CHAPTER 3

RAINFED FARMING SYSTEMS IN THE MEDITERRANEAN REGION

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Mediterranean-type environments* are found in the Mediterranean Basin, Central and Southern California, Central Chile, South-West Çape Province, South-west of Western Australia and in the southern part of South Australia. They support a wide range of farming systems, but nearly all contain, or have contained, common elements: cereals, small livestock, olives, vines, fruit trees and vegetables. The major influences that have given rise to differences in presentday farming systems are the history of population growth and settlement; political developments and the type of relationship with metropolitan centres; forms of land tenure and the role of farmers in the social and political structure; and the growth of urban demand and the degree of commercialisation and specialisation in production.

The Mediterranean Basin itself has been important since settled agriculture began, being a centre of origin of many of the major cereal and legume crops and of the early domestication of sheep and goats. It is also the area where dry farming techniques of growing cereal crops were first developed (White, 1963, 1970) and was a focal point for the introduction and spread of new crops and the development of intensified agricultural systems during the spread of Islam. (Watson, 1974; Grigg, 1974).

The region experienced two periods in which it probably contained the most highly organised and productive agricultural systems in the world, during the Roman administration, and later during the period of Arab domination. However, the more recent colonial experiences of the 19th and 20th centuries resulted in a period of stagnation and decline of productivity, particularly of the main food crops, as the colonising powers, supporting the settlers and the wealthy landowning classes, concentrated on high value export crops, often grown on the

* The geographic, topographic, climatic, edaphic and vegetation features of Mediterranean environments have been adequately described elsewhere (de Brichambaut and Wallen, 1963: Emberger, 1977: Hills. 1966: Matthews, 1924; Meigs, 1964; Newbegin, 1929; Papadakis, 1973; UNESCO/FAO, 1963; Whittlesey, 1963). The principal land use systems have also been discussed (Duckham and Masefield, 1970; Grigg, 1974; Stamp, 1961; UNESCO, 1964) and a number of writers have considered present farming systems in the Mediterranean basin in comparison with the historical development of agriculture in similar regions elsewhere (Aschmann, 1977; Grigg, 1974; Oram, 1979).

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most productive land. This perpetuated the under-development of large areas of semi-arid lands and marginalised the peasants (Amin, 1976). Since independence, governments have placed increasing emphasis on the production of food crops, redistributed many of the former, large land ownerships among the rural poor, and provided greater support for poorer farmers through price control, credit facilities and cooperatives.

At the same time, governments have a major control over the resources and inputs necessary for production, and several favour the development of large scale highly capitalised with a small labour input farming systems as a means of supplying national food and export requirements. Knowledge of what has been achieved in similar environments elsewhere, and advice from aid agencies serve to reinforce this view. Consequently, large amounts of capital for development are channelled into large scale, predominantly irrigated, production projects.

During the past 30 years, the population of the region has increased rapidly and mobility has increased among both rural and urban populations. Migration of labour is an important feature of some of the farming systems that are discussed in this chapter. Migration occurs to the wealthy countries of the region and to northern Europe, and the returns are often a significant component of household, and indirectly of national, income.

Present day farming systems in the Mediterranean Region are therefore influenced by a range of circumstances related to their past and recent history, the extent of intervention by governments, forms of land tenure, and ownership and inheritance, all of which are unlike those found in similar climatic regions elsewhere. Hence environmental similarities between Mediterranean regions are not necessarily relevant to the potential for change.

The links that exist between the main types of farming systems make it very difficult, and in some ways misleading, to classify systems into distinct categories. Indeed, this type of crude classification may have created some false perceptions of farming systems.

The categories that follow merely identify dominant trees, crops or livestock within farming systems. The whole farming system generally centres on the needs of the household for food, clothing, housing and capital. The choice and balance of enterprises, both on an off farm, is the result of many influences, including these requirements, social obligations, and the whole structural context of productive activities.

- *Steppe-based nomadic or semi-nomadic pastoral systems*, primarily with sheep and goats. Animals are generally based in the drier areas during the spring and early summer, moving into the higher rainfall, arable areas after harvest and increasingly, during recent years, relying on supplementary feeding during the autumn and winter.

- *Rainfed cereal production systems.* These are predominantly based on a cereal: fallow rotation with wheat the main cereal in higher rainfall areas, and barley in areas below 300 mm and on shallower soils in the wetter areas. This system is found throughout the low-altitude regions of the Near East and North Africa and in the high-altitude areas of Spain, Turkey, Iran, and Afghanistan.

  Where there are deep (> 100 cm) soils in areas of more than 300 mm rainfall, many more crops are grown, including the grain legumes, but also a wide range of summer crops are grown using stored moisture after a winter fallow. In these areas, more complex rotations have developed, but none is longer than four years. In several countries, all the main operations of these systems have been mechanised.
- *Rainfed mixed tree and arable crop systems,* often with dairy cattle and some goats. This type of system is found in the wetter areas (higher than 600 mm annual rainfall) of the region and tree crops (olives, figs, fruit crops, vines), cereals and legumes are grown; usually in combination.
- *Irrigated farming.* Within this category it is possible to identify a range of systems, from those based entirely on the supply of water from a dam or river, to those where enough water is available only for the supplementary watering of summer crops. It is also important to distinguish large irrigation schemes run by government agencies, from those with individual ownership of land and water rights. Each may give rise to very different farming systems, but these are not relevant to this chapter.

It is important to recognise that there are transition zones between these categories and also areas where significant interrelationships occur. At the wetter end of the predominantly rainfed cereal areas (400–600 mm annual rainfall), tree crops, principally olives, are an increasingly important element in the farming system, and tend to replace cereals as the main source of income.

One conceptualisation of a trend in present day farming systems, constantly referred to in the literature, is the growing polarisation of production systems, particularly between livestock and crop systems. This concept has presumably arisen from a limited view of existing farming patterns in some countries and the writers are not aware of the complex interrelationships that can exist between livestock owners and arable farmers (who may be the same family) in ensuring that livestock are provided with a year-round supply of adequate feed. Arable owners may get some return from renting crops for grazing in dry years, and the soil many benefit from organic residues.

In the drier, rainfed cereal areas (< 250 mm annual rainfall), sheep production is an increasingly important part of the farming system. In many areas in this zone there is a cereal: sheep system with sheep based in the arable area for some of the year, and the young stock moving to the steppe for grazing during the spring.

Throughout the rainfed arable areas, the presence of ground water, even in limited quantities, makes irrigation possible, and the range of alternative crops and systems is increased considerably where it has been developed. The interrelationships between rainfed and irrigated systems are often important here, particularly with respect to allocation of scarce resources between systems.

Other significant links between systems include the seasonal migration of people from the drier areas after their cereal harvest, to higher rainfall or irrigated areas for the cotton and olive harvests.

STABILITY OF PRODUCTION SYSTEMS

The main factor affecting stability is rainfall. This has been discussed in physical terms in previous papers. One of our main concerns is the ability of farmers to develop strategies to overcome the inherent variability in rainfall. We may consider three types of problems

(i) Short-term seasonal lack of moisture, late arrival of rains, low annual rainfall or an early end to the rainy season. All of these may occur in areas of low annual rainfall, and generally result in farmers deciding to let their sheep graze their crops. It may also necessitate the migration of animals to wetter areas, or an increase in supplementary feeding. In the year after a dry season, the cereal may be planted again on the same land and output is usually lower than it would have been, had it followed a fallow;

(ii) A succession of dry years in areas of low average annual rainfall, tends to result in an increased reliance on income from non-agricultural work through migration to urban centres or outside the country, or from agricultural labouring in higher rainfall areas. In such areas, income generated from outside the village can become the major source of income; and

(iii) In some areas, major shifts in rainfall patterns have occurred. Grigg (1970) quotes an example from Tunisia, where the 200 mm isohyet shifted 200 km north between 1931–34 and 1944–47. This type of shift will have a profound effect on the whole nature of farming and the possibilities for future development of stable systems.

The annual variation in production of cereals is influenced by the distribution and amount of rain falling. The area planted in one season appears to vary with the previous season's annual rainfall: poor rains in one season result in a reduction in the area planted in the following season (ICARDA, 1979). The area harvested is also highly variable, as crops sown on shallow soils and in drier areas may not survive and certainly will not be harvested in dry years. Yield potential varies considerably with soil type, crops growing on the shallow soils in the

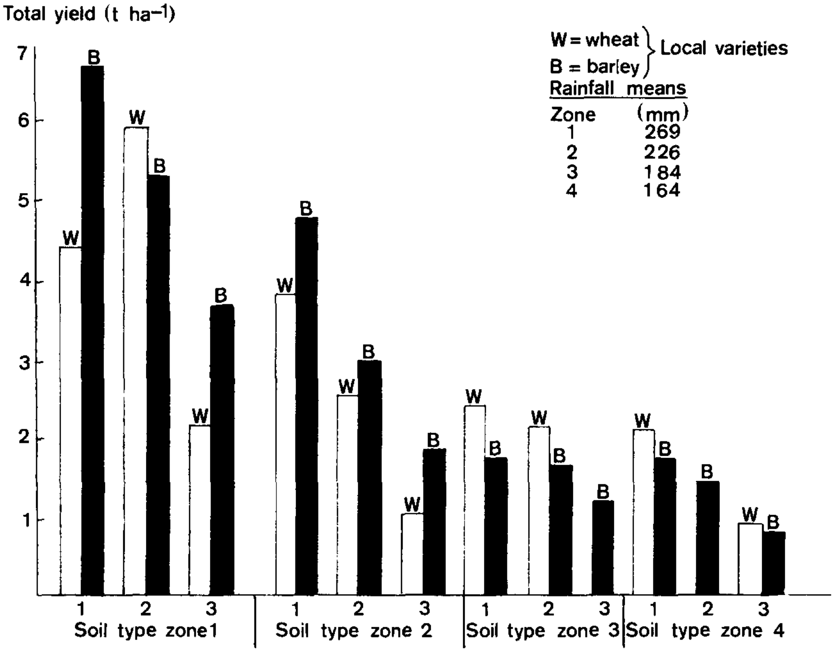


Fig. 1a. Wheat and barley total yield by soil type and rainfall zone 1978–79.

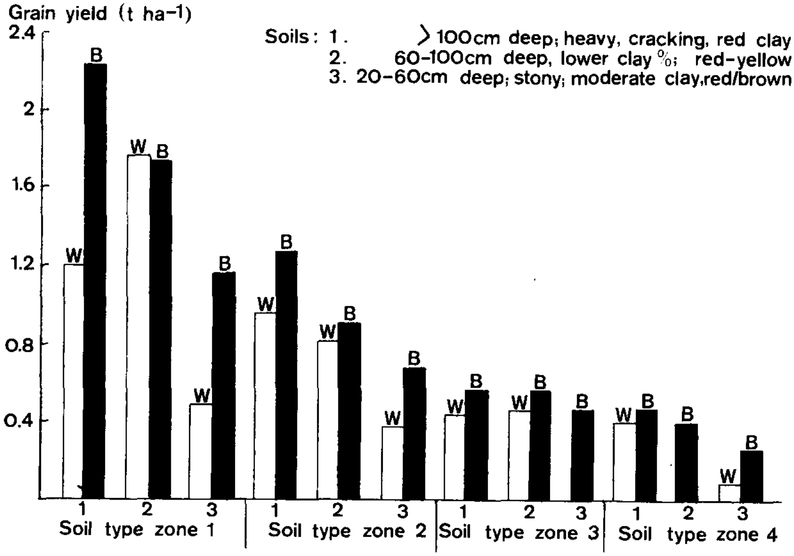


Fig. 1b. Wheat and barley grain yield by soil type and rainfall zone 1978–79.

higher rainfall areas producing comparable yields to those on much deeper soils in drier areas. Some data from farmers' fields illustrate this. (Fig. 1).

The adherence to a cereal: fallow rotation has provided an element of stability, with the fallow giving the opportunity to control weeds, contribute a small amount of moisture, and allow the mineralization of some nutrients for the succeeding crop. In the drier areas, abandonment of the fallow in favour of continuous cereals, may create instability in the system by increasing indebtedness and dependency.

A number of other important factors affect stability of production. The first, is the extent of government intervention in input and output channels and in controlling prices of commodities. Access to inputs at the right time and in the right quantities, the marketing and payment arrangements and the timing of announcement of prices, in addition to their relative levels, all can have an effect on decision making with respect to the allocation of resources and time, and thus have repercussions throughout any farming system.

PRODUCTIVITY OF FARMING SYSTEMS

As some of the factors affecting primary productivity in rainfed systems, namely availability of moisture and soil nutrients, and the efficiency with which they are utilized by crops, are dealt with in other papers I will consider a number of other factors that may influence productivity in farming systems, but are rarely considered in technical discussions. When we compare existing productivity with potential productivity, we frequently make comparisons between average farm yields and the maximum potential yield achieved in experimental trials or on demonstration plots. (IRRI, 1974; Oram, 1977). Emphasis is then placed on identifying the principal physical and technical constraints in existing production systems and in devising methods of closing this 'yield gap'.

This can be a very misleading approach, particularly when average farm yields are compared with experimental station yields or even demonstration plot yields, and also where the yield of certain crops is considered in isolation from the output of other crop or livestock enterprises in the system. In all crop production systems, the output from one crop is strongly influenced by previous cropping or previous land management, the sequence of crops, the input from animals, the allocation of resources between crops and livestock, competing demand for labour use, the timing of cultivations, weeding and fertilizer use. Other demands on labour of a social and political nature, problems of infrastructure and the longer term interests and objectives of farming families may also influence output. Some of these interrelationships are indicated in Fig. 2.

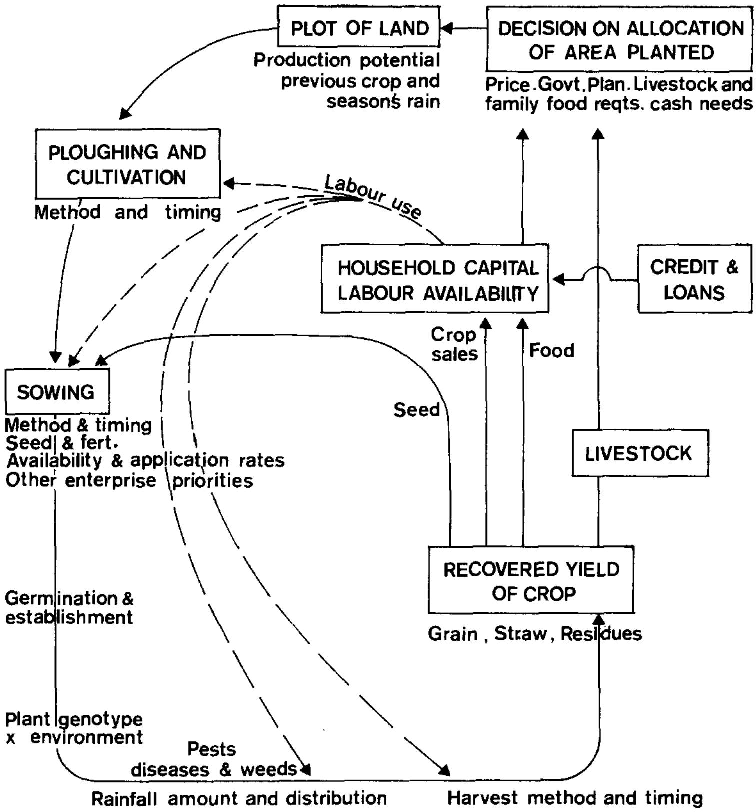


Fig. 2. Some factors affecting production and returns of a crop within a farming system.

Estimates of productivity that take account of the range of actual total biological and 'economic' yields and of potential productivity under conditions that are fully specified, may give a more realistic picture of the potential for yield improvement (Fig. 1). Yields in Zones 1 and 2 compare favourably with yields in so called 'high technology' areas (French, 1978; Russell, 1967).

Small land-holding size and small plot size are sometimes regarded as being important factors which limit productivity and modernisation of farming (Grigg, 1974; Oram, 1979). So far, we have no evidence to support this contention from work done in northern Syria. Practically all farmers have access to a tractor and cultivation equipment, and cultivation, planting and harvest of all the main crops are done without any major delays from small sized plots or small holdings. Fig. 3

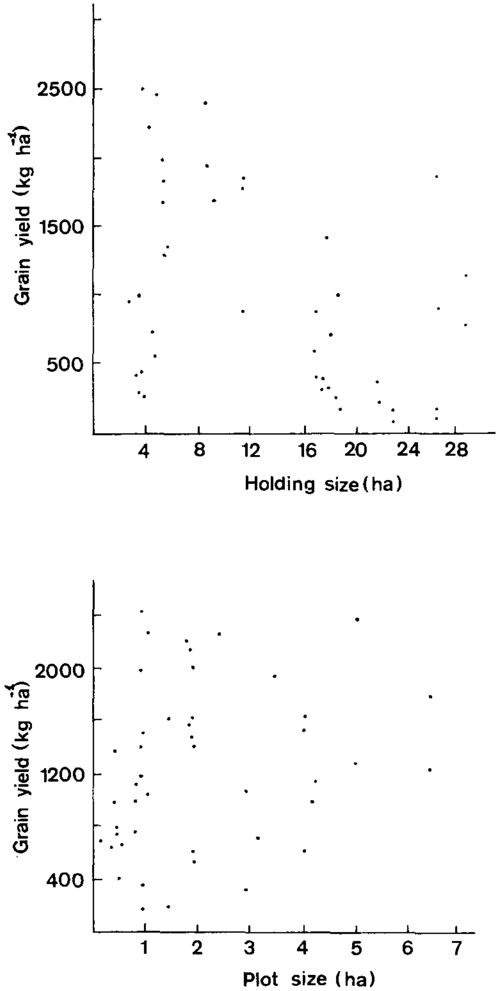


Fig. 3. Grain yield x holding size and plot size. Data from farmers' plot records, Aleppo Province, 1978-79.

illustrates yields from different-sized holdings and plots in Aleppo Province. In no case is there any significant correlation. The assumption by some people (e.g. Carter, 1977) that 'modernisation' of agriculture can come about only through the use of large machinery on large areas needs to be questioned.

Two examples from studies in Aleppo Province may illustrate some of the characteristics of existing systems in relation to the links between cropping and

Table 1. Farm family sample Aleppo Province 1977–78

	Village 2A/06	Village 4/04
Number of families in sample	8	10
Areas (ha)		
average cultivated	14.75	20.8
total cultivated	117.9	208.1
wheat	28.9	37.0
barley	27.6	136.6
lentil	19.0	–
vetch	6.2	–
Yields (kg/ha)		
wheat	651	235
barley	824	307
lentil	838	–
vetch	379	–
cereal straw	112	110
legume straw	798	–
Rainfall (mm)		
average annual	351.0	222.0
1977/78	316.8	240.5*
People in sample families	52	67
Land/person ratio (ha: people in family)	2.27	3.11
Wheat consumption (kg per person per day)	0.61	0.77
Number of milking ewes and goats	102	95
Average yield of milk (kg/head)	55	60
Consumption of metabolizable energy (GJ per productive ewe)	5.5	5.4

* 34 mm of this fell in three showers during mid-October, and the next significant rain fell on December 4.

livestock systems, and the flows of human food and livestock feed energy within village farming systems. In each of the following studies, the combined information from a 25 per cent sample of farming families is used to illustrate these features and the sample profile characteristics are given in Table 1.

Case 1 Village 2A/06

This village has 283 people. Total land area is 500 ha with three main soil types ranging from deep, red cracking clays to shallow, stony soils. Average family size is 7.2 people (range, 2–13) and average land holding is 12.9 ha (range, 1.5–40 ha). Average annual rainfall is 331 mm. There are 714 sheep plus goats in the village and eight tractors. Common rotations include cereals, legumes and summer crops in two, three or four year rotations. The summer crop provides an opportunity for weed control and also provides a useful cash income in wet years. Cereals usually follow summer crops which leave some moisture in the soil at planting (about 30 mm per m depth more than the profiles left after cereals and lentils). This may be significant in drier than average years (Fig. 4).

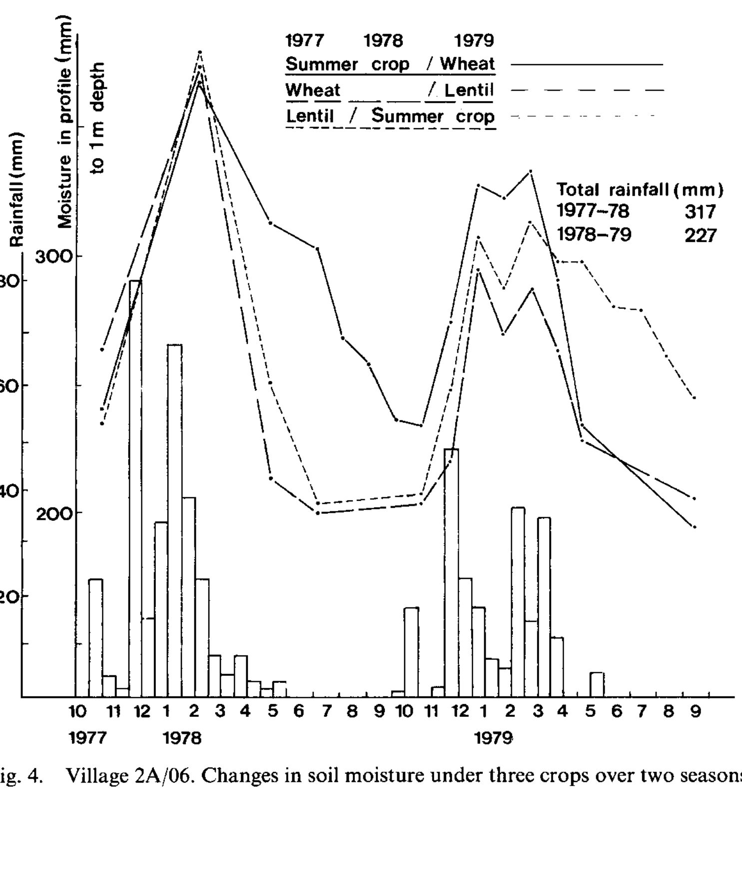
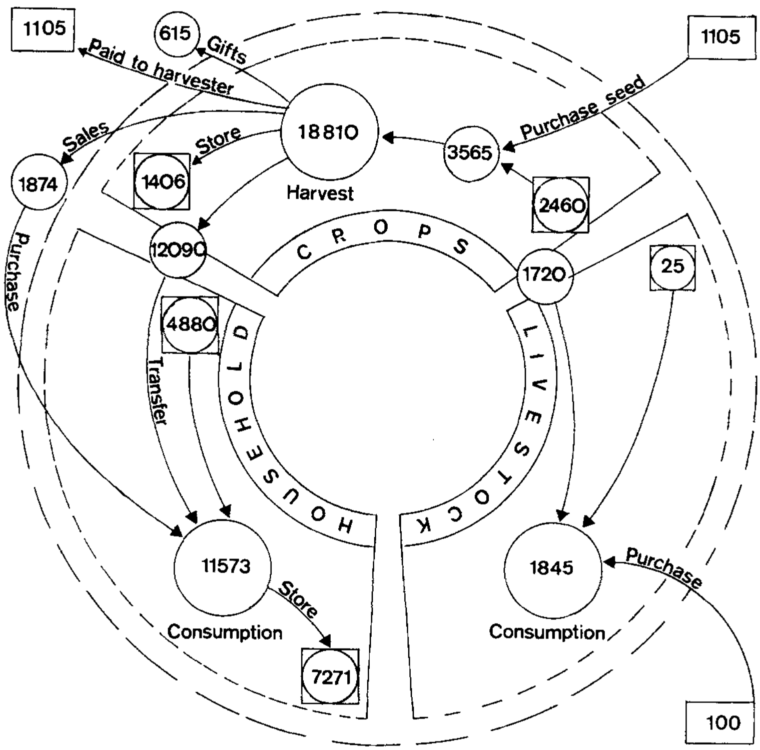


Fig. 4. Village 2A/06. Changes in soil moisture under three crops over two seasons.



Inflow	Outflow
1105 100 1205	1105 615 1705

△ Flow	+	515
△ Stocks	+	1312

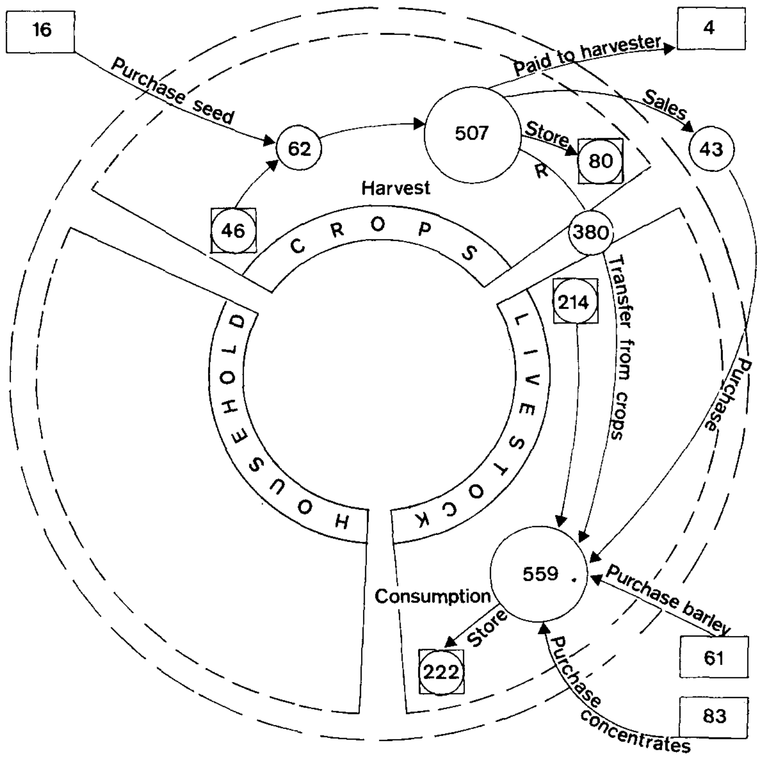
△ System change + 1827

Store

100 per cent of wheat input to household generated within the system

Fig. 5. Village 2A/06: Wheat flows (kg) November 1977-October 1978.

For village 2A/06, families generally aim to achieve self sufficiency in wheat in most years even though barley normally outyields wheat by 50 per cent in average rainfall years. Fig. 5 shows that for 1977–8 a moderate surplus of wheat was produced with a harvest: seed ratio of 5.28: 1. This supplied all of the household needs, and the straw contributed to livestock feed requirements.



Inflow	Outflow
16	4
61	
83	
·60	4

△ System change	− 114

△ Flow	−	156
△ Stores	+	42

○ Store

75 per cent of metabolizable energy input to livestock generated within the system

Fig. 6. Village 2A/06. Animal feed flows (gigajoules of metabolizable energy) November 1977-October 1978.

In considering animal feed flows* within the system (Fig. 6), all feeds have been converted to gigajoules of metabolizable energy (1 gigajoule = 10^9 joule). Although the feed system shows a deficit of 114 GJ, farmers are reluctant to make this up from home grown crops as this would upset the winter crop: summer crop balance. The deficit could, for example, have been made up by an extra 11.5 ha of barley (at 1977–8 production levels) but this would have to have come from summer crop land (29.5 ha available) or some other crop. In 1977–8 the winter crop: summer crop ratio was 2.76: 1; to substitute barley for summer crops would change this ratio to 5: 1. The same argument applies to increasing the legume area, plus the fact that lentils and vetches are too labour intensive to increase beyond present levels.

So long as the sales of the surplus crops (lentils and summer crops) can offset the energy deficit, the system 'balances'. The 83 GJ of purchased concentrates supplies proteins, minerals and vitamins which are not produced in the farm feed, and the present flows in the system are further supported by the availability of cheap feeds from the General Organisation for Feeds.

Case 2 Village 4/04

This village has 192 people. Total land area is 501 ha with three main soil types which have a lower clay content and a poorer structure than those of village 2A/06. Average family size is 6.4 people (range 1–11) and average land holding is 19.7 ha (range 17–27 ha). There are 328 sheep plus goats in the village and one tractor. The cereal crops alternate with a fluctuating proportion of fallow and in the recent succession of drier-than-normal years, barley crops are being grazed and the proportion of land fallowed has declined from 45 per cent to 17 per cent. The whole season fallow contributes very little to the store of moisture available for the succeeding cereal crop. (Fig. 7). In this situation, the problems of livestock feed supply are closely linked to the deterioration of the range through overgrazing and an increase in cereal cultivation in marginal areas. Reliance on supplementary feeding is common.

In this village, farmers also plan to grow enough wheat to supply their family needs, but in 1977–8 only 33 per cent of the wheat supply of the household was produced within the system (Fig. 8).

* In the cropping sector, the calculation includes apportioned allowances for seed plus stores of wheat and lentils as their contribution to feed. Thus 8 per cent of wheat harvest went to animals, so 8 per cent of wheat in store/purchased was 'chargeable to animal feeds'. The equivalent figures for barley, lentil and vetch are 100 per cent, 14 per cent and 100 per cent respectively. Of the metabolizable energy input from outside the system, 61 GJ was for barley plus straw and 83 GJ was for cotton seed cake, cotton hulls and other products.

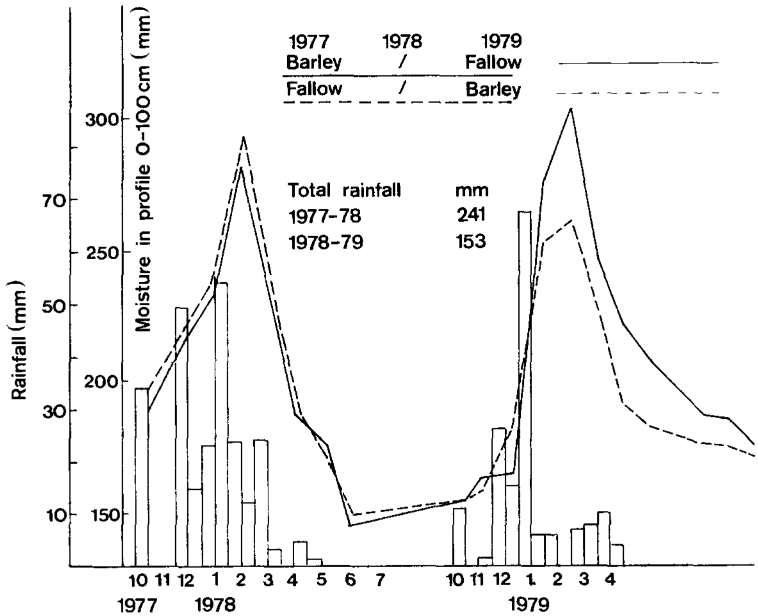


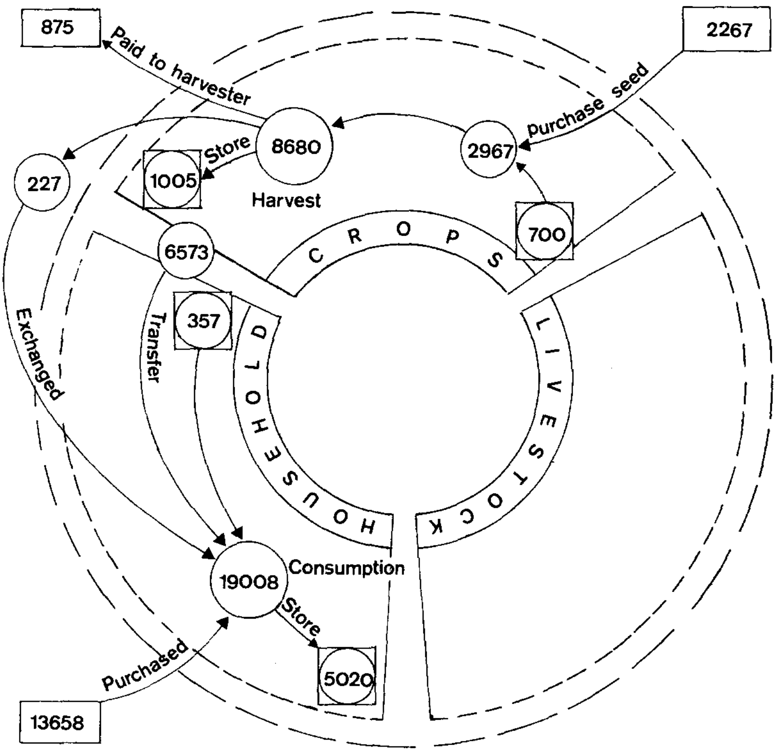
Fig. 7. Village 4/04. Changes in soil-moisture under cereal/fallow over two seasons.

In order to balance, the yield would have to be 595 kg/ha which is generally expected in 'average to good' rainfall years. Alternatively, an extra 56.6 ha of wheat would have been necessary to ensure self-sufficiency in 1977–8 leaving only 80 ha available for barley. However, this would have increased the feed deficit by 244 GJ giving a total deficit of 270 GJ on feeds. Wheat and barley prices and costs of production are broadly similar, but barley is expected to give a higher yield, so the bias towards barley in the area planted seems sensible.

With regard to the feed balance (Fig. 9) the system deficit is 46 GJ which is equivalent to 11 ha of barley or 4182 kg of barley grain. In a more 'normal' rainfall year, the additional 31 kg/ha needed to cover this deficit would be met.

So, although in a 'normal' year the system would balance satisfactorily, the last three poor years have created a very difficult situation, particularly as a portion of the metabolizable energy that could be supplied by the system for feeds is sold cheaply and bought back dearly.

These examples give only a partial picture of flows and links in farming systems but they illustrate the close interdependence of crop output, livestock needs and household food requirements. It would be even more informative to examine



Inflow	Outflow
2267 13658 15925	875 875

△ Flow	-15050
△ Stocks	+ 1755

△ System change -13295

Store

33 per cent of wheat input to household generated within the system

Fig. 8. Village 4/04. Wheat flows (kg) October 1977-September 1978.

how these relationships change over time and, in particular, how the systems are able to cope with continuing adverse conditions in village 4/04. The scope for alternative crops in village 2A/06, such as forage, appears to be limited, given current relative prices and in view of the repercussions which such a change would have throughout the system.

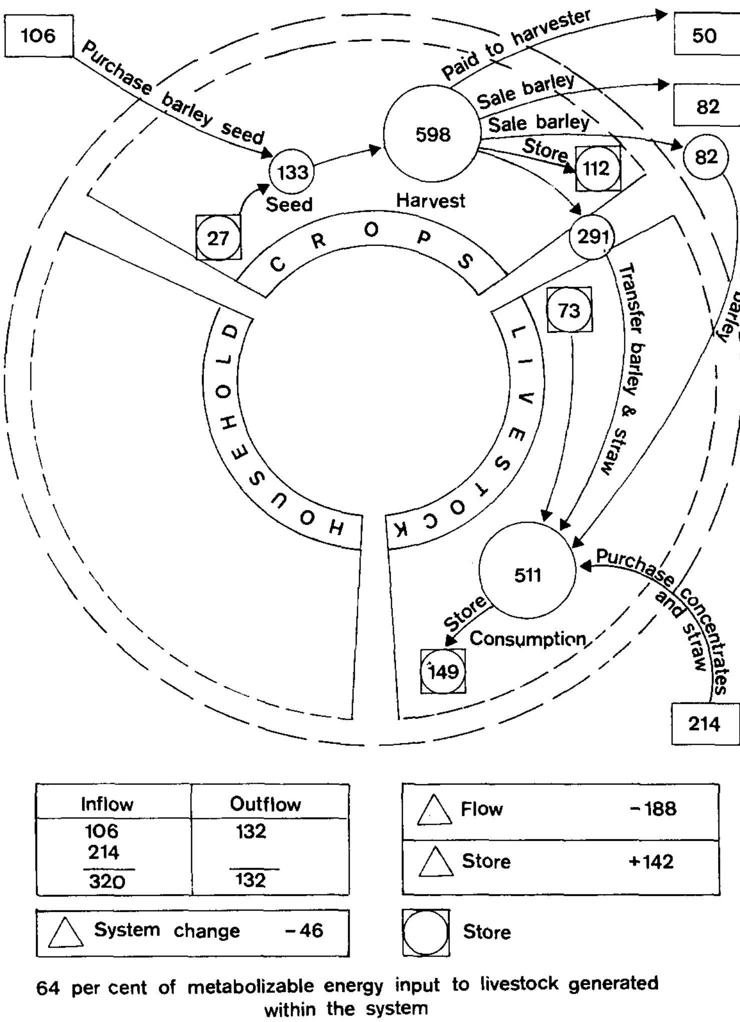


Fig. 9. Village 4.04. Animal feed flows (gigajoules of metabolizable energy, sheep) October 1977-September 1978.

Loans, credit and income from work off the 'home' farm help to sustain a farming system in many ways. Most of the farmers in our study area are obtaining money or credit from a variety of sources and its role is indicated in Fig. 10 (based on earlier figure, Gibbon and Martin, 1978) which combines some physical flows

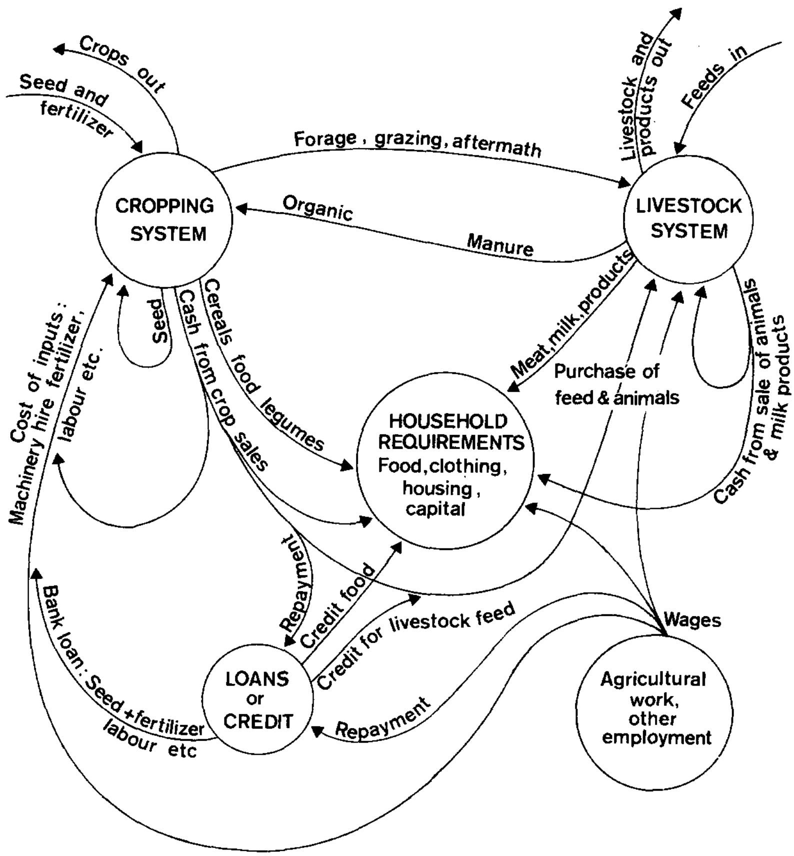


Fig. 10. Some farm system interrelationships.

with cash flows. This figure, along with the previous flow diagrams, highlights the importance of developing an understanding of household needs as these constitute the focal point of the farming system.

THE POTENTIAL FOR IMPROVEMENT

Attention is repeatedly drawn to the relatively slow improvement in agricultural production in the Mediterranean Basin over the past 30 years, in contrast to the spectacular developments that have occurred in California, in relation to irrigated agriculture, and in South Australia, with respect to rainfed agriculture (Arnon, 1971; Oram, 1977).

In discussing the possibilities and potential for improvement, many writers have considered that a series of relatively simple technical changes in existing systems will transform agriculture, making it more stable and much more productive. (Arnon, 1971, 1979; Bolton, 1979; Carter, 1975; Leeuwrick, 1975; Oram, 1956, 1979.) While there is no doubt that more productive systems and mixed crop: livestock systems, proven elsewhere under totally different political, social and economic environments, can be shown to be technically feasible in parts of the Mediterranean (Doolette, 1977; Leeuwrick, 1975; Lozoides, 1979), the fact remains that the so called 'complete systems' advocated so far have not been widely adopted, nor, indeed, are they always actively encouraged or supported by governments, except in Cyprus (Photiades, 1979).

Perhaps too much emphasis is being placed on particular types of technical change and on importing technology, while the structure of farming systems in the region and the fact that constant changes are taking place within present farming systems are imperfectly understood. It is also not generally appreciated that changes in the use of resources in farming systems are only part of a wider process of rural development, from which they cannot be isolated.

We can initiate changes that will provide more food and secure a more reliable income to many people, only if we first understand the processes and interrelationships within existing systems as illustrated, in part, by Figs. 2, 5, 6, 8, 9, 10; and secondly if we involve rural people themselves in the development of alternative technologies. Technologies that are imported complete, or constructed inside fenced research stations by research scientists, are likely to have minimal application as only the ultimate users of technologies can decide what is appropriate for their own circumstances (Biggs, 1978; Bunting, 1978; Taylor, 1969).

I nevertheless accept that much knowledge from elsewhere can be important at various stages in the development of our research programme. The wealth of material presented at the workshop indicates how much is already known of the basic processes operating in this and similar environments. Our primary task would seem to be to see how much of this information is relevant to our situation, how much new knowledge is needed, and what are the appropriate experimental techniques to be used.

We also need to appreciate that farming families themselves can make a major contribution to a research programme through their intimate knowledge of their environment and of soil and crop behaviour, their constant experimenting with alternative techniques and their ability to develop strategies to cope with adverse conditions. Such information should have a major influence on the way we conduct our research, but it rarely does. (Belshaw and Hall, 1972; Richards, 1979; Swift, 1979.)

RESEARCH STRATEGIES

The assembly, evaluation and use of information of the kind which I have discussed necessitates a systems approach to research and requires a team of people whose experience spans a range of disciplines. To understand how existing farming systems work and the nature of problems which farmers face, team members must be committed to a type of programme very different from that adopted by conventional research institutes in developing countries. Only by following such a programme can we hope to identify the new knowledge which is needed to explore the alternative techniques and inputs which may increase agricultural production.

A framework for a systems research programme is given in Fig. 11. This scheme merely identifies the components of the programme and indicates how they interrelate. In the actual organisation of the programme, a sequence of steps may be followed, though not in the conventional sequence: identification of constraints – experimental station trials – off-site trials – farmer testing – extension. Recent discussion and writing have improved our whole approach to this methodology (Biggs, 1978; CGIAR/TAC, 1978; Flynn, 1978; Norman, 1976).

We need alternatives to the development of an 'improved package of practices', particularly as farmers already have their own set of inputs, quite logical for their own circumstances. They usually select from a technology package made up by research scientists whatever they consider to be initially beneficial and appropriate in their circumstances (Mann, 1975; Ryan and Subrahmanyam, 1975).

The continuing study-of, and involvement-in, existing farming systems becomes the focus of the whole programme for developing an understanding of change, generating ideas and knowledge, and for evolving alternatives for making more efficient use of available resources. Thus, experiments of various kinds, ranging from the testing of a new crop variety under farmer management, to site-replicated factorial trials, under alternative management systems, are also important components of the programme.

At the same time, studies should continue on such topics as the effect of government intervention, the utilization of labour, the interrelationships between livestock and arable systems, the effect of power structure on the distribution and access to resources, and studies of the methods of exchanging information with farming communities.

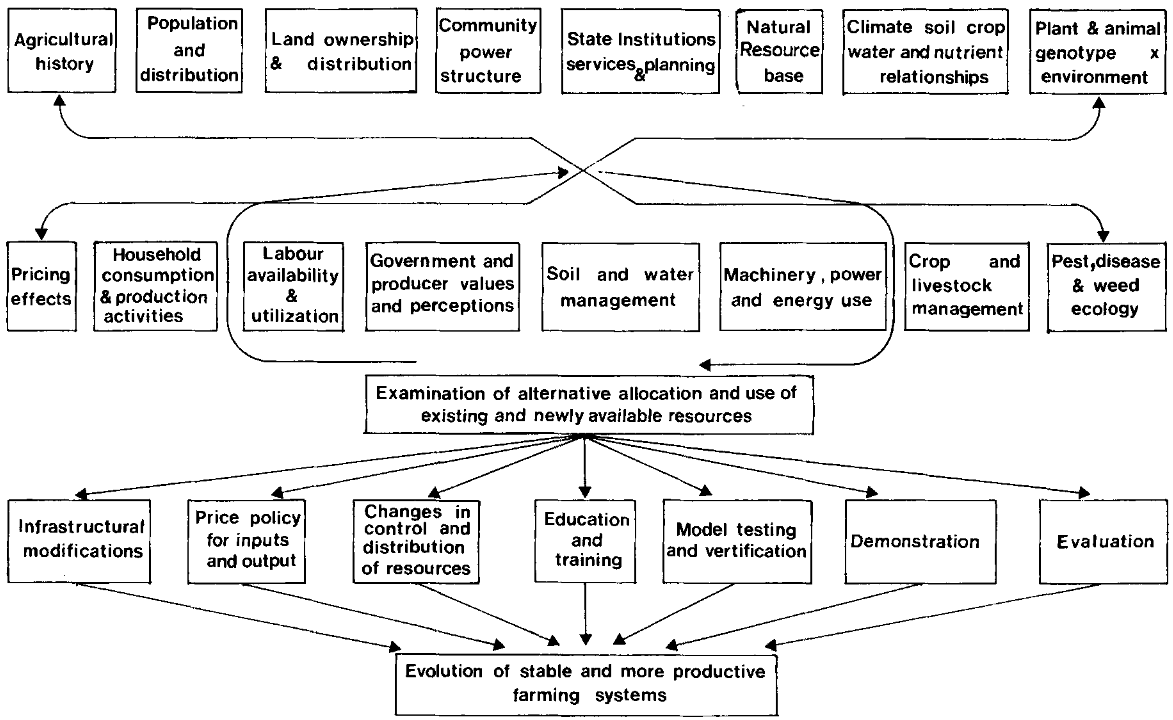


Fig. 11. Framework for a systems research program.

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