmers' practice of planting in the spring. Cultivars for winter planting must necessarily possess enhanced resistance to Aschocyta Blight or risk complete loss in cool humid winter conditions. The cultivars that currently display this resistance are separated into two district morphological groups -- erect and spreading canopy types. The morphotypic environment interaction is a further major consideration in this study as the erect types, though they display the greatest degree of disease resistance, appear to be inherently less productive than the spreading types. Both aspects of this study are intimately linked to Component 3 of this Project which investigates the growth behavior and moisture relations of legume crops.

Results

The results of this research from the 1980/81 season are reported in "Kabuli" Chickpea as a Winter Sown Crop in Northern Syria - Moisture Realtions and Crop Productivity, by J.D.H. Keatinge and P.J.M. Cooper, to J. Ag. Sci, Camb. In press.

In the 1981/82 season, it may be seen from the data (Table 2.8) that, unlike the findings of the 1980/81 season, the winter plantings of the spreading type ILC 482 showed no seed yield advantage over the erect types ILC 202 and ILC 72. This resulted from a combination of circumstances, the principal factors of which were: (1) the significant occurrence of Aschocyta Blight on the pods of ILC 482 in particular at Tel Hadya which

Table 2.8. Chickpea productivity 1981/82.

Site	Cultivar & Planting Time	Seed yield (t/ha)	Dry matter Production (t/ha)	Harvest Index	100 Seed Weight (gm)
		1982 (1981)			
Jindiress	ILC 482 (W)	3.44 (4.20)	6.51	0.53	22.3
	ILC 202 (W)	3.14	7.38	0.43	24.5
	ILC 72 (W)	3.48 (3.24)	8.32	0.42	24.9
	ILC 482 (S)	1.37 (1.88)	2.41	0.57	25.8
Tel Hadya	ILC 482 (W)	1.17 (2.o9)	2.94	0.40	20.5
	ILC 202 (W)	2.21	4.50	0.49	25.3
	ILC 72 (W)	1.92 (1.38)	4.30	0.45	26.5
	ILC 482 (S)	1.43 (0.80)	2.65	0.54	24.7
Breda	ILC 482 (W)	0.45 (0.99)	0.79	0.57	25.5
	ILC 202 (W)	0.63	1.40	0.45	23.3
	ILC 72 (W)	0.51 (0.28)	1.05	0.49	26.0
	ILC 482 (S)	0.36 (0.74)	0.85	0.42	20.2

W = Winter Planted S = Spring planted

()= Previous growth season's results 1980/81.

may have been due to an atypical late rain, (2) the effect of extensive frost in February which seems to have had more impact on the productivity of the earlier maturing and less densely planted cultivar ILC 482.

The significant late rains and patchy diseases incidence at Tel Hadya and Breda also served to eradicate the expected yield advantage of winter planted ILC 482 over these planted in the spring. However, an increase in productivity was measured at Jindiress where the disease incidence was not a factor. The advantage of winter versus spring plantings was clearly evident in the behavior of the resistant erect types.

Further comprehensive growth analysis was carried out at all eight BNF trial sites on the optimum agronomy chickpea and forage pea treatments; the analysis of these data is in progress.

In the 1980/81 season the total moisture used by chickpeas planted in the winter and spring was similar at any one site and largely depended on the amount of the current season's precipitation. In both winter and spring planted crops, a marked cut-off point was observed in the relationship between the fraction of extractable moisture remaining in the soil profile and the crop's evapotranspiration ability to respond to increasing atmospheric demand. (See Fig. 2.6). Moreover, significant differences were observed in the patterns of crop moisture use between winter and spring plantings.

As a result of these findings, the relationship between moisture supply and plant water status was considered in greater detail in 1981/82. This was examined at Tel Hadya at weekly intervals from pre-flowering to maturity. Plant water potential measurements were taken at bi-hourly intervals from pre-dawn (3:30 hr) to late evening (22:30 hr) on winter

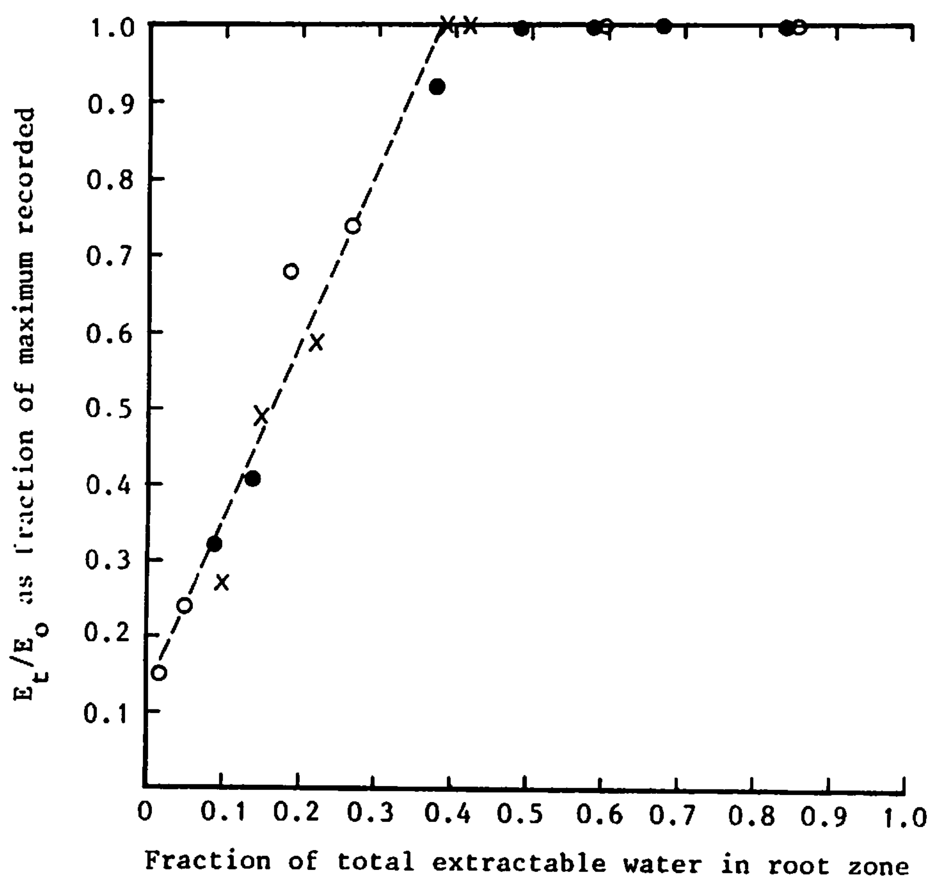

Figure 2.6. The influence of extractable moisture on the relative value of the E_t/E_o ratio of winter and spring-sown chickpea at Jindiress (•), Tel Hadya (o) and Breda (x).

E_t = Evapotranspiration.
E_o = Evaporative Demand.

planted ILC 482 (spreading type) and ILC 72 (erect type) and the spring planted of ILC 482. The diurnal plant water potential profiles shown in Fig. 2.7 indicate that winter planted ILC 72 experienced an increasing overall stress through the period represented by the time period covered by Fig. 2.7 A, B and C by 18 May, 1982 was unable to recover high (less negative) potential values in the overnight period. In direct contrast, spring planted ILC 482 showed an unchanged plant water potential profile over this period due to the development of a smaller canopy; thus, water-use is deferred to later in the season. However, in the period close to its maturity (three weeks later) ILC 482's diurnal plant water profile was similar to that of ILC 72 at a corresponding maturity stage (dotted line, Fig. 2.7 C). This suggest that the soil moisture reserves are depleted to comparable levels. This similarity of plant water potential profiles in ILC 482 and ILC 72 both nearing maturity, indicates that the development of pre-dawn potentials in the region of -1.0 to -1.5 MPa and/or minimum (most negative) values of -2.0 to -2.5 MPa may in fact trigger the maturation process.

Proposed Research for 1982/83

In the 1982/83 season these studies concerned with the effect of physical environmental factors on the growth of legume crops will be continued in association with the proposed root development study. Effort will be concentrated on examining the interaction between the development of moisture stress, maturity date and productivity. Further measurements of the canopy light extinction coefficient will be made to determine whether it is appropriate to assume a constant value over a season. In addition, canopy development, radiant energy interception and dry matter production measurements will be made in association with the soil moisture studies.

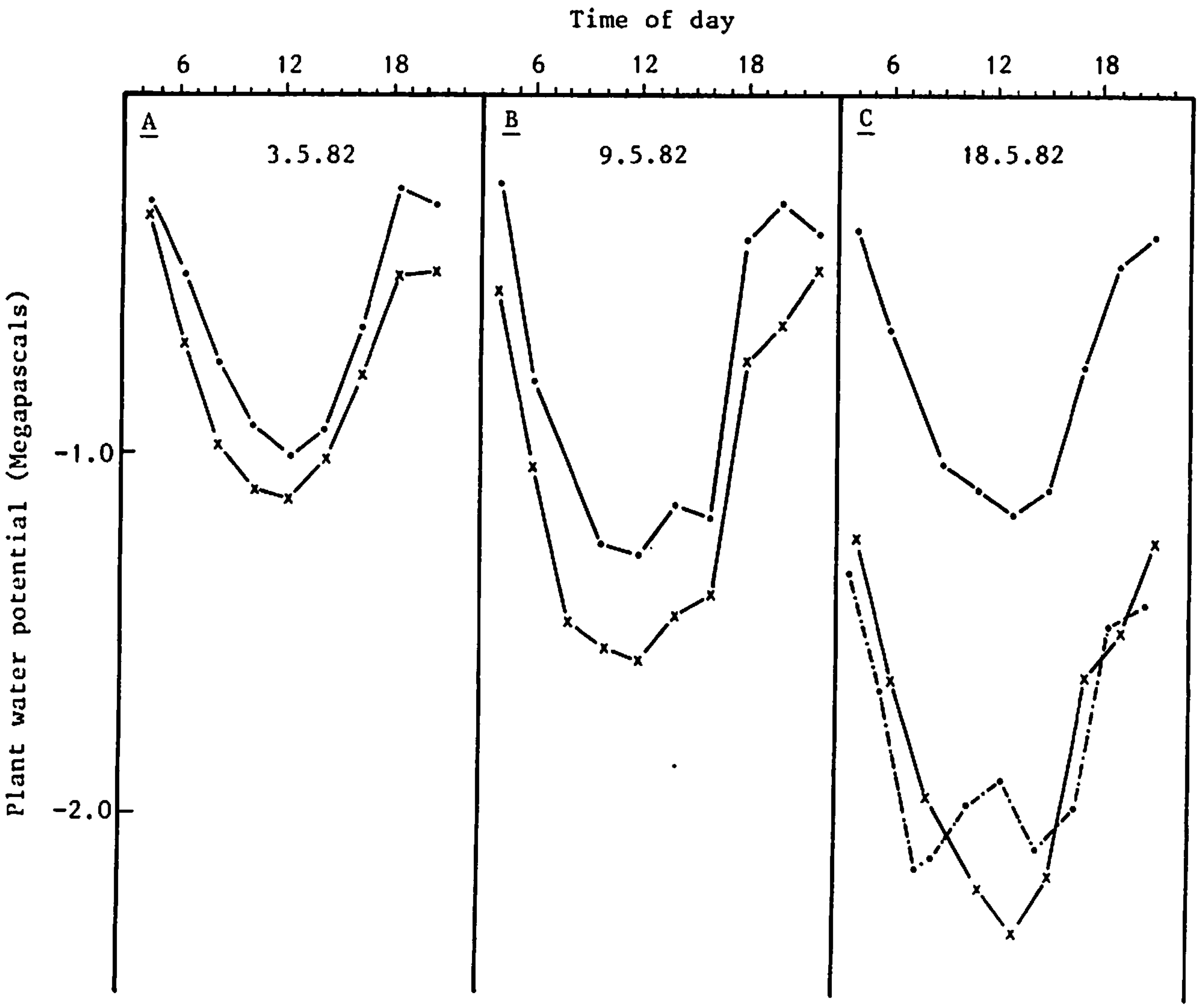

Figure 2.7. Diurnal variation in plant water potential on three dates for ILC 482, spring planted (o) and ILC 72, winter planted, Dense (+).

Final (pre-harvest) readings for ILC 482 also shown (—·—) 7.6.82.

Component 5. Survey of Lentil Production in Syria

At an early stage in its development, ICARDA recognized that there was little available information on legume crops. There was a serious lack of information on production practices of lentils by farmers in the region and the role that lentils play vis-a-vis the other productive enterprises of the lentil farmer. Thus, a survey was conducted in Syria during the growing season of 1978/79 and 1979/80 to collect this information. The Project was conducted jointly by the Food Legumes Improvement Program and the Farming Systems Program. One hundred and fifteen lentil producers in 52 villages in Syria were interviewed on their farms; each farmer was visited four times. Now that the Computer Center is operational, the information on this crop is being reanalysed in order to understand better the relationship among variables that we found to be important.

In order to illustrate the value of this kind of research, a summary of the findings is given. The incidence of weeds and the low use of fertilizer are two factors that may be suppressing lentil yields. Therefore, as examples, these two topics are discussed in slightly more detail, to illustrate the data that this type of survey can provide.

Summary of Results

1. Yields vary greatly as one can see in Table 2.9. Major yield constraints as seen by the farmers were:

   (1) irregular rainfall,

   (2) insufficient supply and unavailability of phosphate fertilizer,

   (3) weed infestation, (Orobanche infestation when it occurs is very serious),

   (4) insufficient supply of mechanical implements, especially for land preparation, and the lack of mechanical harvesting implements.

Table 2.9. Yields of lentils.

	1977/78 (kg/ha)	1978/79 (kg/ha)	1979/80 (kg/ha)	Normal year Farmers' Estimate
Average grain yield	1080	610	1020	1070
SD[a]	430	650	440	340
Range	0-2000	50-1750	0-2000	300-2000
Average straw yield	1250	930	1270	1220
SD	500	530	530	450
Range	150-2800	200-3000	0-3000	250-2800

[a] SD = Standard Deviation.

(5) pests, in particular pod borers, and

(6) temperature fluctuation during flowering.

2. The use of phosphorus and nitrogen on lentil production was found to be so variable among the farmers in the sample that an effort by ICARDA in providing firm fertilizer recommendations would be beneficial to the farming community. At present, a large number of the farmers use neither chemical fertilizer nor manure on lentil fields, whereas those that do use fertilizer show considerable variation in the quantity applied. For example, phosphorus application varied from 50 kg to 250 kg of TSP. Although ICARDA has general agronomic recommendations on fertilizer usage in lentil production at present, an economic analysis of the benefit of fertilizer application would currently be of value in guiding farmers to determine their most profitable management practice. (See Table 2.10.)

3. Weeds certainly have the potential to be a serious problem. More than 46 percent of the plots in the sample were highly infested and 29 percent were moderately infested by different types of weeds. Only two percent of plots were weed free. Weeds comprised more than 20 percent of total vegetation; in Hama Province, the figure was 33 percent. Note that farmers estimate that weeds cause, on average, a 20 percent yield loss. (See Table 2.11.)

   (a) The level of weed severity was higher in Zone 2 than Zone 1. This could be due to the more frequent cultivations performed in Zone 1.

   (b) The timing of cultivations before sowing and quality of soil are recognized by 71 percent of farmers as the most important factors affecting weed populations. Seed rate (49 percent), rainfall (30 percent), frequency of cultivations (22 percent), fertilizer application (16 percent) and rotation (9 percent) were also mentioned as related factors.

Table 2.10. Distribution of fertilizer use.

	Large Holders %	Small Holders %	Zone 1 %	Zone 2 %	Overall Sample %
PHOSPHORUS kg/ha of TSP					
0	31	67	55	37	50
50-60	8	0	2	7	3
90-120	27	16	18	30	21
130-170	21	8	17	7	14
200	9	6	5	16	8
250	4	3	3	3	4
Total	100	100	100	100	100
NITROGEN kg/ha of Urea					
0	75	78	78	73	77
50	11	3	6	10	7
100-120	10	9	9	10	10
130-160	4	8	7	3	6
350	0	2	0	4	1
Total	100	100	100	100	100

Table 2.11. Weed infestation.

	Zone 1	Zone 2	Combined
	-------- percent of plots		--------
I. Level of infestation			
- Nil	2.3	0.0	1.7
- Low	27.6	10.0	23.0
- Moderate	26.4	36.7	29.0
- High	43.7	53.3	46.3
Total	100.0	100.0	100.0
II. Dominant type			
1. Broad leaf weeds	43.5	73.5	51.3
2. Grassy weeds	20.0	0.0	14.8
3. Both of the above	23.5	16.7	21.7
4. Orobanche	3.5	0.0	2.6
5. Both one and four above	9.5	10.0	9.6
Total	100.0	100.0	100.0
	Plant/m^2	Plant/m^2	Plant/m^2
III. Plant population			
- Broad leaf weed	43	78	52
- Grassy weeds	17	7	14
- Orobanche	5	2	4
Total	65	87	70
Lentil plants	259	311	272
Total	324	398	342
Weeds as percent of total plants	20%	22%	21%

(c) Due to increasing labor shortage and raising daily wages, manual weeding is less common (33 percent of farmers weeded once, five percent twice and one percent did three weedings). Manual weedings is carried out by the family when possible or sometimes by neighbors.

4. Since straw is an important component of total revenue in the production of lentils (See Component 6.), it is worth noting that grain yields vary more than straw yields. Straw acts to stabilize income over time, makes up a higher proportion of total biological yield in dry years and also commands a higher price in such years.

5. Lentil production plays an important role in the cereal-lentil-summer crop rotation in Northern Syria. The fact that lentils can improve the soil (or at least not cause further degradation of fertility) is recognized by farmers. Few, however, understand the biological nitrogen fixation capability of a legume plant.

6. Lentil production is sensitive to the economic environment, and the area seeded to lentils has decreased within the past few years due to a fall in the price of lentils relative to other crops and a rise in the cost of manual labor. Lentil production currently uses more manual labor than, for example, cereal crops.

Processing this kind of data by computer will substantially improve the usefulness of this type of survey. We will proceed with (1) multiple regression analysis, (2) mapping of production practices and problems and (3) more refined categorization of farmers and farm characteristics. A report will be submitted in the spring of 1983 to complete the study.

Component 6. On-Farm Trials

Most farmers cooperating in the on-farm lentil trials cited two main reasons for not sowing lentils earlier in the year. These reasons were weed infestation and the increased risk of frost damage. The trials on early vs. late sowing over the past three years give some evidence that, on average, these disadvantages may be outweighed by higher yields. (See Table 2.12).

Higher yields of grain and straw obtained due to early sowing generally produce higher gross revenues. An average of 142 Syrian lira per hectare more revenue was gained from early sowing, after subtracting the cost of an extra weeding. However, variations in the effect of sowing data between years were substantial.

In first year of the on-farm trials, 1979/80, an advantage of SL 775 per hectare was achieved from early sowing of lentils. In 1980/81 the comparable revenues of the early and late sowing were nearly identical, differing by only SL 19 per hactare. In 1981/82 the late sown trials showed higher comparable revenues of SL 367 per hectare; a considerable disadvantage to early sowing. The range of year to year variation in comparable revenues was greater for the late sown trials than for the early sowings; if early sowing does stabilize and increase the profits of lentils production, the practice will be of interest to many Syrian farmers.

Trial sites were selected partly to avoid areas having notorious weed problems, e.g., Orobanche infested areas. Thus, the above results may not apply to lentil farms in general. Even with two weedings, the early-sown lentils may suffer serious yield declines relative to the normal sowing on sites if the weed populations are heavy. Thus, further trials are justified to define, more precisely, the conditions (especially weed environments) under which early sowing is more successful than late sowing.

Table 2.12. Summary of on-farm trials for early vs. late sowing of lentils: average partial budgets for three growing seasons.

Seasons and Locations	Item	Early sowing: Yield (kg/ha)	Early sowing: Revenues[a] and cost[b] (SL/ha)		Late sowing: Yield (kg/ha)	Late sowing: Revenues[a] (SL/ha)		Difference in comparable revenues (Early-Late) (SL/ha)
1979/80 9 locations in Aleppo and Idleb Provinces	Grain	1223	1223		640	640		
	Straw	2642	1057		1601	640		
	Cost of extra weeding		-225					
	Comparable Revenue			2055			1280	775
1980/81 13 locations in Aleppo and Idleb Provinces	Grain	1150	1150		990	990		
	Straw	3160	1264		2950	1180		
	Cost of extra weeding		-225					
	Comparable Revenue			2189			2170	19
1981/82 8 locations in Idleb Province	Grain	967	967		1174	1174		
	Straw	2298	919		2135	854		
	Cost of extra weeding		-225					
	Comparable Revenue			1661			2028	-367
Average (Early-Late) difference in Comparable Revenues for three years =								142

[a] Revenues based on assumed prices of SL 1.0/kg for lentil grain and SL 0.4/kg for lentil straw for all years.

[b] Cost of extra weeding based on 15 labor days per ha at SL 15 per day.

PROJECT III

CROP PRODUCTIVITY AND PROFITABILITY WITHIN ROTATION SYSTEMS

INTRODUCTION

Improvements in crop productivity can be achieved by the introduction of new technologies within traditional cropping rotations or by changing the rotations themselves. The interaction of the many factors needs to be understood from an economic as well as agronomic viewpoint before any changes can be promoted within the region. This project is designed to test the new techniques and crop varieties in proper rotational sequence and refine our experimentation in the future.

Component 1. Socio-Economic Perspectives

Twenty years ago, the agricultural sector in Syria began a process of modernization. The speed and scope of this process stands in sharp contrast to the long period before 1960, when agricultural techniques were primitive and agricultural development was stagnant. Within these twenty years, rapid and wide ranging changes have taken place; the Syria peasant has switched from the animal drawn feddan plough to a tractor drawn tillage implement, from hand harvesting and threshing to a combine harvester.

Although these changes were profound, others, equally important, can be observed today. Land reform, improved transportation facilities and the changes in communications have all contributed to completely modifying the agricultural environment. As a result, people living in these areas are forced to adjust to new circumstances and incentives. The adjustment process is just beginning and is slow; the system in no longer in equilibrium. This has created problems, some which are severe and deserve immediate attention.

In the past twenty years, tremendous disparities in potential have developed between agricultural regions, and all regions have not equally benefited from new techniques. As an example, consider the impact in areas which we call marginal. In these areas, modernization has been restricted to partial mechanization. Marginal areas are located in the drier zones of sedentary agriculture, and production per unit area is stagnant or even declining. The neighboring areas have increased their productivity, and the relative importance of the marginal villages has been dramatically reduced. Due to their lower potential, compared with higher rainfall and irrigated areas, the marginal villages are neglected by government agricultural policy; yet, the plight of marginal villages goes beyond development policies. Compared with areas which have increased their productivity through modernization, the cost of sheep production in the marginal areas is higher and thus less profitable. In some cases the returns are negative, and this raises questions about the future prospects of sheep production in these areas. The situation becomes even more critical when we look at the resource base. Villages that were recently settled are suffering from a decline in soil fertility which can be very sharp indeed. If the degradation process is to continue during the coming years, and we think it will, the process clearly jeopardizes the system's future. The declining production and profitability has caused other changes in the villages. In general, agriculture in this area has become either a mining activity or a secondary activity depending on the availability of off-farm employment, the latter becoming more common as off-farm income increases.

The future prospects of the marginal villages are critical not only for the area, but also for the country as a whole, and there is an urgent need to improve them. The plight of marginal villages is highly related to the modernization process at national level. If it is to succeed, an approach aiming to provide suitable improvements will necessarily have to take into account the on-going evolutionary process and the forces affecting it. Rather than simple technical changes, the area requires a strategy combining technical and socio-economic improvements.

In response to these problems, research efforts designed to examine the role of alternative cropping rotations, their profitability and likely effects on long term production stability are discussed in the following sections with particular reference to the drier areas (350 mm precipitation pa. or less).

Component 2. Two-Course Rotation Trials in Breda and Khanasser

Introduction

This is the second year of a two-course rotation trial at Breda (275 mm precipitation pa.) and Khanasser (220 mm). The objective of this research was to compare, from a technical and economic perspective, existing and alternative rotational systems which could make a more profitable use of land resources and provide a more stable source of food and income, while maintaining or improving soil fertility.

Traditional rotations under study are barley/fallow and barley/barley with and without fertilizer, and alternative rotations are barley/vetch with and without fertilizer, barley/chickpeas and barley/lentils with fertilizer

Results

Yield data obtained in 1981/82 are given in Table 3.1. There was a marked difference in barley yields in response to the applied treatments, particularly at Breda (from 490 kg/ha in Bo/Bo to 1710 kg/ha in B_{np}/F). Seed yields of barley grown after fallow at Breda were the highest of the rotations studied. Barley yields following chickpeas (the latter yielding 790 kg/ha ub 1980/81) and lentils (yielding 615 kg/ha in 1980/81) were also promising. Barley/chickpeas and barley/lentils were the two most productive rotations after the barley/fallow rotation. Unfortunately, the chickpea yields in 1981/82 were infested by Aschocyta Blight and were very low. This may affect

Table 3.1. Yields and yield components of barley, vetch, chickpea and lentils in 2-course rotation at Breda. 1981/82

Treatment	Breda Total D.M. kg/ha	Breda Grain yield kg/ha	Khanasser Grain yield kg/ha
Bo/F	3700	1470	940
Bnp/F	5250	1710	1120
Bo/Bo	1300	490	640
Bnp/Bnp	2790	920	780
Bo/Vo	2380	870	850
Bo/Vp	2500	870	960
Bnp/Vo	2890	1020	830
Bnp/Vp	3220	1120	1020
Bnp/Lent. p	-	1250	690
Bnp/Ch.P. p	-	1320	1010
LSD (p=0.05) for barley yields	740	150	217
Vo/Bo	1200	-	-
Vo/Bnp	1830	-	-
Vp/Bo	1900	-	-
Vp/Bnp	2010	-	-
LSD (p=0.05) for vetch	260	-	-
Ch.P./Bnp	980	160	-
Lent./Bnp	2580	860	-

<u>Notes</u>

a. Breda results given here are from combined yields. Combining was done after severe storm. Hand harvesting of $1m^2$ quadrats before storm gave higher yields and an estimate of grain loss due to storm was established and used to correct combined yields. (Mean value of estimated grain loss = 290 kg/ha).

b. No vetch, lentil or chickpea yields are available from Khanasser, as these crops were completely destroyed in late winter by birds and frost.

B=Barley; F=Forage; V=Vetch; Lent.=Lentil; Ch.P.=Chickpea.

o=No fertilizer; n=Nitrogen added; p=Phosphate added.

the results of this rotation next year as well. Yields of vetch plots where fertilizer was applied were about two tons/ha. Given the high cost of animal feed, these yields are likely to be highly profitable.

In Khanasser, the yields were in general about 25 percent lower than in Breda and the treatment effects were less.

The effect of the rotation on yields can best be highlighted when we compare unfertilized treatments. At both locations, the highest yields were obtained in the barley/fallow rotation; yields from continuous barley were the lowest. At Breda, the barley grain yield of the barley/vetch rotation was 78 percent higher (380 kg/ha increase) than continuous barley; at Khanasser it was 33 percent higher (210 kg/ha increase). The increase in barley yields after a fallow are even more dramatic when compared to continuous barley. This increase was 200 percent (a gain of 980 kg/ha) at Breda and 47 percent (a gain of 300 kg/ha) at Khanasser. These yields, at Breda at least, were higher than expected. The cropping history of the plot always plagues rotation trials. In this case, the plot was in fallow for two years prior to the barley crop,and this may explain part of the 200 percent increase. In the third year of these trials, this problem should be less important.

Yields of barley after vetch at Khanasser were not significantly different from barley after fallow; at Breda, barley/vetch yielded less barley grain than barley/fallow. The barley yields in the barley/vetch rotation were about the same at both Breda and Khanasser (870 and 850 kg/ha respectively). This was less than we expected at Breda. A tentative explanation is that vetch was mixed with barley in 1980/81 (mean percentage barley of total dry matter produced was 69 percent in Breda and 57 percent at Khanasser) which resulted in poor nitrogen fixation by the vetch crop and decreased yields the second year. This effect was less important at

Khanasser due to the high nitrogen levels in the soils at this site. During the 1981/82 season the vetch treatment was a pure vetch stand, and next year's results will more accurately reflect those of a barley/vetch rotation.

There was a large barley yield response to fertilizer application only at Breda, in contrast to the previous season where a significant fertilizer effect was observed at both locations. Phosphorus increased vetch yields even when applied to the barley phase of the barley/vetch rotation. However, residual phosphorus did not appear to affect barley yields in this same rotation when applied to the vetch crop. This year's results suggest that the most efficient ways of applying phosphorus is on the barley phase of the barley/vetch rotation and in combination with nitrogen. In this way, barley production is increased and vetch is still able to benefit from the residual phosphorus.

Fertilizer application failed to increase grain yields significantly at Khanasser this season, contrary to 1980/81, even though the total amounts of annual precipitation were similar (246 mm in 1980/81 vs 250 mm in 1981/82). Temperature and rainfall distribution, however, were different this season. Frost damage was more severe than in 1980/81 and rainfall distribution was characterized by a dry spell from mid-February to the end of April when most growth occurs (34 mm in 1981/82 vs 69 mm in 1980/81). By increasing vegetative growth and thus moisture use in the beginning of the season, fertilizer may add to the water stress during dry spells and at the end of the season during grain filling. This will reduce grain yield.

Moisture Studies

This season, soil moisture was monitored in the unfertilized barley plots at both locations and on vetch in Breda. (No vetch crop was obtained at Khanasser due to frost and bird damage.)

Results

Profile recharge occurred from the start of rainfall until mid-February, when maximum recharge occurred at both locations (Figures 3.1 a, b and c). Less recharge occurred at Khanasser than at Breda and, in general, did not extend beyond 105 cm depth in the fallow plots and 75-90 cm in the other treatments at either site. Rapid profile discharge, due to increased plant growth combined with a dry spell, occurred at both sites from mid-February until the end of April, when late rains slightly recharged the soil.

Studies conducted this year on fallow management at Breda and Khanasser indicated that water storage is possible under a well-managed fallow. This is confirmed by the results of 1981/82 Bo/F moisture-use (See Fig. 3.1) where 12 mm available moisture at Breda and 6 mm at Khanasser was stored on the fallow. Although very low, these amounts are used very efficiently; 1 mm of stored water yielded approximately 30-40 kg/ha of grain.

In the continuous barley rotation at Breda, growth was so poor that the crop could not extract all available moisture present in the soil profile. This is in contrast to barley following vetch and indicates that a nutrient deficiency is a major limiting factor in continuous barley.

As indicated in Fig. 3.1 b, the vetch crop did not use all available water stored from the current season rainfall. The reason, however, is not poor growth, but early harvesting of the crop for hay (mid-April). This moisture can be saved for next season's crop, if cultivations can provide a good mulch layer soon after harvest.

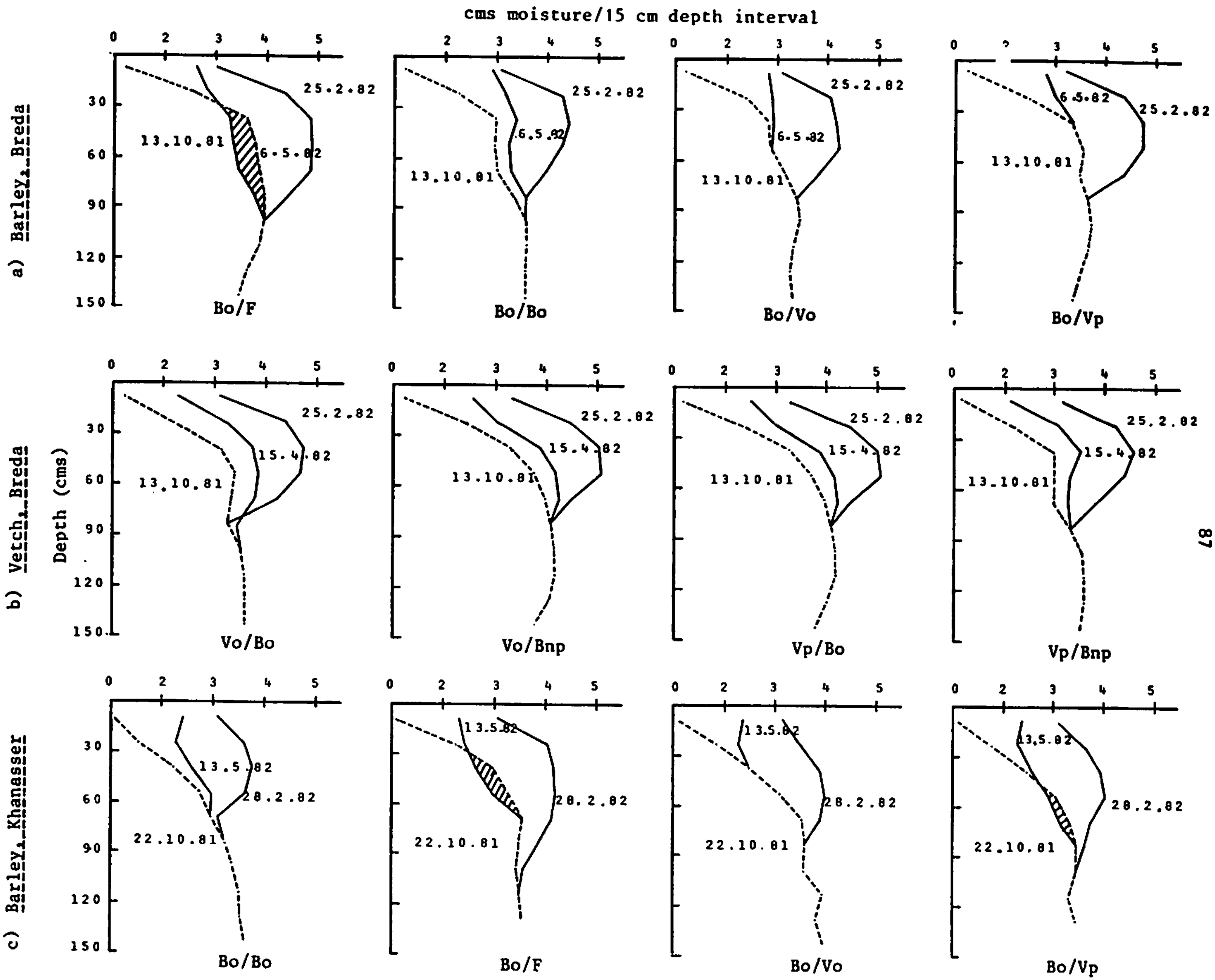

Figure 3.1. Moisture distribution on three selected dates under barley and vetch at Breda and Khanasser, 1981/82. (Shaded areas represent available water stored from from the previous season.)

At Breda, water-use-efficiency (WUE) was greatly increased by fallowing which produced 5.51 kg grain/ha/mm and 13.86 kg dry matter/ha/mm, compared to 2.06 and 5.46 respectively in continuous barley (See Table 3.3). At Khanasser there was little difference in water-use-efficiency between treatments except in continuous barley which was less efficient in using water (See Table 3.2).

The inefficient use of water from germination to anthesis at Brida (See Table 3.3) was caused by the very low proportion of evapotranspiration of the crop which occurred as transpiration from the crop. In addition, the accumulation of dry matter in the roots is not measured in dry matter production. From anthesis to maturity,however,WUE are higher and approach Fisher's predicted values of transpiration efficiencies of 45 kg/ha/mm for April and May in Aleppo. These higher rates of WUE in the spring are due to the development of a much greater ground cover by the plants (about 75 percent in Bo/F). Transpiration constitutes a greater proportion of the measured E_t. Root growth in cereals effectively ceases at anthesis, and dry matter production is then more accurately reflected by measuring the part of the plant above the ground.

Research Proposals 1982/83

In 1982/83 a more intensive effort will be made to gather data from the rotation trials, aiming to develop a deeper understanding of soil nutrient and moisture dynamics of the different rotations and the climatic constraints on crop growth. In addition, we will add a new dimension to this trial at Breda and Tel Hadya which will further examine the role of forage crops as a possible replacement for the fallow in a two-course rotation. The choice of legume crop, the effect of legume/cereal mixtures, the addition of fertilizer and the harvesting technique will be studied. Full treatment details are given in Table 3.3.

Table 3.2. Barley yields and water use efficiencies in Breda 2-course rotation trial. 1981/82

Treatment	D.M. anth. (15/4) kg/ha	D.M. matur. (6/5) kg/ha	Seed yield kg/ha	Et Germ-anth. (mm)	Et Anth-matur.	Total Et mm	W.U.E. (a) (kg/ha/mm)	W.U.E. (b) (kg/ha/mm)	W.U.E. (c) (kg/ha/mm)	W.U.E. (d) (kg/ha/mm)
Bo/F	2486	3700	1470	178	37	215	10.26	33.7	13.86	5.51
Bo/Bo	1609	1300*	490	158	29	187	7.70	-	5.46	2.06
Bo/Vo	1935	2380	870	169	30	199	8.68	31.8	10.04	3.67
Bo/Vp	2203	2500	870	178	31	209	9.62	21.2	10.28	3.58
		Harv. (15/4)								
Vo/Bo	-	1200	-	-	-	207	-	-	5.80	-
Vo/Bnp	-	1830	-	-	-	219	-	-	8.36	-
Vo/Bo	-	1900	-	-	-	212	-	-	8.96	-
Vp/Bnp	-	2010	-	-	-	214	-	-	9.39	-

(a) W.U.E. germination-anthesis

(b) W.U.E. anthesis-maturity

(c) Total W.U.E.

(d) W.U.E. of seed yield

* Higher yields obtained at anthesis than at maturity

Table 3.3. Forage rotational trial treatments 1982/83

	1st Year		2nd Year[a]	
1.	Cereal	+ 20 kg/ha N, 60 kg/ha P_2O_5	Peas	No Fertilizer
2.	Cereal		Peas/Cereal	
3.	Cereal		Vetch	
4.	Cereal		Vetch/Cereal	
5.	Cereal	+ 20 kg/ha N, 30 kg/ha P_2O_5	Peas	+ 30 kg/ha P_2O_5
6.	Cereal		Peas/Cereal	
7.	Cereal		Vetch	
8.	Cereal		Vetch/Cereal	
9.	Cereal	+ 20 kg/ha N	Peas	+ 60 kg/ha P_2O_5
10.	Cereal		Peas/Cereal	
11.	Cereal		Vetch	
12.	Cereal		Vetch	
13.	Cereal	No Fertilizer	Peas	No Fertilizer
14.	Cereal		Peas/Cereal	
15.	Cereal		Vetch	
16.	Cereal		Vetch/Cereal	
17.	Cereal	No Fertilizer	Fallow	
18.	Cereal	+ 20 kg/ha N, 60 kg/ha P_2O_5	Fallow	
19.	Cereal		Cereal	+ 20 kg/ha N, 60 kg/ha P_2O_5
20.	Cereal	No Fertilizer	Cereal	No Fertilizer

[a] Cereal crops will be barley at both sites. Nitrogen rates at Tel Hadya will be increased to 40 kg/ha

Component 3. Moisture Conservation under Fallow Land

Introduction

Much work has been done on the role of fallow in the cereal/fallow rotation system in the Mediterranean environment. Invariably barley after fallow out-yields barley after barley, and this has been confirmed both by farmers and scientists in the ICARDA region. The major factors involved in this difference appear to be water conservation, available nutrient accumulation, (principally nitrogen), weed control, ease of seed bed preparation and control of diseases.

Results

In previous reports, it has been shown that whereas little moisture conservation is achieved by current levels of farmer-managed fallow in areas receicing lsss than 300 mm rainfall, there remains the potential for increased moisture conservation when fallow land is managed at optimum levels. This study was continued at several locations in Aleppo Province in 1981/82, and the results to date are presented in Fig. 3.2.

The results represent moisture distribution on three dates during the season: (a) at the start of the season, (b) at maximum profile recharge and (c) two months prior to seeding the following season. The shaded area represents moisture stored from the current season. It is expected that between 6-12 mm of further evaporative loss will occur before profile recharge starts in the 1982/83 season.

Optimum fallow management was achieved by rotavations to a depth of 25 cm in late spring. The deep uniform tillage used in this treatment would be difficult for farmers to duplicate using local implements. From two years data there appears to be a general relationship between preci-

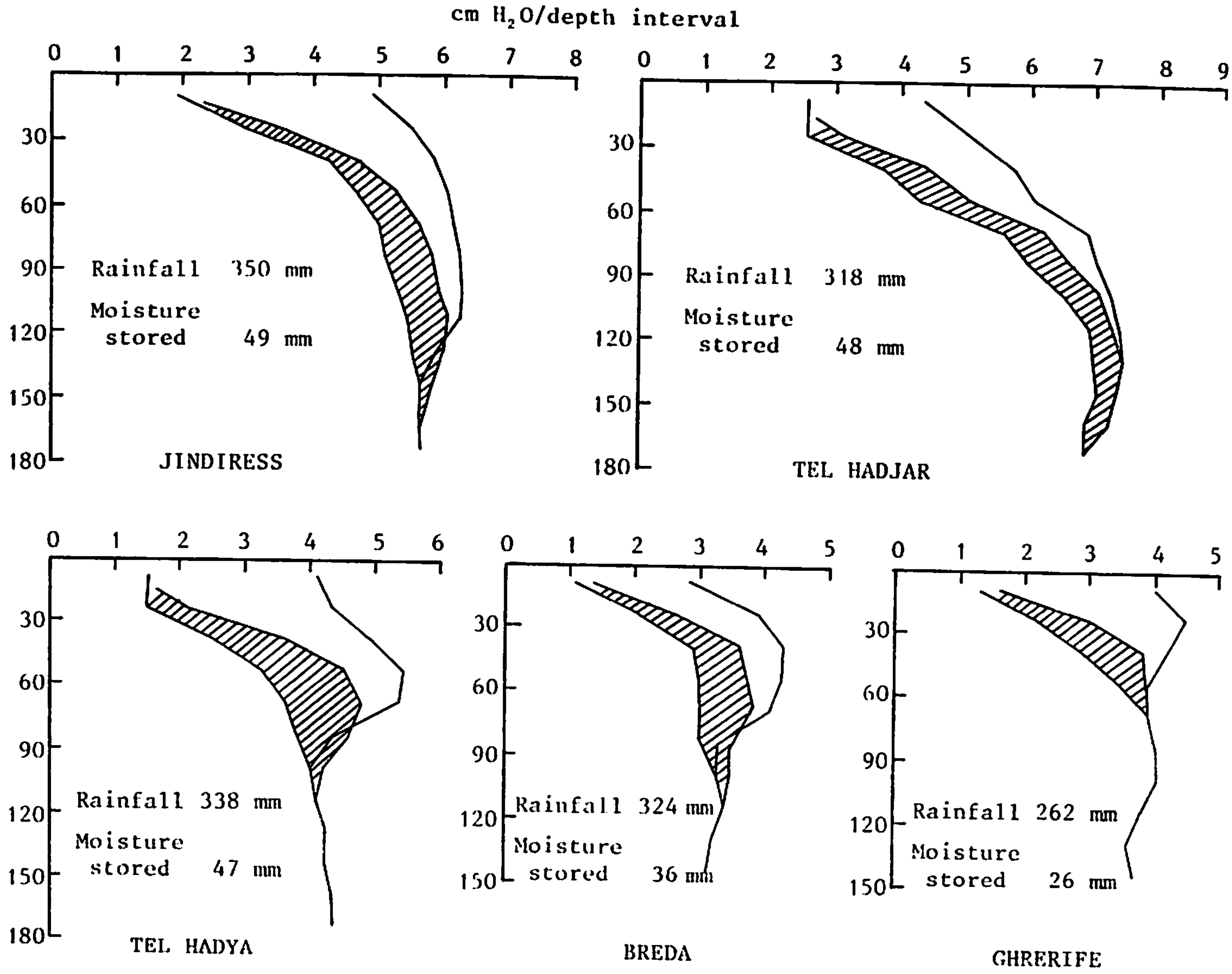

Figure 3.2. Moisture loss under fallow managed at optimum levels during summer months 1982 at 5 locations in N. Syria.

pitation and moisture storage. Even under optimum fallow management it seems that no moisture can be expected to be stored in areas receiving less than 260 mm of annual rainfall,and this may be true for even wetter areas where local management practices are used.

To investigate whether moisture can be stored with these practices, a very simple trial was carried out in the 1981/82 season. A simple comparison was made at Breda (275 mm precipitation pa.) on fallow management using a farmer's ducksfoot cultivator. The cultivator was set up by the farmer with a single bank of tynes at a 45 cm row width. In one treatment the land was cultivated by one pass of the implement, and in the second treatment the land was cross cultivated a second time on the same day.

This cultivation followed the last heavy rainfall at the end of April. The moisture loss was monitored by use of a neutron probe with four access tubes per treatment. Initial results from this trial clearly show that the deeper, more even soil mulch achieved with the cross cultivation has significantly reduced the rate of soil evaporation during the summer months. Because of these interesting results, a more detailed fallow management trial is planned for the 1982/83 season.

Proposed Fallow Management Trial for 1982/83/84

This trial will continue for two years. In the first year, five fallow management techniques will be applied on land which was under uniform cereal for the previous two years. The treatments will range from a farmer managed fallow, with one cultivation only, to an 'optimum' level of management with four cultivations. (See Table 3.4) In all cases the ducksfoot cultivator (plus or minus a taban) will be used . These implements are commonly used locally and are accessable to farmers.

Table 3.4. Fallow management treatments

Tr.	JUN	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY
1	Stubble Grazed	-	-	-	-	Volunteer allowed to grow and then grazed					Land Cultivated Ducksfoot Cultivator	-	-	-
2	Stubble Grazed	-	-	-	-	Volunteer allowed to grow and then grazed					Land Cultivated Ducksfoot Cultivator + tabban	-	-	-
3	Stubble Grazed	-	-	-	-	Volunteer allowed to grow and then grazed		Land Cultivated Ducksfoot Cultivator		-	-	Land Cultivated Ducksfoot Cultivator + tabban	-	-
4	Stubble Grazed	Land Cultivated Ducksfoot Kills summer weeds	-	-	-	Volunteer allowed to germinate	Volunteer killed by Ducksfoot Cultivation	-	-	-	Land Cultivated Ducksfoot + tabban	-	-	-
5	Stubble Grazed	Land Cultivated Ducksfoot kills summer weeds	-	-	-	Volunteer allowed to germinate	Volunteer killed by Ducksfoot Cultivation	-	-	Land Cultivated Ducksfoot + tabban	-	-	Land Cultivated Ducksfoot + taban	-

In the second year, the plots will be split three ways, and barley will be sown with a basal dressing of 60 kg/ha P_2O_5 and three rates of N:0, 20 and 40 kg/ha. Moisture-use by the crop will be measured after all fallow treatments at one fertilizer level (60 P_2O_5, 20 N). Simple crop growth and Nitrogen uptake studies will be carried out on all treatments. In the second season we can study the effects of the fallow management on germination, weed establishment, soil nitrogen dynamics and physical conditions of the soils. Yield and yield component analyses will compare the cultivation costs of each treatment and the benefit derived from grazing the volunteer barley.

Component 4. Cropping Systems and Crop Rotation Experiments at Tel Hadya.

Introduction

Long term large scale trials were established at Tel Hadya in 1978 to examine typical two and three course rotations. The management of these rotations were varied to allow a comparison of an improved agronomic package and the traditional farmer practice. Treatment details are summarized in Table 3.5.

Data from two seasons (1980/81 and 1981/82) in the correct rotational sequence are now available and reported in Tables 3.6 and 3.7. This is currently inadequate to analyse specific long term trends, but some generalized comments can be made. Owing to the large size of these trials (currently occupying 50 ha), agronomic management in the improved practice rotation proved to be a problem given the available resources. This, coupled with seasonal climatic variation, is reflected in inconsistant and variable yields. In general, however, improved management increased cereal yields in all rotations; yet, there was no clear indication that the management practice affected lentil yields. Data on summer crops were severely affected by the very low sesame yields in 1980/81 as a result of a severe disease infestation.

Table 3.5. Cropping sequences in two and three course rotational trials at Tel Hadya

A. TWO COURSE ROTATIONS

Rotations	Deep soil		'Shallow' soil[a]	
Years	1978/79	1979/80	1978/79	1979/80
I	SC	W	F	B
II	SC+	W+	F+	B+
III	Fo+	W	Fo+	B

B. THREE COURSE ROTATIONS

	1978/79	1979/80	1980/81
I	L	SC	W
II	L+	SC+	W+
III	SC	L	W
IV	Fo+	SC	W

F=Fallow B=Barley Fo=Forage W=Wheat L=Lentils

+=Improved management SC=Summer crop: Water melon or sesame

[a] A soil survey showed that only a small proportion of the soil is really shallow.

Table 3.6. Crop productivity from two course rotations at Tel Hadya in the 1980/81 and 1981/82 seasons.

	Cropping season	
	1980/81	1981/82
A. SHALLOW SOIL		
1. Barley (grain kg/ha)		
Barley after fallow Traditional management	2388	2654
Barley after fallow Improved management	4728*	2555
Barley after forage Improved management	2256	1613
2. Vetch (Total Dry Matter kg/ha)		
Vetch/barley mixture after barley Improved management	2282	3611
Vetch/wheat mixture after wheat Improved management	1877	3131
Vetch/wheat mixture after water melon Improved management	2530	2301
B. DEEP SOIL		
1. Wheat (grain kg/ha)		
Wheat after sesame Traditional management	2264	1321
Wheat after sesame Improved management	4048*	2522*
Wheat after forage Improved management	1986	1092
2. Sesame (grain kg/ha)		
Sesame after wheat Traditional management	69	160
Sesame after wheat Improved management	17	150

* Significant effect of management

Table 3.7. Crop productivity from three course rotations at Tel Hadya in the 1980/81 and 1981/82 seasons

	Cropping season	
	1980/81	1981/82
A. WHEAT		
Wheat after lentil Traditional management	2440	1299
Wheat after water melon Traditional management	2366	1648
Wheat after water melon Improved management	4140*	3346*
Wheat after water melon	2342	1706
B. LENTIL		
Lentils after wheat Traditional management	1149	897
Lentils after water melon Traditional management	1552	737
Lentils after wheat Improved management	932[a]	1559
C. SESAME		
Summer crop[b] after lentil Traditional management	81	4156
Summer crop after wheat Traditional management	54	3717
Summer crop after lentil Improved management	44	3097
Summer crop after forage Improved management	22	4162

* Significant effect of management

[a] Sowing was delayed

[b] In 1980/81 the summer crop was sesame and in 1981/82 it was water melon

The yield of cereal crops, following either forage or fallow, showed no differences in 1980/81 but yields were reduced in 1981/82 on the plot following forage. More time is needed and an economic evaluation of all components in these trials will be necessary to determine whether a forage/barley rotation can effectively replace the commonly practiced fallow/barley rotation. It is clear that replicating a farmer's practices on an experimental station is difficult and perhaps not a valid exercise. Research on crop rotations will change focus next year and more alternatives to a two or three course rotation will be considered.

CONCLUSION

Results obtained from this Project suggest that it is possible to increase crop productivity in marginal, low rainfall areas, by the introduction of new technologies and by changes in the traditional crop rotations. Continued investigations during the next year, particularly into moisture conservation, fallow management and changes in the traditional two or three course rotation systems are expected to show the importance of this Project within the Farming Systems Program.

PROJECT IV

LIVESTOCK IN THE FARMING SYSTEMS

INTRODUCTION

Animal production accounts for 30 to 40 percent of the value of agricultural output in the countries of North Africa and West Asia. Demand for meat and milk products in particular is expanding rapidly due to human population growth and rising incomes, and it is necessary to increase production to meet this demand. However, the producers of these products are as important as the consumers; they are often resource poor farmers with small areas of cultivated land and a few sheep and goats.

In this region, livestock are so completely integrated into the farming systems that research aimed at increasing animal production must take into account that it complements crop production. The aim of livestock research in this context is to find ways of increasing farm income while raising the supply of animal products for consumers and enhancing ecosystem stability.

In the following section some highlights of the livestock research are presented to demonstrate the approach being used. The research is organised into three components: 1) crop-livestock systems, 2) animal production from forage crops, and 3) performance of Awassi sheep.

Component 1. Crop-Livestock Systems

A. Forage and grain values of a barley crop

Few crop management decisions in the drier areas are taken without considering the feed demands by livestock, and few livestock management decisions are taken without regard to the availability and prices of these feeds. One very close relationship between sheep and barley management is illustrated by the farmers' decision to harvest a crop for grain or let the animal graze it.

The raltionship between harvest costs and the economic value of barley grain and straw when harvested or the standing crop when grazed can be understood if a few assumptions are made:

1. Prices are constant through time and across locations;
2. The frequency distribution of grain yields is stable through time for a given cultivar and location, but differ between location (as between Khanasser and Breda in Fig. 4.1c);
3. Harvest costs, grain and straw values all increase as grain yield increases (See Fig. 4.1a); and
4. The direct grazing value of a standing crop (See line dg in Fig. 4.1b) also increases with grain yield and is positive even at the lowest grain yields.

The shaded area in Fig. 4.1b represents the contributions of forage to the total value of the crop. Grain yields are so low at Khanasser that farmers would have little interest in barley cultivation if there were no demand for forage. At Breda, average grain yields are nearly double those at Khanasser, and are rarely low enough for farmers to choose to graze rather than harvest. Nevertheless, forage values at Breda add substantially to the total value of the crop.

A farmer may be indifferent when choosing two cultivars if one exhibits lower grain but higher forage values than the other. Such an amibiguous case is shown in Fig. 4.2. What cultivar A lacks in grain yields, relative to cultivar B, is compensated by its superior grazing and straw values. Another cultivar with the same yield distribution as cultivar B could be considered to both cultivars A and B if its forage value were only slightly higher than that of cultivar B.

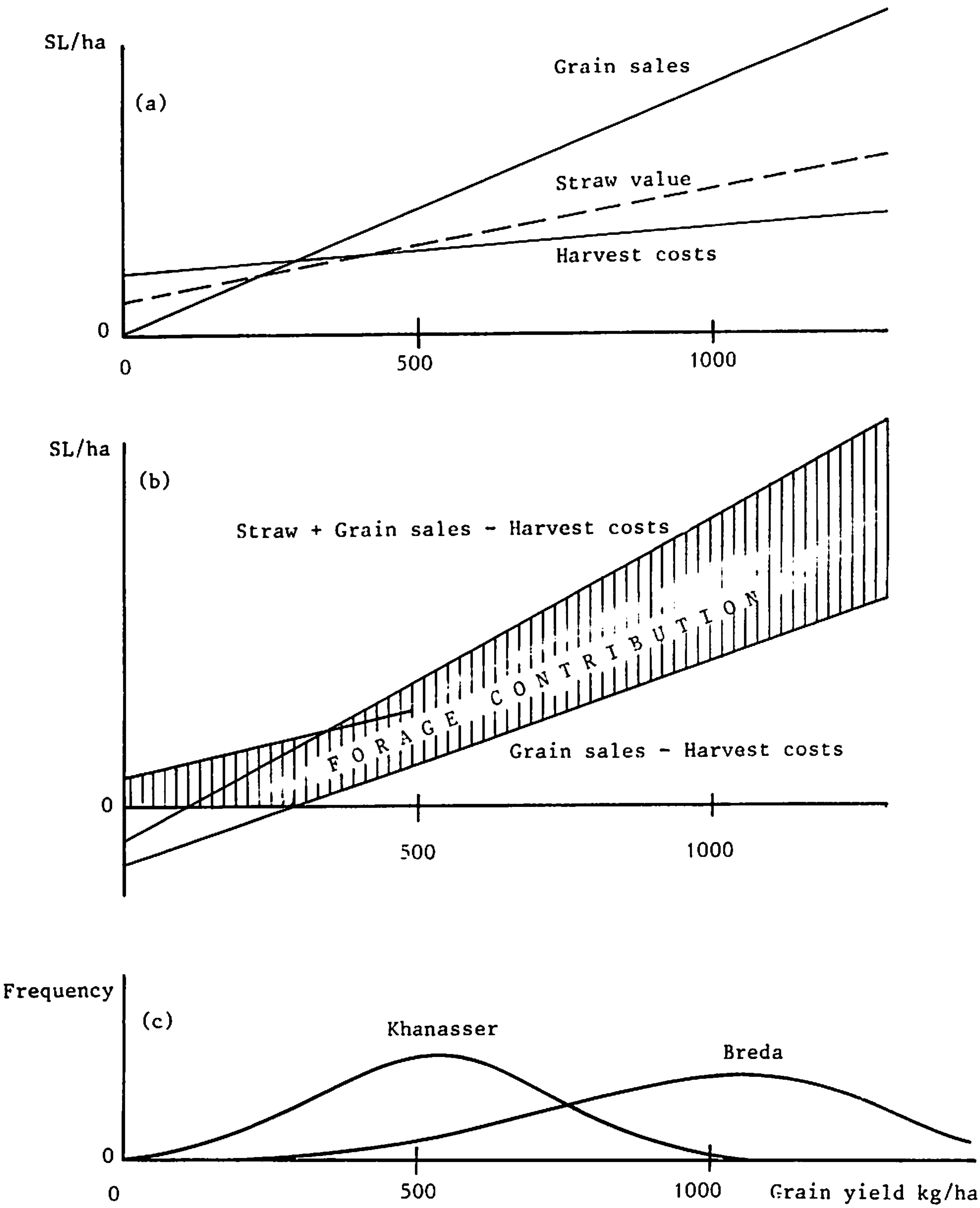

Figure 4.1. Forage contributions to barley crop value.

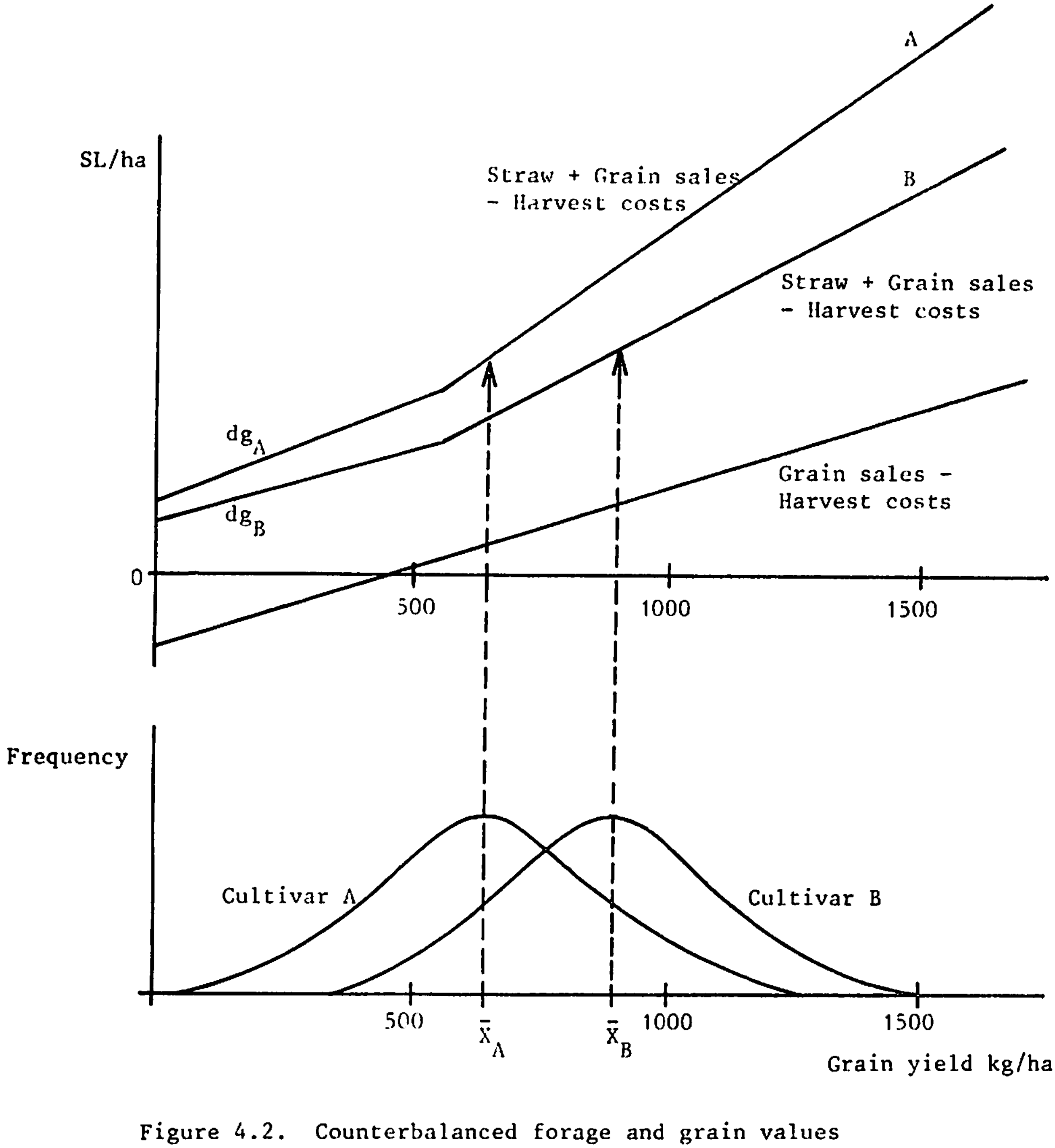

Figure 4.2. Counterbalanced forage and grain values of two cultivars A and B.

Barley is Syria's number one forage crop, most of its above ground biomass being used in one way or another by livestock. ICARDA's barley breeders should be encouraged to develop cultivars superior to the local ones with respect to mature forage quality and quantity as well as cultivars with higher grain yields.

B. Livestock-crop survey results

An important objective of the livestock studies has been to identify economic and husbandry constraints which limit animal productivity. Information on husbandry systems and sheep performance was collected in survey work conducted in the steppe area of Aleppo and Raqqa provinces receiving about 200 mm annual rainfall. Results have been compiled on the flock structure, reproductive rate and mortality levels of the 18 flocks. (See Table 4.1).

During the three years of the survey, sheep members expanded on average by three to four percent per annum even though sheep numbers decreased due to a dry year in 1978/79. The flocks ranged in size from 30 to over 1,000 head. Additions to the ewe flocks averaged 31 percent, of which two percent were purchased. Attrition from the flock totalled about 30 percent. After deducting transfers, which represent ewes given to other members of the family, the culling rate was 33 percent. This culling rate suggests that the average ewe bears four or five lambs and is culled at an age of six to seven years. Increasing the culling rate would have little impact on ewe productivity since farmers are already removing ewes from the flock that are found to be barren following the mating season.

Table 4.1. Summary inventory balance sheet of survey flocks, 1978 to 1981[a].

	EWES (per 100 ewes in opening inventory)	YEARLINGS (per 100 yearlings in opening inventory)	LAMBS (per 100 lambs born)
Transfers In	29 ± 6.9	101 ± 49.7	-
Purchases	2 ± 2.4	1 ± 3.2	-
Lamb births	-	-	84 ± 11.3[b]
Sales	15 ±10.7	5 ± 5.1	40 ± 7.3
Deaths	7 ± 6.7	2 ± 2.5	11 ± 9.5
Consumption	1 ± 0.6	2 ± 1.7	6 ± 3.0
Transfers Out	7 ± 7.3	90 ± 9.3[c]	43 ± 9.1[d]

[a] Average flock size was 176±110 ewes and 58±39 yearlings. Over three years these numbers expanded at an annual rate of 3 and 4 percent respectively.

[b] Per 100 apparently fertile ewes

[c] To ewes

[d] Female lambs to yearlings

Lambing percentage is defined as the number of lambs born per 100 ewes mated. The average lambing percentage of 84 percent for the flocks in the survey is well below the 97 percent achieved across the three Tel Hadya flocks in 1981/82. However, large variations across flocks were evident, the range being from 69 to 102 percent. The 84 percentage lambing rate is the same as that estimated in the earlier FSP studies of six villages in Aleppo Province. Low lambing percentages are a major factor limiting the biological and economic efficiency of the system. Increasing the lambing performance from 84 to 100 percent and holding mortality constant at 10 percent would increase lamb sales by 30 percent. The causes of low lambing percentages in village flocks warrants further study.

Mortality levels for ewes, yearlings and lambs in the sample were less than expected. These values may be slightly higher since some sick animals are sold. Again the mean values are associated with large variations. There were cases where losses exceeded 30 percent in localized epidemics. The pathogens responsible for these epidemics need to be identified. They often attack healthy lambs which have passed through the critical neo-natal period. Good husbandry practices, particularly nutrition of ewes in late pregnancy, can reduce neo-natal deaths. But good nutritional practices can do little to reduce mortality of older lambs when virulent pathogens are involved. Instead, routine vaccination may be the only effective control.

Component 2. Animal Production from Forage Crop

The unit farms at Tel Hadya have shown increasing value as testing grounds for prototype crop rotations and sheep husbandry practices in the context of a complete system. Particular emphasis is being put on the replacement of fallow by a pasture crop and the impact of improved nutritional regimes on the reproductive rates and milk production of ewes (as measured by the growth performance of their lambs).

One medium input and one high input unit farm, respectively 14.1 and 10.9 hectares in size, have been developed. Each has an area of stony-shallow soil and an area of deep soil. On the medium input unit farm a barley/fallow rotation is practiced on the stony-shallow soil and a wheat/lentil/watermelon rotation on the deep soil. On the high input unit farm a vetch pasture replaces fallow on the shallow soil and a vetch/wheat-hay mixture replaces the lentil crop on the deep soil. In addition, improved crop varieties, higher fertilizer levels, seed drills and herbicides are used on the high input unit farm.

Flocks of 36 and 42 Awassi sheep are assigned to the medium and high input unit farms, respectively. The medium input flock is managed in a manner similar to those in the Tel Hadya area. The high input flock receives additional supplementary feed during the mating season, during late pregnancy and early lactation. They are also vaccinated against diseases such as foot-and-mouth and enterotoxaemia.

Each flock is allocated a separate 11.5 hectare area of marginal rangeland for grazing. The stocking rates on the medium and high input units are 2.6 and 3.9 ewes per cultivated hectare, respectively.

A third, low input flock (named the sacrifice flock), serves as a control. It is subjected to a poor level of husbandry: limited supplementary feed in winter and over-stocking on marginal land are examples. The management of this flock is considered to be below that practiced by most farmers in the area. The three levels of husbandry - low, medium and high - provide a useful framework for studies which aim to determine the most economical levels of inputs.

The performance of lambs grazing the vetch pasture, which replaces fallow, are shown in Table 4.2. A grazing season of 70 days was achieved in the 1981/82 crop year, close to the maximum that can be achieved with vetch. The daily lamb liveweight gains were less than those recorded in two previous years because of the higher stocking rate. However, there was an increase in liveweight gain per hectare to 260 kg., which is also considered to be near the maximum possible for vetch pasture.

It appears from these results that increasing animal production beyond 260 kg. per hectare will only be possible if dry matter yields can be increased or the length of the grazing season extended. It is unlikely that vetch can fulfil the first condition, so it will be necessary to identify a species with a longer grazing season; such a species has not yet been identified. Alternative strategies could include using a sequence of species or a mixture of species which combine early and late maturity. The Pasture and Forage Program has already identified barley cultivars which can provide early grazing in February.

The animal production potential of a pasture species which replaces fallow has been defined. A goal over the next five years is to reach a liveweight gain of 500 kg. per hectare in a four month grazing season in the 350 mm rainfall zone. Studies which aim to define the animal production potential of pastures in zones receiving below 350 mm are in progress and will receive increased emphasis in the future.

An assessment of the economic returns associated with replacing a fallow with a pasture crop is the most important criterion for judging the viability of this change in rotation. This has been studied in the case of the unit farms and the results presented in Table 4.3. Net benefits are defined as the difference between the gross revenue of a rotation minus the variable (direct) costs of carrying out the rotation. Introducing

Table 4.2. Lamb growth rates on vetch pasture

	1979/80[a]	1980/81	1981/82
Number of Lambs	30	24	38
Start of grazing	22 April	1 April	8 March
End of grazing	19 May	1 June	17 May
Grazing days	18	41	47
Stocking rate lambs/ha	20	16	25
Initial liveweight (kg)	27.2	28.8	23.2
Final liveweight (kg)	34.1	43.3	33.7
Liveweight gains:			
- per hectare (kg)	139	232	260
- per lamb (g/day)	255	238	151
Carrying capacity[b]	540	976	1727

[a] Crop resown in January

[b] Lambs per hectare per day

Table 4.3. Comparison of net benefits for medium and high input two year rotations at Tel Hadya[a]

	Net benefit (SL/ha)[b]	
	Medium Input	High Input
Year 1	1097 (barley)	2369 (barley)
Year 2	-- (fallow)	1497 (pasture)[c]
Two year sum	1097	3866

[a] 1979/82 average performance

[b] Based on constant 1982 prices

[c] Gross revenue based on lamb liveweight gains when fattened on vetch pasture

the pasture crop accounted for nearly 40 percent of the increase in net benefits of the barley/pasture over the barley/fallow rotation. The remaining increase was due to the use of an improved barley variety (Beecher), more nitrogen and use of a seed drill.

Pastures are not yet able to supply sheep with feed from November until March, a period when the nutritional needs of the ewe are considerable. In Syria this deficit is corrected by using supplementary feeds. However, these are usually expensive and some are currently imported. Thus, hay production is being given considerable attention by researchers. There are numerous obstacles to the introduction of hay-making technologies. For example, vetch-wheat mixtures for hay following a wheat crop on the unit farm have not given satisfactorily yields, partly because wheat follows wheat in two years of the rotation. It may be necessary to resort to pure stands of legume forage. Other difficulties include problems of mechanical harvesting on stony soils, loss of highly nutritious leaf material during the hay-making process and making of hay before the end of the rainy season. These problems should be given special attention by researchers, and some are already under study.

Component 3. Performance of Awassi Sheep

A. Lamb growth rates

Part of the 1981/82 survey of 13 flocks, spread across the rainfall transect of Aleppo Province, involved the monthly weighing of about 250 ewes and their lambs. The actual growth performance of lambs in farmers' flocks is compared with those obtained in the three experimental flocks at Tel Hadya (Table 4.4). Such information on the actual and potential performance of a breed makes it possible to define the yield gap that exists in the system. With this information research priorities can be established.

Table 4.4. Daily liveweight gain (lambs to weaning)[a] in farmers' and three experimental flocks at Tel Hadya.

	Daily liveweight gain, g	
	Males (n)	Females (n)
Farmers' flocks	185 ± 32.2 (75)	158 ± 28.3 (71)
Three experimental flocks	246 ± 49.7 (41)	222 ± 49.2 (47)
High input flock only	299 ± 16.4 (13)	247 ± 37.2 (18)

[a] 60 days

Results of the survey showed that growth performance of lambs in farmers' flocks could be increased by 59 percent if management of ewes in late pregnancy and early lactation were given more attention. This aspect, therefore, is given special emphasis in the study reported in the next section.

B. Supplementary feedings of ewes

The level of feeding of ewes during late pregnancy and early lactation can have a marked effect on the growth rate of lambs and on milk production for yoghurt and cheese making. A trial was conducted to study the effect of three levels of supplementary feed during the last 49 days of pregnancy and the first 56 days of lactation on lamb growth rates. The aim was to determine the economically optimal levels of supplemental feeds under various price and cost situations.

The low, medium and high input flocks received three levels of supplementary feed based on barley, cotton-seed-cake, wheat bran and a basal diet of vetch/wheat-hay or lentil straw. Ewes were weighed weekly and supplements fed on an individual basis. The metabolizable energy intakes, mean liveweights and liveweight changes are presented in Table 4.5.

Supplementary feed had a marked effect on liveweight changes of the ewes during late pregnancy. During lactation the daily liveweight change of the low flocks was -96 g, but that of the other two flocks about -205 g. The high level of nutrients supplied from the supplements together with the energy derived from body tissue reserves were the two major factors which lead to the highest liveweight gains in lambs of the high input flock (See Table 4.5). The overall response to the three levels of feeding of the ewes was a 25 and 45 percent gain in liveweight of the lambs.

Table 4.5. Intake of supplementary feed, mean liveweight and liveweight changes of ewes and growth rate of lambs (Tel Hadya flocks).

		Level of supplementary feed		
		Low	Medium	High
PREGNANCY (last 49 days)				
Dry matter intake	kg	0.40	0.68	1.09
Metabolisable energy intake[a]	MJ	3.49	5.43	11.44
Liveweight[b]	kg	45.5	52.3	58.8
Liveweight change	g	1	61	122
LACTATION (first 56 days)				
Dry matter intake	kg	0.45	0.80	1.04
Metabolisable energy intake	MJ	3.89	6.40	10.97
Liveweight[c]	kg	34.9	40.3	48.3
Liveweight change	g	-96	-202	-206
GROWTH RATE				
MALE LAMBS				
Number of lambs		13	15	13
Birth liveweight	kg	4.3	5.1	5.2
Weaning liveweight	kg	16.6	19.1	23.2
Liveweight gain	g	206	238	299
FEMALE LAMBS				
Number of lambs		13	16	18
Birth liveweight	kg	4.1	4.5	4.7
Weaning liveweight	kg	16.0	17.2	18.6
Liveweight gain	g	200	212	247

[a] Estimated from dry matter intake x digestibility of organic matter in the dry matter x 0.15

[b] 24 days before lambing

[c] 28 days after lambing

A preliminary analysis of profitability was based on the data from the three experimental flocks. Nutritional management of ewes had a clear effect on lamb weaning weights, but less impact on milk and wool production. This is significant since about 70 percent of earnings from breeding flocks are derived from the sale of lambs. These animal products are expressed as gross revenues in the budgets presented in Table 4.6, together with the cost of supplements. A measure of the returns for comparing the three flocks is given by the Margin-Over-Supplementary-Feed-Costs (MOFC).

Whereas gross revenues increased by 51 percent from the low to the high input flocks, the increase in supplementary feed costs was 348 percent. Hence the MOFC was lowest for the high input flock. Expressing the MOFC per hectare altered the picture because the stocking rate on the high input unit farm was higher than on the medium input unit farm. The MOFC of the high input flock, however, was still less than that for the medium input flock.

The major reason for the poor economic performance of the high input flock was because of the heavy cost of supplementary feed during the mating period and the absence of an effect of this on reproductive rates. In future studies, emphasis will be put on designing husbandry practices which assure maximum reproductive rates while keeping an eye on costs.

Table 4.6. Level of supplementary feeding and margin over supplementary feed costs.

		Level of Input		
		Low	Medium	High
Unit Farm size	ha	-	14.1	10.9 (10.9)[a]
Unit Farm flock size[b]		32	32	32 (32)
Supplementary period	day	140	140	231 (140)
Flock gross revenue	SL	6541	8853	9904 (9904)
Total suppl. feed cost	SL	1875	2938	6533 (4925)
MOFC[c] per ewe	SL	146	185	105 (156)
MOFC per hectare	SL	-	419	309 (457)

[a] Supplementary feed during mating period given in parentheses

[b] Includes barren ewes and one ram

[c] Margin over feed costs

CONCLUSION

A number of research highlights on livestock were presented to illustrate the approach being used to reach an understanding of crop-livestock systems and ways to improve them. A perspective has emerged which will guide the research during the next five years. Of particular significance is the definition in explicit terms of the unifying role played by livestock in linking most parts of the rainfed farming systems of the region, especially in the drier areas.

Livestock enables farmers to extract an economic value from resources which would, otherwise, be unusable. In the drier farming areas as at Khanasser, for example, sheep constitute an insurance policy against poor grain production which is risky and unprofitable. We will continue to clarify these and other crop-livestock interactions and estimate the parameters of those interactions already identified.

We will also emphasize synthesising new grazing systems, perfecting hay production techniques and measuring livestock production from these systems at Tel Hadya and in on-farm tests. New cropping and feeding sequences will be evaluated from the perspective of rising consumer demand, conservation and enhancement of the ecosystem, as well as from the farmers' viewpoint of adoptability and profitability.

PROJECT V

ENVIRONMENTAL ZONING

INTRODUCTION

There is a need to categorize the ICARDA region by zones to provide realistic targets for agronomic or breeding programs,and this project seeks to fill this need. It has two principal objectives which comprise the initial data collection phase, namely

1. To collect and collate agro-climate data for use in agro-ecological zoning.
2. To collect information on agricultural policies with the purpose of analysing their effects on agricultural production.

Component 1. The Collection, Collation, Distribution and Use of Agro-Climatic Data.

A comprehensive collection of a full range of daily records of meteorological variables was made in the 1981/82 cropping season at the five principal FSP research sites (Jindiress, Kafr Antoon, Tel Hadya, Breda and Khanasser). This information has been widely circulated on a weekly basis within ICARDA. These data serve as the basic information required to assess the effects of climate on experiments in all FSP projects. They are of particular value in crop physiological and soil moisture studies. The value of these data has been further enhanced by the increased use of the FSP research sites by the ICARDA commodity programs in the 1981/82 cropping season. Additional data (usually only precipitation) has been collected from a wide range of on-farm trial sites, to act as the minimum data required for site characterization. Data from all sites has been summarized for the 1981/82 season and is included in Chapter

Important additions to the ICARDA data bank in the current season include all available daily precipitation values for up to twenty-five years from the six Syrian Meteorological Service recording stations nearest to the principal FSP research sites. These include Jindiress, Azaz (for Kafr Antoon), Aleppo and Saraqeb (for Tel Hadya), Breda and Khanasser. Long-term seasonal precipitation values for these sites were generally calculated from daily data over twenty years.

This year, the ICARDA climatic data bank was transferred from the University of New England, Australia, to ICARDA's computer. This comprehensive collection of data will act in the future as the core information for ICARDA's data collation effort.

Initial zoning development steps. The long-term precipitation data, acquired from the Syrian Meteorological Service for the six sites were given to the Agricultural Meteorology Research Group at the University of Reading. These data are currently being analyzed there to quantify the probability of a rainfall event and its likely intensity. Differences in the probabilities of rainfall occurrence between sites are evident. As a result of these differences it is hoped that the descriptive constants of the precipitation probability equations may act as initial building blocks from which a zoning scheme may be developed.

The University of New England/ICARDA wheat maturity modeling project has been further developed in the 1981/82 season. This model, which is driven by meteorological variables, has considerable potential for zoning. The model is near completion and preliminary results are expected by mid 1983.

Intensive data collection at the principal FSP research sites will continue in the 1982/83 cropping season. The daily measurement of soil temperature at two depths will be monitored, and this will greatly assist in the microbiological and root development studies proposed in Project I and II. Further sites will be added to the current on-farm trial network including the majority of cereal agronomy trial sites in Syria and Jordan (Project I). Long-term agro-climatic data collection efforts will continue, particularly acquiring long-term daily precipitation records.

Component 2. Socio-Economic Environments: The Perspective of Agricultural Policies

The basic premise for this component of Project V is that socio-economic constraints, especially those emanating from government policies, are being increasingly recognized as important. Technical research aimed at a physically homogeneous zone may have variable results if the zone is further divided into several different socio-economic environments. If we are aware of such policies, without getting involved in value judgements, we can expect to increase the effectiveness of our agricultural research. This project was initiated in 1982 with a literature survey. Insights have been obtained which have allowed us to economize research effort by emphasizing summary measures or indicators of policy rather than by extensively enumerating specific policies.

We are particularly interested in policies influencing ICARDA crops within the Middle East and North Africa. It is not hard to expect that, despite vast differences in political regimes, agricultural policies within the region will have substantial similarities. These similarities will be clearer in policy objectives whereas policy instruments will show a high degree of variation. These objectives and instruments are mentioned below followed by a brief discussion of summary measures.

A. Policy objectives

Agricultural policies have various objectives. The most important of these are to:

a) change income distribution among classes of producers, among classes of consumers, between consumers and producers, and between the urban and the rural populace,

b) increase production in general or for a particular commodity,

c) stabilize incomes, prices or production,

d) increase government incomes by taxing the agriculture sector, and

e) accelerate economic development as it is now recognized that economic development is impossible without agricultural development.

B. Policy instruments

There are six classes of instruments with which these policy objectives can be achieved.

1. Price policies are the most widely used policy instruments. These include fiscal policies and foreign trade policies which directly influence the prices of agricultural products and inputs. Examples of these are subsidies, preferential credits, export taxes, subsidized sales from imports, etc... The variation in price policies is substantial; support prices, guaranteed prices, minimum prices, input subsidies all reflect on the costs and prices of agricultural products.

2. Fiscal and monetary policies, for example, taxes, subsidies and credit policies, usually impinge on the prices and profitability of the crops. Credit has a particularly important role in agriculture because of the seasonality of production.

3. Foreign trade policies generally involve controls, export and import taxes, tariffs and quotas on imports, etc... Exchange rate policies, even though aimed at foreign trade, have interesting implications for agricultural production. Overvalued or undervalued exchange rates essentially imply, respectively, tariffs or export subsidies for domestic production.

4. Physical controls involve acreage and area controls, delivery quotas to government purchasing agencies, restrictions on the movement of products, etc...

5. Structural change involves a discrete change or transformation with wide spatial and temporal effects. Examples of this sort of policy are land reform, agrarian reform or implementation of irrigation schemes.

6. Agricultural research involving both pure and applied research and covering extension efforts as well, is usually not considered to be a policy instrument. However, the results of and returns from agricultural research and technological developments have indicated them to be most effective instruments, especially in achieving targets of production.

The multiplicity of policy targets and instruments makes analysis quite difficult: what is needed is a summary measure. The initial effort in this project is directed to those cases which are amenable to analysis within the frame of agricultural price policies.

C. Effects of agricultural price policies

The effects of agricultural price policies can be summarized under four headings.

1. Production. It has been demonstrated fairly extensively in the literature that agricultural producers in developing countries are responsive to prices.

2. Costs of the purchasing agency and the state. Effective price policies require efficient nanagement in purchasing, storage, etc...

3. Income distribution. Price policies targeted at given commodities (or inputs used intensively in the production of some commodities) benefit the producers of those commodities relative to other producers. Even for a given commodity, larger producers or those who market a larger amount benefit more. Price policies aimed at consumers are in essence income transfers.

4. Resource allocation. Changes in the absolute price of a given commodity implies a change in relative prices. These changes alter the relative profitability of producing different commodities. Consequently, resources will be drawn out of the production of less profitable commodities and transferred to more profitable uses.

D. Summary measures

Only an example of a summary measure is given here to indicate the direction that this research is taking and its value. The Nominal Protection Coefficient (NPC) is the ratio of domestic prices to border prices, i.e.,

$$NPC = P_d/rP_b$$

where: P_d = domestic price,

P_b = border price, and

r = official exchange rate.

Table 5.1. NPC ratios for a country in the ICARDA region

	Durum Wheat	Bread Wheat	Barley
1972-1973	.65	.65	.53
1973-1974	.47	.45	.41
1974-1975	.68	.70	.63
1975-1976	.91	.94	.78
1976-1977	1.24	1.26	.93
1977-1978	1.10	1.20	.88
1978-1979	.93	.95	1.00
1979-1980	1.02	1.08	.97

NPCs provide simple measures which can easily be calculated. Furthermore, they provide a good idea about the extent to which a commodity is being subjected to interventions and whether these are in the form of incentives or disincentives. Following on the dicussion above, a NPC less than 1 implies that the domestic producers are discriminated against whereas a NPC more than 1 indicates policies that support local producers by protecting them from the effects of the international market.

For example, the NPC for collection center purchases from farmers in a country in the ICARDA region are given for wheat and barley for 1972/73-1979/80. (See Table 5.1). The general indication from these data is that there is a significant bias against agricultural production. Even when there are periods of preferential treatment of certain commodities, this treatment lacks continuity. The serious bias which exists in national policies against ICARDA crops will be a serious impediment to the effective dissemination of the new technologies we are developing.

E. Objectives for 1982/83

In 1982/83 work will continue in this project with a shift to data collection for detailed studies of the region and for ICARDA crops. Preliminary emphasis will be on calculating NPC. The analysis will involve other commodities so that comparisons can be made, and in particular, agricultural inputs will be given high priority. Furthermore, supply response analysis will also be initiated with a literature survey and subsequently with analysis. This will provide insights into whether the bias against agriculture is justified. This general shift will necessitate an effort to obtain current information on product and input prices and policy changes. Presentation of these statistics and other information is expected to be of value in itself to ICARDA and regional scientists.

CONCLUSION

During the 1981/82 cropping season, the Farming Systems Program made considerable progress towards organizing its effort into projects which focus on problem areas. The search for solutions to these problems requires a multidisciplinary team which works closely with the farming community. This approach has at least three advantages over traditional agricultural research: first, it assures that research efforts address relevant issues; second, it provides a framework for measuring research progress; third, it increases the usefulness of the results for farming families.

In this document, we present a summary of the research results from the past cropping season which illustrates both Farming Systems Research strategy and the value of such an approach. The progress includes (1) integrating the research efforts of socio-economic and production scientists, (2) understanding the importance of the inter-relationships between animal and crop production and (3) determining the different characteristics of agro-climatic zones and their associated farming systems in the region. Within specific projects, the tentative findings include (1) confirming the large gap between actual and potential of cereal crop production, (2) measuring the potential for improved efficiency in the use of limited natural resources, particularly water, by better crop management practices, (3) emphasizing the role of different crop rotations and the introduction of forages into the cropping system, and (4) improving the productivity of livestock through better feeding practices.

Although this is only the first year in which this approach to FSR has been used, the results are encouraging; we will continue with it during 1982/83. Hopefully this will enable the Program to further sharpen its focus while developing the methodology for solving these problems. It is our firm belief that the Program is now posed to make a more significant contribution to help ICARDA achieve its objectives in the region.

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*Left the Center during 1982.

**Weed Science and Microbiology research was transferred into the Program in 1982; this research is not extensively reported in this document, but will be in 1983.