DISCUSSION PAPER
No. 5

Summer Crops in Syria

by

J. A. Harvey

The International Center for Agricultural Research in the Dry Areas
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PREFACE

This paper was written by Jim Harvey, an agriculturalist with ICARDA's Farming Systems Research Program. It is based on information collected by Hisham Salahiet, 'Abd al-Karim Ferdawi (Research Assistants with the Program) and the author.

The study of summer crops in Syria was made as part of the village surveys conducted by Farming Systems staff. Information was obtained from 20 villages in the Aleppo and Idleb Provinces during 1978 and 1979. This Discussion Paper is intended primarily for scientists at ICARDA and for interested agriculturalists and researchers elsewhere in the Near East and North Africa.

This paper is seen as complementary to the Internal Document 'Farming Systems Research Report No. 2' which gives a more general discussion of the cropping systems of Aleppo Province.

Transliterations of Arabic words are underlined in the text.

CONTENTS

SUMMARY

This paper gives background information on rainfed summer crops in Syria, with particular reference to the NW Provinces of Aleppo and Idleb. Most of the information relates to watermelon, sesame and musk melon which together account for almost 60 per cent of the total area planted in summer.

The part played by summer crops in the rainfed rotations of NW Syria is discussed in the first section. The author treats summer crops as an alternative to fallow, and discusses the effect of these different rotation components on a subsequent wheat crop.

The second section summarises the information on summer crops collected from group interviews in 20 villages in 1978. The different varieties, cultural practices, harvesting and labour requirements, pests and diseases, contractual arrangements and the profitability of the water melon crop are described.

The final section presents a hypothetical model which gives a simplified framework for discussing the role of summer crops and fallow in a rotation where wheat is the next crop. This simple model could be important in discussing the effects of:-

i. a change in the profitability of wheat through new varieties and/or cultural practices,

ii. the introduction of forage legumes into the rotation.

Appendices give information on agricultural zones in Syria, soil types, the effect of rainfall on summer crop yields and a checklist of the information collected from farmers.

INTRODUCTION

This discussion paper contains background information on rainfed summer crops in Syria, with particular reference to the northwest Provinces of Aleppo and Idleb. It serves to put the information gained from the Farming System Program Village Level Studies (VLS) in a wider context.

Summer crops -- for the most part grown entirely on the moisture stored from a winter fallow -- constitute a valuable and, in some cases, extremely profitable component of cropping systems of the area.[1/] They represent a modified use of fallow, and need to be given consideration in the discussion of alternative methods of fallow utilization. A hypothetical model relating fallow utilization, soil moisture storage, rainfall, and the yield of subsequent crops, is discussed (page 26).

Most of the information and discussion relates to the three principle rainfed summer crops: watermelon, sesame and musk melon. Together these account for nearly 60 per cent of the total area planted.

Information was obtained from:

1) Statistical data published by the Central Bureau of Statistics and the Ministry of Agriculture and Agrarian Reform, Damascus;

2) Interviews and discussions with farmers in 20 villages of Aleppo and Idleb Provinces, in addition to those regularly contacted in the VLS survey. Also contacted were a number of merchants, commission agents and Government Officials.

1/ For a discussion of the generalised cropping systems of Aleppo Province, see Farming Systems Research Report No.2,(ICARDA Internal Document) Section 2.

1. SUMMER CROPS IN SYRIA

1.1 National summer crop production

TABLE 1 lists the principle summer crops in Syria (1976).

Watermelon, Citrullus lanatus, is by far the dominant crop in the rainfed area, occupying some 42 per cent. TABLE 2 shows that in five of Syria's 12 provinces it ranked first, and in 4 provinces it ranked second. Other important crops include sesame, melon(Cucumis melo), grain sorghum and tobacco, the latter largely confined to the coastal provinces, where higher rainfall levels (generally above 600 mm per year) allow their cultivation.

TABLE 1 MAIN SUMMER CROPS GROWN IN THE RAINFED AREA OF SYRIA - 1976/77

C R O P	Area (ha)	
	1976	1977
Watermelon	73,605	82,937
Sesame	20,223	24,387
Melon	23,800	23,823
Sorghum	18,082	20,530
Tobacco	17,219	14,829
Tomato	9,449	13,342
Snake cucumber	7,886	10,698
Cotton	9,100	10,223
Okra	4,259	6,068
Pumpkin	3,953	4,818
Maize	3,119	2,826
Sunflower	504	2,083
Dry onion	1,707	1,940
Squash	1,805	1,605
Sumec	1,725	1,538
Broom sorghum	167	527

Source: MAAR, Damascus. Annual Agricultural Statistical Abstract, 1977

TABLE 2

PRINCIPAL RAINFED SUMMER CROPS RANKED WITHIN PROVINCE BY PERCENTAGE OF TOTAL RAINFED SUMMER CROPS, 1976

PROVINCE	RANK 1	%	RANK 2	%	RANK 3	%	RANK 4	%	Provincial total as a proportion of all-Syria Rainfed area %	Provincial total as a proportion of within province total cultivated area %
Damascus (rural)	Snake cucumber	62	Watermelon	18	Melon	8	Okra	8	0.9	3.7
Dara'	Sesame	58	Watermelon	26	Snake cucumber	7	Sorghum	4	2.6	3.0
Suweida	Watermelon	60	Tomato	22	Snake cucumber	17	-	-	1.9	4.4
Quneitra	Sorghum	72	Watermelon	11	Maize	6	Tomato	3	0.7	9.0
Homs	Sorghum	50	Watermelon	27	Green kidney beans	4	Maize	3	7.1	6.7
Hama	Watermelon	50	Sorghum	16	Snake cucumber	8	Melon	6	8.4	8.5
Lattakia	Tobacco	64	Tomato	9	Sesame	7	Onion	5	7.7	32.2
Tartous	Sorghum	27	Tobacco	19	Maize	18	Tomato	11	6.7	21.5
Idleb	Watermelon	42	Sesame	20	Tobacco	10	Melon	9	26.1	23.8
Aleppo	Watermelon	33	Sesame	22	Melon	19	Cotton	8	23.5	7.2
al-Hassakeh	Watermelon	63	Melon	28	Snake cucumber	6	Sorghum	2	12.6	3.0

Note: No rainfed summer crops recorded for Damascus city, ar-Raqqa and Deir ez-Zor Provinces. Data excludes small areas in Ghab.

Source: Ministry of Agriculture.

1.2 Trends in national summer crop area

Between 1967 and 1976, the irrigated summer crop area was between 270,000 and 330,000 ha, generally increasing in the four years up to 1976.

The rainfed summer crop area, on the other hand, was much less stable, fluctuating in the same period between 115,000 and 230,000 ha, with no general trends apparent.

Rainfall in the previous winter appears to be an important factor affecting the area planted. A rainfall index (see Appendix II) calculated for the major summer crop areas shows a significant correlation with area planted ($r=0.79$); rainfall fluctuation therefore appears to account for 63 per cent of the variation in area.

1.3 Trends in summer crop yield

National yield of watermelon varied between 1967 and 1976 from 1.73 to 7.91 MT/ha, and sesame 100 to 425 kg/ha. Yields of both are significantly correlated with rainfall in the previous winter ($r=0.86$ and 0.87 respectively - see Appendix II). Such variation, and the over-riding effect of rainfall, makes it difficult to see whether there might be any long term effects on yield due to increased fertilizer use and better cultivation methods.

A summary of yields of rainfed summer crops in 1976 and 1977 is given in TABLE 3.

TABLE 3 YIELDS OF MAIN RAINFED SUMMER CROPS IN SYRIA
1976 and 1977
(kg/ha)

CROP	1976	1977
Watermelon	6,901	7,759
Sesame	312	243
Melon	6,119	7,177
Sorghum	729	838
Tobacco	662	713
Tomato	5,058	3,676
Snake cucumber	5,862	4,250
Cotton	481	406
Okra	1,320	1,264
Pumpkin	7,609	7,438
Maize	885	N.A.
Sunflower	327	866
Dry onion	6,828	6,356
Squash	9,160	6,930
Sumec	589	622
Broom sorghum	725	905

Source: MAAR, Damascus. Annual Agricultural Statistical Abstract.

1.4 Summer crop areas in NW Syria (Aleppo and Idleb Provinces)

Whilst national rainfed summer crop area has been shown to be strongly correlated with rainfall, the combined areas of Aleppo and Idleb provinces have exhibited an upward trend, from 25,400 ha in 1970 to 93,300 ha in 1976. The winter crop area also increased (from 64,900 ha to 80,100 ha), but summer crops as a proportion of the total have increased from 3.8 to 10.4 per cent.

Watermelon and melon area, whilst declining slightly as a proportion of the summer crop area (78 and 60 per cent) has increased considerably in absolute terms, from 19,900 ha to 55,800 ha. This expansion has almost certainly come in response to an increasing urban demand and better transportation.

1.5 Annual production and retail prices of watermelon and melon

National production and retail prices have been:-

Year	Total Production MT	Prices 1/ (piasters/kg)	
		W'melon	Melon 2/
1970	129,337	29.5	41
1971	267,874	25	37
1972	459,868	22	30
1973	100,349	54	67.5
1974	516,816	49.5	56
1975	551,566	56.5	55.5
1976	556,774	60.5	58

Source: Central Bureau of Statistics, Damascus

1/ Average of Aleppo and Damascus retail market prices
2/ Sesame prices not available.

It is interesting that prices remained buoyant in spite of higher production in later years. Exports, which reached 40,000 MT in 1971 and 1972, did not exceed 13,000 MT between 1974 and 1976. All the indications point to a considerable absolute increase in domestic demand and consumption.

1.6 The place of summer crops in rainfed rotations

Summer crops play an important part in the rainfed rotations of NW Syria -- and elsewhere in the country -- constituting a valuable alternative to what might otherwise be fallow. On the deeper soils above 325 mm mean annual rainfall (MAR), they are regularly included in the prevailing two, three and four course rotations, and they may substitute for fallow on shallow soils in years of adequate rainfall. Below 325 mm and down to about 250 mm MAR, they may be planted on the regular fallow break in years of above average rainfall. Between 325 and 400 mm the regularity of summer cropping increases on all soil types, with crops such as the Cucurbitaceae and sesame. The wide spacing generally adopted for these crops suggests that their culture might be regarded as partial cropping (alternatively partial fallowing); indeed at least part of the benefit to a subsequent crop that might be expected from fallowing is observed when summer crops are planted. Above 450 mm full-season fallowing is virtually non-existent and crops with a higher moisture demand e.g. sorghum, maize and cotton, make an appearance.

Gravimetric soil moisture estimation in VLS villages shows the changing pattern through the season under different crop sequences. Figure 1 illustrates this in village 2A/06. The point of particular interest is the additional amount of moisture stored after the summer crop, at the start of the next growing season, compared to either wheat or lentil.

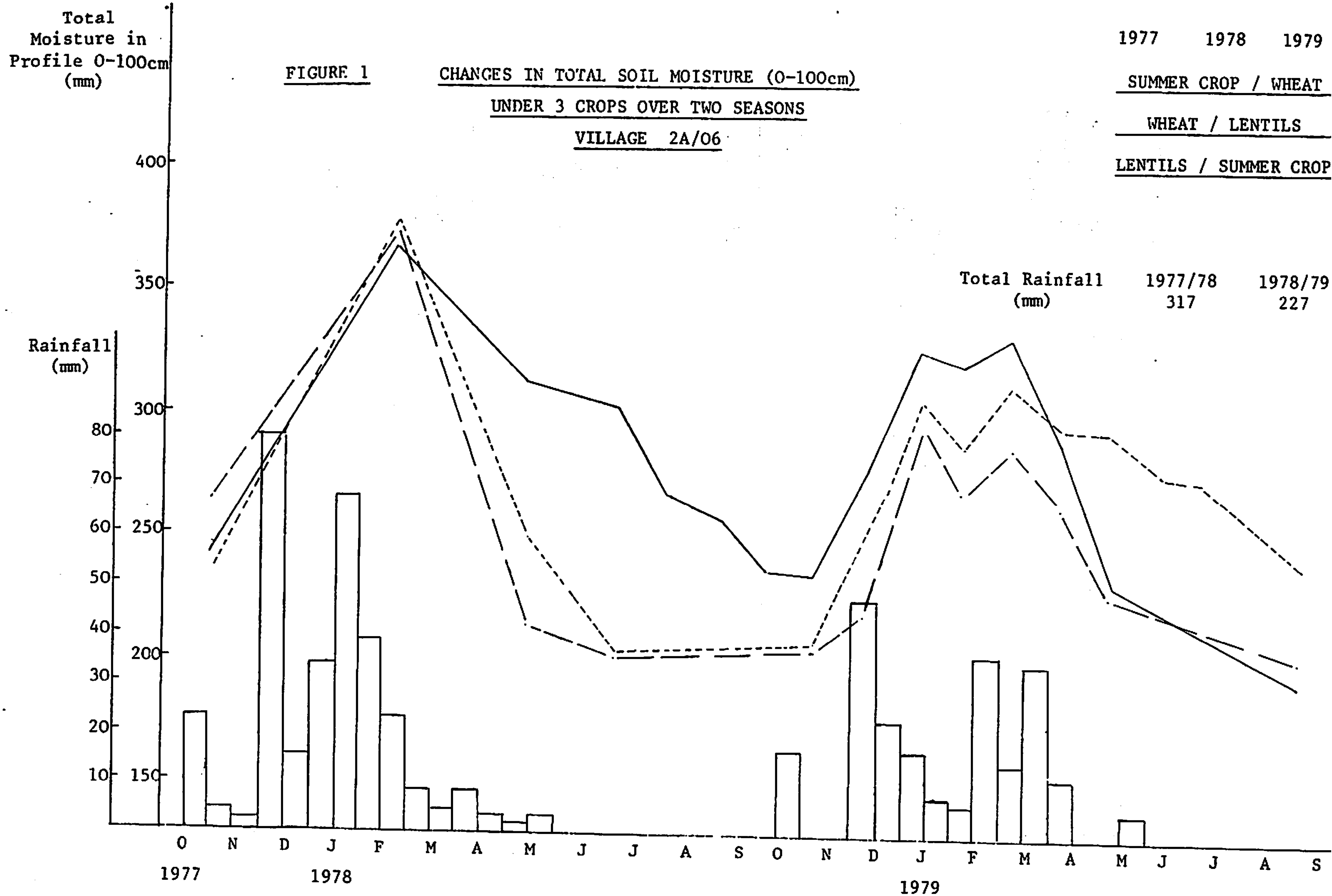


FIGURE 1 CHANGES IN TOTAL SOIL MOISTURE (0-100cm) UNDER 3 CROPS OVER TWO SEASONS VILLAGE 2A/06

This pattern is generally repeated in other locations, following either summer crop or fallow. TABLE 4 shows that on average, an additional 37 to 58 mm of moisture was stored in the top metre of the soil profile under summer crops. In the drier locations, under fallow, there was an additional 3 to 45 mm, with almost no moisture benefit from fallowing at the driest site, village 4/04.

TABLE 4 ADDITIONAL MOISTURE IN A ONE METER PROFILE AFTER SUMMER CROPS OR FALLOW COMPARED TO WHEAT, MEASURED AT THE START OF THE GROWING SEASON

(mm moisture/meter of soil)

	Additional Moisture (mm/m)					
	After Summer Crops			After Fallow		
Location:	1A	1B	2A	Tel Hadya 1/	3	4
Date	(decreasing annual rainfall ⟶)					
Autumn 1977	60	-	32	22	36	-6
1978	73	53	30	43	34	0
1979	41	40	48	53	66 2/	14
Mean	58	47	37	39	45	3

Source: Gravimetric sampling in VLS villages. For full data refer to Farming Systems Research Report No.2 (ICARDA Internal Document), Section 5.

1/ Tel Hadya, ICARDA's main station, is situated in a cropping system that would normally include summer crops rather than fallow.

2/ This figure probably includes some run-on.

Farmers in all villages who regularly grow summer crops report higher yields -- especially for cereals -- when following summer crops. Yield data from VLS village IRR/09 (400 mm MAR) illustrates this:-

TABLE 5

GRAIN YIELD OF WHEAT FOLLOWING DIFFERENT CROPS IN ROTATION VLS IRR/09, (kg/ha)

	Grain Yield(kg/ha)	
	following summer crops	following lentil
Yield	1,651	1,041
S.D.	452	233
n	5	5

Summer crop of lentil significant ($p = 0.05$)

In other VLS villages, there is a tendency to higher wheat and barley yields after summer crops, but there are altogether too few plots following crops other than summer crops to enable statistically valid comparisons. However, the low numbers of such plots might be taken as an indication of farmers' perceptions of the matter. It is not possible to estimate how much of the yield advantage might be due to moisture, residual fertilizer effects or other factors such as mineralisation, the effect of micro-organisms, and a reduction in the weed population.

Thus summer crops can increase the intensity of rainfed winter crop systems whilst still enhancing the performance and reliability of subsequent crops. They can make an important, though highly variable contribution to farm income, and provide a valuable and welcome supplement to farm families' food self sufficiency.

2. SUMMARY OF INFORMATION FROM GROUP INTERVIEWS

2.1 Background

Visits were made to farmers' fields in 20 villages of Aleppo and Idleb Provinces during August and September 1978. Discussions centred round a checklist of questions (see Appendix III), and mostly involved more than one farmer with the aim of obtaining some consensus on local practice.

The geographical spread of villages is shown in Figure 2.

Group (1) villages, SW of Aleppo, span 300 to 400 mm MAR in a quadrant between the Aleppo-Hama Highway and the road to Bab al-Hawa. The area is well supplied with minor roads, and the main highway offers a unique opportunity for "farm gate" marketing.

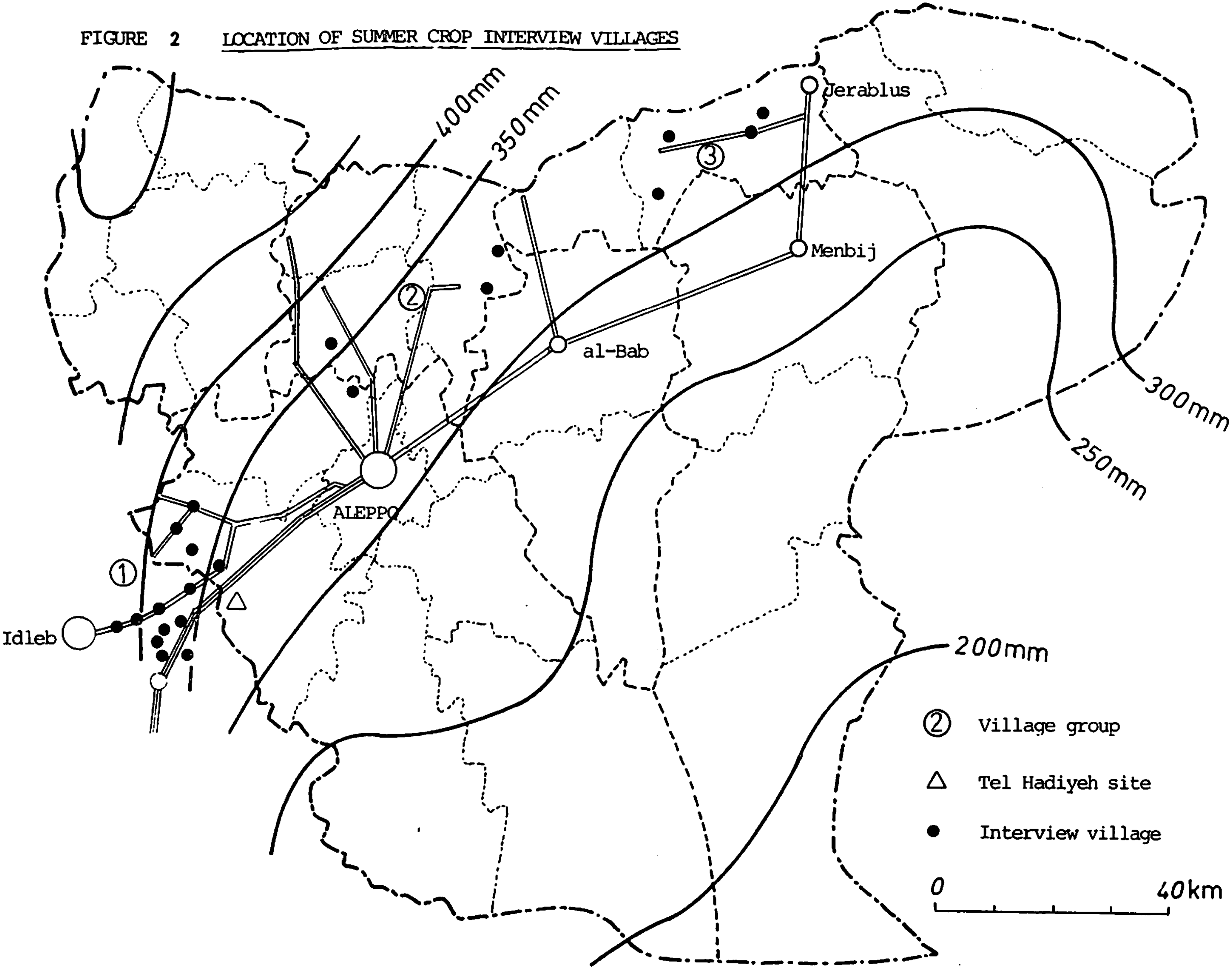
Group (2) villages, N and NE of Aleppo, span 300 to 350 mm MAR and are less well served by roads.

Group (3) villages, in the NE part of the Province, are relatively remote from Aleppo and serve the minor markets of Jerablus, Menbij and al-Bab.

2.2 Area devoted to summer crops

Group (1) villages reported from 33 to as high as 85 per cent of their rainfed cropped area under summer crops. Those exceeding 66 per cent were situated near the main road between Aleppo and Idleb, in areas of 350 and 400 mm rainfall. VLS village 1B/05, just to the north of group (1) had 32 per cent of the area under summer crops.

FIGURE 2 LOCATION OF SUMMER CROP INTERVIEW VILLAGES



Group (2) villages reported 33 per cent, indicating presence of the basic three-course rotation of the area: cereals: legumes: summer crops. VLS village 2A/06, just to the east of group (2), recorded 23 per cent and 28 per cent in 1978 and 1979 respectively.

In group (3), the reported proportion ranged between zero and 20 per cent. Two villages had grown summer crops in the past but had recently gone over to an all-cereal rotation without fallow, apparently permitted or encouraged by the advent of HYV wheats and increased availability of fertilizer.

2.3 Rotational sequences

According to prevailing rotations, summer crops might follow either cereals or legumes and apparently, in those villages having more than 50 per cent summer crop, other summer crops. In VLS village 1B/05, adjacent to group (1), 46 per cent of the summer crop area followed cereals, and 54 per cent followed legumes. In VLS 2A/06 adjacent to group (2), the figures were 81 per cent and 19 per cent respectively.

Only in one village were there strong feelings about the importance of the preceding crop: it was said that summer crops performed better after legumes than cereals.

More important, perhaps, are the consequences for succeeding crops as mentioned in 1.6. This favoured position is overwhelmingly given to cereals rather than legumes, with the result that, at least in the three course rotation, legumes must follow cereals, rather than vice versa.[2/]

2/ Other reasons for cereals not following grain legumes are discussed in Farming Systems Research Report No. 2 (ICARDA Internal Document).

2.4 Crops grown

A distinction can be made between crops grown for cash, and those planted for home consumption:

Cash crops: In groups (1) and (2), the principal crops are watermelon and melon. In group (1) these crops have replaced sesame and rainfed cotton; it is said that sesame had become particularly susceptible to pests and diseases, and that cotton had become less profitable than other crops. Cotton, maize, sorghum and sunflower are only grown above 400 and 450 mm MAR.

Group (3) villages, if cash summer crops are grown at all, give preference to sesame and secondly watermelon. In this relatively remote area, sesame poses less of a marketing problem.

Household crops: Tomato, melon, snake cucumber, okra, marrow, pumpkin, squash, lubia, other vegetables, broom sorghum and sunflower, are grown on small plots.

Tall plants such as sunflower and broom sorghum are used to delineate boundaries, and larger plots are often ringed with unpalatable pumpkin to deter errant livestock.

The following sections, unless otherwise stated, refer principally to watermelon.

2.5 Varieties

For rainfed watermelon and melon, "local" varieties predominate. Many derive from Chilean Black, introduced about 20 years ago, and are known variously as "American", "Black" and "44". Also found are "Hamoudi", "Bulgarian", "Nimis" and local red.

"American" and other Chilean Black derivatives have been selected for thicker skins and smaller fruits than the original. The market preference is for red flesh, dark green skins and a round shape. "Nimis" is late-maturing but with elongated fruits. Thick skin is important to avoid transport damage.

The new sweet early hybrid cantaloupe melons are gaining popularity, but mainly under irrigation.

2.6 Pre-planting cultivations

Across all areas, the pattern of preparatory cultivations is similar. Differences occur in the number of full ploughings, the type of plough and the number of secondary cultivations up to planting.

First ploughing takes place in late summer or autumn. In higher rainfall areas and on deep soils, the mouldboard plough is preferred, often behind crawler tractors, and is used deeply for better weed control, particularly for the grasses and euphorbias that grow up after the lentil harvest. On shallower soils, or where weeds are less of a problem, the disc plough is used.

The second cultivation is done after the rains have started, either in December, or as soon after as conditions permit. Ploughing, by disc or mouldboard plough, is preferred, although the ducksfoot cultivator is sometimes used. The decision, like many others to do with summer crops, is said to reflect the farmer's resource position; a full ploughing can cost LS 50/ha whilst a cultivation costs LS 20/ha.

Subsequent cultivations include from one to three passes with a ducksfoot cultivator. The last of these, before planting, may be along the marked crop rows only, the cultivator usually being followed by a leveller (taban) to produce a fine-tilthed seedbed. Timing of these operations can be critical, delayed spring cultivations resulting in a cloddy tilth which is subject to excessive drying out.

2.7 Fertilizer rates and application

Whilst farm yard manure is said to be beneficial, little is applied to summer crops, except on small household plots. Application in reasonable quantities, usually before the second cultivation in winter, is said to obviate the need for chemical fertilizer, and has the effect of allowing the soil to "warm-up" earlier. Rates quoted range from 5 to 20 MT/ha.

A wide range of chemical fertilizer rates is quoted for farmers who use it. It was reported that a proportion of farmers use none.

	Fertilizer rate	
Fertilizer	Extreme Range (kg/ha)	Common Range (kg/ha)
P_2O_5	35-115	46-69
N	20-83	26-33

There is also a wide range of practices regarding timing and placement of chemical fertilizer. Methods include broadcasting or applying to the crop rows down a funnel and tube attached to a cultivator before planting, or directly to plant hills at the time of planting.

One reason for such a wide range of practices could be the difficulty of observing responses in crops sown on residual moisture. Fertilizers applied to the soil surface, in particular, are likely to become unavailable through lack of moisture. Arnon (1972 p. 357) states that summer crops rarely respond to fertilizers that are applied to them directly, although early growth may be stimulated. However, they do react favourably to a fertility build-up resulting from fertilizing previous crops.

2.8 Date of planting

The range of planting dates quoted for 1978 was:-

Group(1)	Atareb area	1 March - 10 April
	Aleppo/Hama Highway	1 April - 15 May
	Aleppo/Idleb Road	30 April - 30 May
Group (2)		20 March - 20 April

Within one village, the range is commonly 15 to 25 days, the lighter "warmer" soils being planted first. Local variations in topography, aspect and micro-environment appear to be important, and villagers describe their lands as "warm" or "cold". This can have considerable effects on the potential profitability of summer crops -- particularly watermelon.

Marrow and snake cucumber are planted before other summer crops, and sesame about 20 days later.

2.9 Spacing, seed rate and depth of planting

Most crops are planted in hills at fairly wide spacings, although the higher rainfall crops of cotton, maize or sorghum are sown in drills about 0.6 and 0.65 mm apart. For watermelon, hill spacing varies between 3 X 3 m and 4 X 4 m, and, exceptionally, 4 X 5 m. Hill population does not appear to vary consistently with soil type or rainfall zone, but wider spacings are said to encourage larger fruits.

Watermelon seeds are planted four to six per hill and occasionally up to 10 to 20 where soil pests are known to be a problem. This requires about 1 to 2 kg/ha. Holes are 10 to 15 cm deep for earlier plantings, and 15 to 20 cm for later.

Cross-check planting is increasing on wide plots particularly where draft animal numbers are falling rapidly.

2.10 Post-planting operations

Two hand weedings, close to the newly emerged seedlings, are common. These are complemented by one or two passes near the crop row, either with the feddan plough, or by cultivator with the middle tines removed, so as to straddle the row. Later cultivations, mostly by tractor, are made to preserve the dust mulch and fill in cracks as they develop; the cultivator frequently being fitted with a taban leveller. A local adaptation of the regular cultivator is found in some villages. The implement has ducksfeet or sweeps, set at narrow spacing in a delta configuration, and is said to cause less exposure of moist soil.

Plants are usually thinned in two stages; to two and then to one plant per hill. As the tendrils develop, they are separated by clods or sticks, trimmed as necessary, and finally trained downwind, implying that ideally rows run north-south with plants trained to the east. However, all directions can be observed. After fruit-set, thinning takes place to one fruit on about 90 per cent of plants, and two on the stronger plants.

2.11 Harvesting

In good seasons, watermelon can give up to three successions of fruiting, with 20 to 30 days between each. Only one picking would be expected in a poor season.

Within successions, fruits ripen sequentially and the field is swept regularly to take the ripest fruits. Those picked too early lack colour and sweetness; those remaining attached to the plant too long tend to dry out.

2.12 Labour requirements

All villages reported that in general, only owners of larger farms hired labour for any operations. Only one village indicated any clash between summer crop planting and lentil harvest and in this case the work was spread between lentils in the morning and summer crops in the afternoon.

There is some variation in reported labour requirements and wage rates:-

Operation	Worker days/ha	Wage rate LS/WD
Planting	1-3 1/	5-15
Weeding	2-10	6-20

1/ Higher requirements if fertilizer also applied

2.13 Yields

Group (1) villages have the highest overall yields, followed by group(2). These are of course subject to considerable seasonal variation, and there are also large differences between specific plots within any one year. The ranges for watermelon are:-

	Watermelon Yield (metric tons/ha)		
	Poor Year	Average	Good Year
Group (1)	1-3	2-4	3-6
Group (2)	1-2	1.5-4	3-4.5

Record yields are often quoted, and in Group (1) some as high as 7 to 10 MT/ha have been claimed. However, some crops fail completely in poor years or after severe damage from pests or disease. In VLS 2A/06, the 1978 crop largely failed through aphid attack, and in 1979 it failed through drought.

2.14 Fruit weights

The reported average weight in fair to good years is about 8 kg. Consumer preference is for fruits of 6 to 7 kg, and the State Fruit and Vegetable Corporation specifies a minimum 4 kg in its contracts. There is little demand for overweight fruits.

2.15 Pests and diseases

Watermelon and melon are reported to be subject to attack from a number of soil-borne insects, particularly the mole cricket, *Gryllotalpa gryllotalpa*, and a number of cutworms. Mole-rats can be a problem, and farmers may pay as much as LS 5/head for their elimination.

Later in the season, attacks by aphids, which were generally severe in 1978, and the melon fly *Myiopardalis pardalina* are reported. Systemic insecticides may be used in cases of heavy infestation.

Fungal diseases are present, particularly powdery mildew.

2.16 Factors affecting yield

Within one season or locality, the factors unanimously quoted by farmers as having an important influence on yield are:-

- The quantity of fertilizer used in the rotation;
- The number and timing of cultivations;
- The care with which the finer points of husbandry are applied.

Farmers, particularly in Group(1), frequently stated that increased investment in inputs was paying off in yield response. Soil type, usually related to depth and moisture availability, has a significant effect on yield, as with all crops (see Appendix I).

2.17 Factors affecting maturity

Time of maturity is a critical factor, as it affects the price that might be received for the crop. Farmers are therefore concerned with factors that will affect and usually advance the average maturity date.

The following factors were mentioned as important by farmers:-

Date of planting, and consequently of harvest, is affected largely by the local environment. The majority of villages visited were described as "cold" or late, and therefore unable to escape the glut ripening period.

Fertilizer. Use of farm yard manure in reasonable quantities is said to allow the soil to "warm-up" sooner in spring, permitting earlier planting. FYM presumably has a physical effect on soil heat flux through allowing better aeration and perhaps by increasing radiant heat absorption.

Higher nitrogen applications are said to hasten maturity. A similar response occurs with some other summer crops - maize, sorghum, cotton and sunflower (Russell, 1973, p.34) and even, in some circumstances, wheat (Arnon, 1972, p.404).

Cultivations. Greater numbers of post-panting cultivations are reckoned to advance maturity. The function of these cultivations is to maintain a dust-mulch and fill in cracks as they develop; conceivably, preservation of moisture ensures the availability of nutrients, so advancing maturity.

Variety. A late maturing watermelon cultivar, Nimis, can be used to escape the glut period, so catching the increasing prices late in the season.

2.18 Contractual arrangements

2.18.1 Sharecropping

Sharecropping arrangements are most common in villages where larger landholdings persist. The usual arrangement quoted is:-

	PARTY 1 (Owner)		PARTY 2 (Sharecropper)
Supplies:	Land, cultivations, fertilizer, seed transport to market	Supplies:	All labour (subcontracting if necessary)
Takes:	75 per cent of the output	Takes:	25 per cent

2.18.1 Financing contracts

Arrangements may be made between farmers and commission agents for other dealers; the agent loans the cash needed to grow the crop and in return has first option on handling the sales. Agents interviewed at Aleppo's suq-el-hal insisted that the prices offered and commission charged did not differ from non-contracted crops, and that the arrangement merely guaranteed them a proportion of the market. It was not possible to confirm this.

2.13.3 Forward selling (daman)

This arrangement is more common in high yielding years. The crop is valued on the field, usually sometime before harvest is due, and a fixed block price is paid; the farmer receives his money and all further arrangements for marketing are made by the sub-contractor. Prices offered fall somewhere between the best and worst that might be expected; the farmer thus receives a guaranteed return and the sub-contractor, who is usually a dealer with access to transport and market information, aims to profit from his superior marketing skill. Many farmers talked enthusiastically about this arrangement and in 1978 payments for daman crops ranged from LS 1000 to 2000/ha.

2.18.4 Government contracts

For the first time in 1978, the State Fruit and Vegetable Corporation entered into direct contracts with farmers through the Farmers' Union. The aims of the State Marketing agencies are described elsewhere[3/]. Contracts in Aleppo and Idleb were for 15,000 MT of watermelon, at a price to the farmer of LS 0.38 and 0.39/kg.

Many villages in Group (1) had experience of these contracts, though unfortunately problems over scheduling of loading were apparent. Additionally, it was reported that merchants, posing as farmers, had taken contracts and were fulfilling them with produce purchased at lower than the contract price. However, farmers were enthusiastic about the possibilities of fixed price marketing, particularly in view of the free market prices prevailing through 1978.

The Corporation acknowledged that it had handled a relatively insignificant part of the total crop, but aimed at increasing the proportion.

2.19 Transport costs

With the exception of the State Corporation contracts and daman arrangements, farmers are usually responsible for transportation costs. In Group (1) villages, the rates varied between LS 30 and 40/MT from field to suq-el-hal. Group (2) were paying LS 20 to 30/MT and Group(3), marketing into Menbij and al-Bab paid LS 15 to 25/MT. Group(3) indicated that transport costs to Aleppo and other disadvantages of distance did not favour watermelon production.

3/ See Farm Systems Project Report No. 1 (ICARDA Internal Document), Section 6.8

2.20 Commission on sales

Agents at suq-el-hal stated that charges ranged from 7.5 to 10 per cent of the sale price depending on whether produce was off-loaded or not. This is an interesting admission, given that the Ministry of Domestic Trade and Supply legally limits commission to 5 per cent.

2.21 Profitability

With the tremendous range in prices through the season, earlier maturing crops are at a premium, all other things being equal. Given the range of yields and marketing dates reported by farmers, there must be tremendous variation in the value of production. To quantify this would require further study almost every ton sold fetches a different price.

Farmers considered that, on average, a price of LS 0.30/kg was necessary to give a minimum reasonable return. This figure was confirmed at suq-el-hal, but agents estimated that more than half of the crop offered up to the end of September 1978, had fetched less.

Total costs, excluding labour, could range between LS 300 and 500/ha depending on the number of cultivations and amount of fertilizer used. A four ton crop sold at an average LS 0.30/kg, less transport and commission, would net LS 990, giving a margin over direct costs of LS 490 and 690/ha. Crops yielding two tons would have done little more than break even at LS 0.30/kg.

Group (1) villages estimated net output (value of total output less all costs) from earlier-marketed crops at between LS 800 and 1500/ha. Later maturing crops in 1978 were less profitable. In VLS villages, the range in 1978 and 1979 for recorded farmers was from LS-53 to 496/ha and from LS-385 to 0/ha respectively. Both seasons, especially 1979, were considered as very poor in these villages owing to inadequate spring rainfall and pest problems.

Seasame, yielding 100 to 400 kg/ha could produce an output of LS 400 to 1600/ha and with slightly lower costs than watermelon could prove competitive in some situations.

3. A HYPOTHETICAL MODEL RELATING TO SUMMER CROPS AND FALLOW

3.1 Summer crops and fallow

Observation of farm practices and the measurement of soil moisture and yields on farmers' fields suggest a frame-work for considering the farmer's rationale regarding fallowing and summer cropping.

That farmers are seeking some benefit to their wheat crop is clear (see 1.6). However, the prospect of marketing crops such as watermelon both locally and as far afield as Saudi Arabia, presents farmers in suitable rainfall zones with a unique opportunity.

We need to examine in what circumstances a modified use of fallow, by summer crops, makes more sense to a farmer than simply maximising his yield of wheat.

The discussion is based on the assumptions that:

(1) The crop sequence is fallow, or summer crop, followed by wheat;

(2) The factor of greatest importance is the supply to and utilization of moisture by the wheat crop;

(3) The farmer is seeking to maximise the total benefit from a crop cycle rather than from any single crop alone.

Whilst fallowing, or summer cropping, may have many effects on the subsequent crop other than through moisture conservation, it is suggested that moisture effects can be assumed in addition, possibly with interaction, to these.

3.2 The Model

The response of a wheat crop, in terms of yield, to available moisture through a season is expected to be non-linear, i.e. it shows diminishing returns. Figure 3 illustrates such a response, which is simplified, ignoring particularly questions of moisture distribution, but which takes into account general features described elsewhere:-

(1) A minimum moisture supply (M_{min}) below which a minimum acceptable crop will not be obtained (Arnon, 1972; Russell 1973). Arnon suggests 300 mm mean annual rainfall (MAR) in winter rainfall areas. Figure 3, based on yield estimation in Aleppo Province, suggests that levels as low as 275 mm MAR might be appropriate.[3/]

(2) Considerable responses in yield to small increments of moisture above M_{min}, which ultimately decline (Arnon, 1972).

(3) A maximum yield response (given fixed conditions of variety, fertility, agronomic practices etc.) beyond which yields may decline (Colville *et al*. 1967; Russell 1973; Shalhevet *et al*. 1976). Figure 3 suggests 600 mm as equivalent to M_{max}.

Some evidence of limiting responses to moisture (as rainfall) can be shown from national yield statistics; the ratio of yields in the higher rainfall (coastal) provinces to those of the middle rainfall areas varies inversely with overall rainfall levels. Thus in generally dry years, the coastal provinces have higher average yields whilst in wetter years the position is reversed.[4/]

The total available moisture (TAM) comprises the moisture contributed by current rainfall, plus that available to crops at the start of the growing season from moisture stored in the soil. This stored moisture would normally be defined as that between permanent wilting point and field capacity. However, every mm of extra stored moisture can contribute to the following crop; it is one mm less to be found from current rainfall.

3/ Grain yields of over 400 kg/ha have been recorded for wheat following another cereal under less than 260 mm annual rainfall. See Farming Systems Research Report No.2 (ICARDA Internal Document) Section 5.

4/ A correlation (r=0.83; P=0.05) can be shown between the yield ratio described above and a winter crop rainfall index, details of which are given in Farm Systems Project Report No. 1, (ICARDA Internal Document) Section 3.2.

FIGURE 3 RELATIONSHIP BETWEEN TOTAL AVAILABLE MOISTURE AND CROP YIELD (WHEAT) FOLLOWING SUMMER CROPS OR FALLOW, BY RAINFALL ZONE

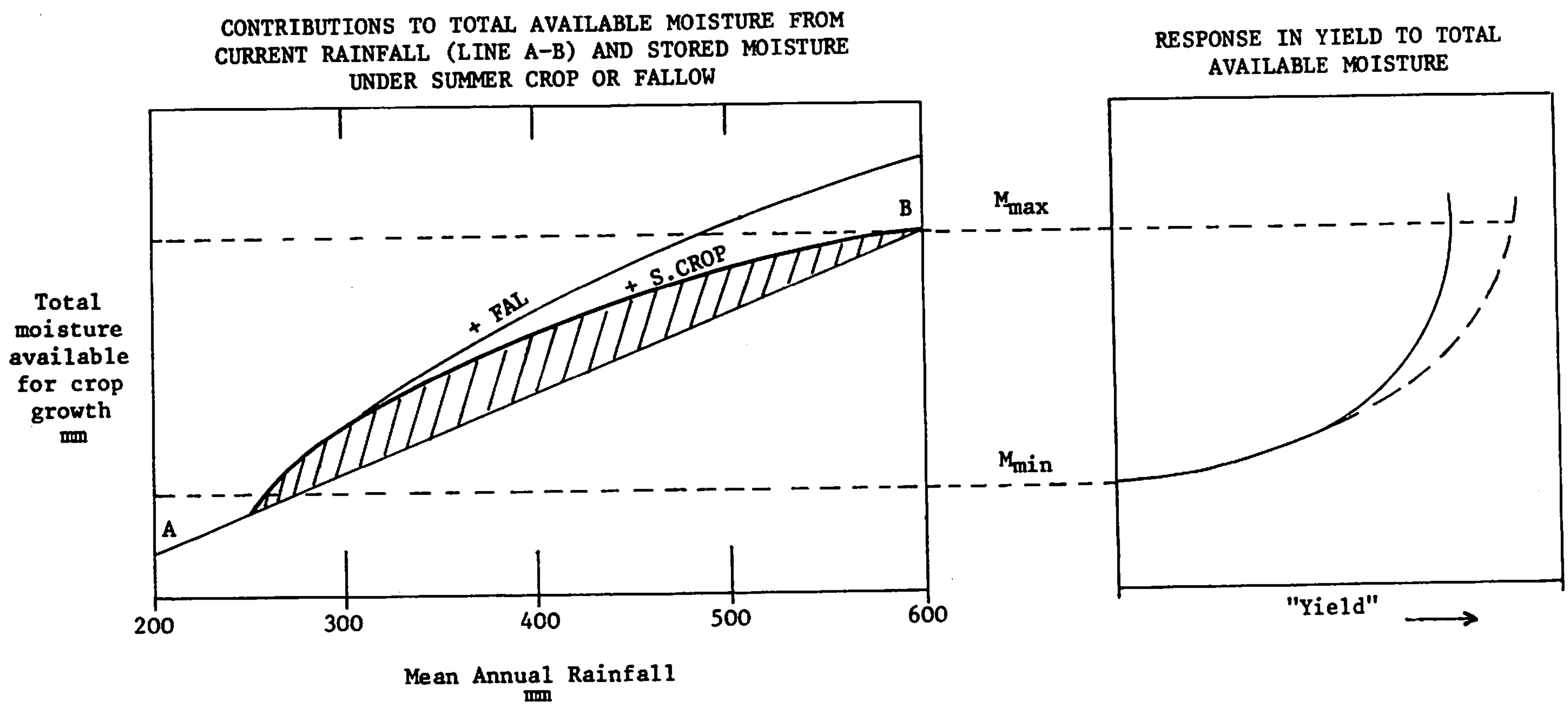


Figure 3 relates TAM to its components of supply. Straight line A-B indicates the contribution of current rainfall, which, subsuming all factors relating precipitation to available moisture, is held generally to increase with MAR. The contributions of stored moisture from fallow or summer crops are shown additively and reflect the general picture shown by VLS moisture sampling over two seasons (FS Research Report 2, Section 5) in the zone 250 and 500 mm MAR. It is assumed that fallow above 300 mm would store more moisture than a summer crop, tending towards a maximum level depending on soil type and cultivation regime. It is also assumed that crops such as sorghum, maize and cotton where planted above 400 mm MAR, further deplete stored moisture. Arnon, 1972, reports that in Kansas, wheat yields after summer crops such as sorghum and maize are frequently lower than in "continuous" wheat cycles, whilst elsewhere cucurbits are described as beneficial preceding crops.

The apparant lack of fallow storage at low levels of MAR might be attributed to a number of factors, including inadequate water penetration down the profile, thereby affecting storage below 45 cm, and the practice of leaving the fallow weedy in those areas until February or March in order to supplement grazing.

The TAM available to wheat after either fallow or summer crop in Aleppo Province farming systems is thus represented by the heavy upper line A-B. From 250 to 300 mm MAR, the extra moisture from fallowing gives a significant boost to TAM, leading to increased yields or at least to the probability of exceeding M_{min} in below average years. That farmers value fallow in this zone is shown by the fact that in villages 3/02 and 2B/01, the proportions of wheat following fallow exceed 95 and 90 per cent respectively. In dry village 4/04, where little fallow storage was recorded, not only is the fallow only 15 to 18 per cent of the cultivated area, but consequently only 55 per cent of wheat follows fallow.

Above 300 mm MAR, wide spaced summer crops use some of the potential fallow storage. However, returns to TAM in terms of wheat yield are declining and the value of the wheat lost is exceeded by the value of the summer crop gained. This tendency continues, as the responses in yield to increases in TAM become progressively smaller. As MAR increases, the need to supplement TAM with stored moisture lessens, to the extent that ultimately, M_{max} can be satisfied by current rainfall alone. Even before M_{max} is attained the low yield responses of wheat would ensure that crops such as sorghum enter the rotation to make maximum use of the summer stored moisture.

Considerably more data than are currently available would be needed to validate and elaborate on this model. It at least gives a simplified framework for discussing the role of summer crops and fallow in existing crop rotation. This would be important in two particular situations:

1) A change in the response curve of wheat, through new varieties, improved fertilization and weed control, so altering the balance of benefits from wheat compared to a preceding summer crop (shown as a dotted line in the wheat response section of Figure 3);

2) The introduction of <u>forage</u> legumes into the rotation; should they displace summer crops or fallow as the predecessor of wheat, in which case the summer crop - if profitable - may then displace grain legumes, resulting in a wheat: summer crop: forage legume rotation? Or should forage legume directly displace grain legumes, resulting in wheat: forage legume: summer crop?

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APPENDIX I

AGRICULTURAL ZONING AND SOIL PRODUCTIVITY CLASSIFICATIONS IN NW SYRIA

A) Agricultural Zoning

The official classification of the Ministry of Agriculture is based on rainfall, and identifies five Agricultural Stability zones, the first of which is divided into two sub-zones. They are:-

Zone 1 a	Average rainfall over 600 mm
Zone 1 b	Average rainfall between 350 and 600 mm
Zone 2	Average rainfall between 250 and 300 mm and not less than 250 mm in two years out of three
Zone 3	Average rainfall over 250 mm and not less than this in one year out of two
Zone 4	Average rainfall 200-250 mm and not less than 200 mm in one year out of two
Zone 5	Below 200 mm, and covering the rest of the country.

B) Soil Productivity

Farmers in the Farm Systems Village Level Studies (VLS) recognise several soil types by their productivity and physical characteristics. Broadly speaking they are as follows:-

Type 1	Red/black, deep with a high cracking clay content.
Type 2	Red/yellow, medium to deep, lower clay content.
Type 3	Red/yellow/white, shallow to medium depth, frequently rocky.

An idea of the combined productivity differences according to rainfall zone and soil type is given in the table below:-

GRAIN YIELD OF BARLEY BY AGRICULTURAL ZONE AND SOIL TYPE, 1979 SEASON (kg/ha)

Soil Type	Zone 1	Zone 2	Zone 3	Zone 4
1	2244	1362	584	471
2	1681	929	587	464
3	1185	696	505	281

Source:- Farmers' Field Sampling, VLS

For a further discussion of agricultural zoning and soil types see:-

Farming Systems Project Report No. 1(ICARDA Internal Document) Section 2 (Physical Environment) and 3.2 (Crops), and Farming Systems Project Report No. 2(ICARDA Internal Document) Section 5.

APPENDIX II

THE EFFECT OF RAINFALL ON SUMMER CROP AREAS AND YIELDS

1) Calculation of the summer crop rainfall index

The rainfall index is based on total precipitation in the season preceding the summer crop year in question. Records of 36 stations having a long term mean of over 300 mm were grouped to obtain Province means. These were then weighted by the Provincial rainfed summer crop area to obtain the national index.

The index therefore excludes stations representing areas where summer crops are not a regular inclusion in the rotation, but does take account of the very different absolute areas of summer crops represented by different groups of stations.

2) Correlations of area and yield with rainfall index

Crop Year	Rainfall Index (units)	Rainfed Summer Crop (area x 10^4 ha)	Watermelon Yield (MT/ha)	Sesame Yield (quintals/ha)
1968	9.304	23.04	6.62	4.04
1969	8.804	20.34	5.64	4.25
1970	5.943	11.51	3.14	2.36
1971	8.539	14.75	6.72	2.74
1972	8.039	20.43	7.91	2.46
1973	4.218	11.83	1.74	1.01
1974	7.658	21.31	6.85	2.54
1975	7.935	20.87	7.20	3.07
1976	8.733	20.84	6.91	3.12
R	-	0.796	0.859	0.872
R^2 %	-	63.3	74	76
P =	-	0.01	0.01	0.01

3) Regressions

I. Summer crop area on rainfall index

$y = 2.156\ x + 1.751$ (x 10^4 hectares)

II. Watermelon yield on rainfall index

$y = 1.092\ x - 2.536$ (MT/ha)

III. Sesame yield on rainfall index

$y = 0.518\ x - 1.13$ (q/ha)

APPENDIX III

LIST OF VILLAGES VISITED

GROUP (1)

Abu Kansr
Al-Jineh
Binnish
Jib Kas
Kafr Halep
Kafr Noran
Ma'aret Nasan
Sheikh Ahmed
Shileh
Taftanaz
Tel Hiyeh
Tel Karatin

GROUP (2)

Aqburhan
Bashkoy
Ghrour
Hardtnein

GROUP (3)

Al-Buran
Hamireh
Shieneh
Tel Hajjar

APPENDIX IV

CHECKLIST OF INFORMATION FOR SUMMER CROPS

1) General information about the villages

- Name of village
- Sub-district
- Date of interview
- Number of people
- Total area
- Rainfed area
- Irrigated area
- Summer crops area
- Number of pumps
- Summer crops planted for marketing, specify importance and kinds
- Summer crops planted for household consumption, and area.

2) Agricultural operations and costs

- Cultivations: Number - types of implement - dates and costs
- Planting: Date - distance within and between rows - depth of seeding and seeds rate
- Fertilizer: Date - kind of fertilizer - amount - method
- Weeding: Dates - methods
- Number of workers for each operation: Number from family or from village or outside - wage rates
- Other husbandry practices: Methods and costs
- Crop harvest:

3) Production

Yield per hectare this year to main crops and range
Maximum and minimum yield over seasons
Factors affecting yield
Pests and diseases

4) Marketing

- Are the crops sold before harvest in the field or by marketing into the city?
- Role of middle-man - Does he pay credit? - Effect of credit on selling price?
- Price changes (early marketing price and present price)?

5) General information

- Factors affecting date of planting and date of maturity
- Is there any clash between planting date of summer crops and harvest of winter crops?
- Profitability?