Mediterranean agriculture - an agro-ecological strategy

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Henning F. C. Mørch

Abstract

Mediterranean agriculture is an agro-ecological strategy, an adjustment to particular climatic conditions in Mediterranean zones: mild, humid winter with no or very little frost, and a warm, dry summer. The strategy is made up of a complex of four components: rainfed annual crops based on the winter rain, permanent treecrops surviving the dry summer, transhumance avoiding the dry summer, and irrigation compensating the lacking (summer) precipitation and opening the possibility for more than one annual crop. In traditional agriculture the components could be combined in an integrated system. In modern, specialized agriculture the Mediterranean agriculture to a higher degree becomes a type on a regional level. Agricultural types determine the landuse and are important for the development of rural landscapes - in the Mediterranean in part dominated by some specific utilization, however, complexity is just as characteristic.

Keywords

Mediterranean agriculture, agricultural system, agricultural type, rural landscape.

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Christiansen (1979) suggests a zonal, ecological classification of agricultural systems, and the purpose of this paper is to characterize one of the types - Mediterranean agriculture. Though the Mediterranean region is globally small, no matter how defined, it is worth studying the agriculture for several reasons. It is important in the early development of agriculture, and parts of the area have been cultivated in millennia. The Mediterranean zone is transitional climatically, economically, and cultural. Therefore is it heterogeneous and offers opportunities for studies of the interaction between different factors and their mutual impact. In the contrary to what is the case for 'Tropical' or 'Arid' agriculture very few, if any, books exist on Mediterranean agriculture as a zonal type. Systematical treatments are Grigg (1974: Chap. 8) and Lopez-Bellido (1992); chapters in Birot & Gabert (1964) respectively Rother (1993) give profiles. Agricultural systems and types are essential for the development of the cultural landscape and the regional character; agriculture is a fundamental factor for the treatment of the man-made modifications of Mediterranean landscape in Houston (1964) as well as the historical geography of the region in Smith (1979). A multitude of case studies deals with specific areas and topical features; it is not the purpose to review this literature here, but to give a short account of the Mediterranean agriculture as a type and zonal-ecological strategy in the Mediterranean Basin. Other areas (in Australia, California, Chile, S. Africa) Mediterranean by a climatic definition are out of consideration.

Heterogeneity of the Mediterranean region

The 'Mediterranean' is a concept, a phenomenon, everybody imagines knowing what is, and it might be needless to line up the general characteristics. '*Mediterranean: is clear-cut definite, unique, indivisible within its inner limits and readily recognisable within its outer limits*' (East, 1940:13). However, taking almost any topic, examinations reveal great heterogeneity within the Mediterranean region, and Isnard (1973:5) puts it: '*Nothing is worse defined than the word Mediterranean*'. Rother (1993) lines a dozen conceptions of the 'Mediterranean'. Most textbooks on the Mediterranean region just treat the countries bordering the

Mediterranean Sea - and Portugal, usually with a common and weak interpretation behind. Latest for example King et al. (1997) wisely desist to define the concept, and each essay in the book tries to characterize the peculiarity of the Mediterranean area under sixteen broad headings: history, water resources, tourism, etc.

Restricted to agriculture the heterogeneity is obvious, too. This is hold for biophysical resources: topography, soil, and the climate (cf. below), as well for socio-economic factors: history, politics, farm size, and many other features.

The topography in the Mediterranean region is generally mountainous and rugged, a glance in any atlas shows. Therefore elevation and exposion modify the climate, steepness impedes cultivation, and the soils are frequently shallow and stoney - factors, which are widely crucial for the choice between arable and permanent crops. Due to topography terracing of slopes has been widespread in millennia to improve the agricultural utility.

The soils in the Mediterranean region are heterogeneous due to geological conditions, though some Mediterranean soil associations are widespread - (e.g. Calcic Cambisol, Cromic Luvisol - the red and brown Mediterranean soils; cf. FAO/Unesco, 1981). They might influence the selection of crops and type of rotation, but are generally not decisive. For example, apart from the limited acid soils, olive can grow in any soil - although some are particularly well suited for or perhaps better suited for olive than for some other crop. Vertisols are unfit for permanent crops as the roots might be seriously damaged by the periodic shrinking and craking when drying up, respectively the swelling up, when wet. But these soils are not widespread in the Mediterranean.

The political division has shifted and so also the economic-political conditions for agriculture. Sometimes the area has been more or less unified as in the Roman or Byzantine era. Nowadays, to some extend, parts of the region are unified by EU, but at the same time the area is separated in almost twenty individual countries. Well-known is the uneven economic development in the region - on a national scale as well as at lower regional levels. A wide spectre of other socio-economic circumstances and factors could be put forward, many of which are widespread and frequently found typical for the Mediterranean region (e. g. King et at., 1997). However, they are not 'Mediterranean' *per se*, irrespective of how important they are for the regional character and change of agriculture.

Agricultural classification and Mediterranean agriculture

Several scholars have suggested classifications of agricultural systems or types - classifications that include a Mediterranean one. In the search for suitable principles for classification of agriculture a complaint appears: '*We are left, however, without an entirely satisfactory solution to our problem. Pragmatism must - sadly - take precedence over principle, and the basis for the discussion ... is Whittlesey's map of the agricultural regions ...* (Grigg, 1974:3)'. However, the aim of classification is to separate objects and to reveal common features as well - systematically to state similarities and peculiarities. Apart from formal logical criteria and relationships - classifications of complex phenomena and conditions, like agricultural systems, have to be purposive, and thus there is no need to complain. Some classifications of agriculture are genetic, i.e. focus on origin and development, others focus on technology, organization, economics, etc. - in the case of Christiansen (1979 & 1992) ecological factors like regimes of temperature and precipitation and the circulation of energy and matter is the purpose for classification.

On this foundation, the heterogeneity of the area mentioned above and the purposive character of classification, then the only factor which agriculture in the Mediterranean region shares in common, and which can be a criterion for a definition of Mediterranean agriculture, in a strict sense, is the climate and its impact on agriculture (cf. also Birot & Gabert,1964(1): vii).

The Mediterranean climate appeared in classifications a hundred years ago, by the turn from the 19th to the 20th century, when several attempts to classify and regionalize geographic phenomena arose. The most famous among the climatic ones is that of Köppen (1900 and later versions). Though primarily it is a climatic classification, it is in part in reference to agriculture, and in relation to the present subject it identifies a Cs-climate, the 'Olive- & Erica-climate'. At the same time Engelbrecht made global regionalisation of agricultural zones, probably the first, and identified a Mediterranean winter barley zone (Engelbrecht, 1930 - the first version of the classification was 1899). Hettner (1901) elaborated on the idea and stressed further the importance of wheat and especially permanent treecrops. Troll (1925) related Engelbrecht's zones to zones of natural vegetation. Parallel to this Vahl (1911; also Vahl & Hatt 1922; Reumert 1946; Vahl & Humlum

1949) made a classification of climates and vegetational zones and biochores, in part also in reference to agriculture; relevant here is Vahl's subtropical maquis-zone (Figure 1). Naturally, there is a strong connection between at one side the climate and at the other the natural vegetation, the agricultural possibilities, and the actual farming. Other classifications of climate are not to put forward here, but in contrast to many other climatic zones, there is commonly accordance among the different identifications of the Mediterranean zone - irrespective of the specific criteria.

Turning to classifications of agriculture several refer more directly Mediterranean agriculture as a separate type. Jonasson (1925/-26) made a regionalisation based on climatic zones and land use in two main groups: pasture and crop land - the latter subdivided according to the production of small grains. A Subtropical or Mediterranean fruit zone was identified and subdivided into a humid and sub-humid wheat and fruit zone, and a semi-arid barley zone. Several others have attempted agricultural regionalisation and identify Mediterranean agriculture. Hartshorne & Dicken (1935:102) stated: '*In the area around the Mediterranean Sea having the climate commonly called by that name, is found one of the most distinct and hence universally recognized types of agriculture.*' The importance of tree crops and the minor importance of animal production are stressed. Prominent among the agricultural classifications is that of Whittlesey (1936), who wrote: '*From a geographical standpoint, Mediterranean agriculture is the most satisfactory of alle these types. Probably because it represents an ancient and stable collaboration between man and the land* (Whittlesey 1936: 226)'. Also others delimit more or less the same Mediterranean area: Timmons (1944: horticulture, field crops, livestock), and in the slipstream of Whittlesey e.g.Thomas (1962: Mediterranean agriculture) and Fryer (1965: crop farming and horticulture with subsidiary livestock). Others tell nothing of the principles of classification: Van Royen (1956: Mediterranean agriculture, grains, fruit & generally limited numbers of livestock) and Kawachi (1959: Mediterranean). The classification by Kostrowicki (1984 and later) realized no Mediterranean agriculture. However, for Europe a 'Southern Region' was identified: '. . . because of varied natural conditions and different levels of development. The region has a *quite large proportion of traditional agriculture, market-oriented cropping dominates together with specialized crops, mainly fruit* (Kostrowicki, 1984: 148)'. These classifications and regionalizations are not to be discussed here (cf. Grigg, 1969), but conspicuous is in relation to the subject here: Jonasson (1925) based the classification and regionalisation on climatic zones, all the others are generally based on agricultural practice, crop combination, and economic factors, but non the less they also identify Mediterranean agriculture as a zonal type - the sole one. Consequent in the context here is Christiansen (1979), who suggests a principle for an ecological classification of zonal agricultural systems based on the seasonality, the regimes of temperature and of rainfall (humidity-aridity). The Mediterranean type of agriculture is identified as a winter-rain type with an adjudgment to the seasonality in both rainfall regime as well as that of temperature: wet-dry regime, respectively a temperate-hot, but no precise values are indicated.

Mediterranean climate

In the Mediterranean the winter is humid and mild, temperate - the different classifications state a mean temperature

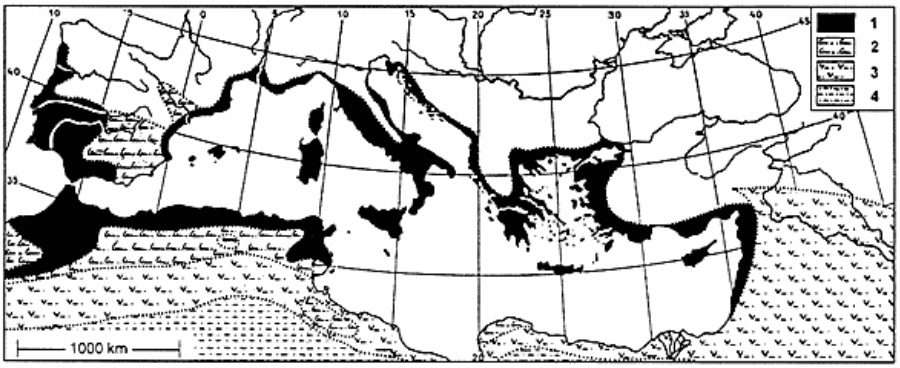

Figure 1: The subtropical zone in the Mediterranean region - an example of a delimitation. 1) Maquis and forest, 2) Grass-Steppe, 3) Desert Shrub, 4) True Desert. Source: Vahl & Humlum (1949).

of 0 to 5°C for the coldest month as poleward limit; frost may occur, but is generally short and not severe; the mean temperature for the warmest month is 25-30°C. The equatorial limit for the Mediterranean climate is determined by (semi-)aridity. The summer is hot and dry, and though sometimes 'subtropical winter-rain' is used as an icon for the region - the dry summer is the characteristic, stable feature. Two thirds of the rain fall in the temperate winter half-year with a maximum in autumn, winter, spring or with a double maximum autumn-spring depending of the area. The precipitation is more variable than in the temperate Europe and typically falls in vigorous showers and rainstorms. This leads to a high risk of erosion in connection with environmental mismanagement: deforestation, overgrazing, worked fallow and other human activities - and problems are widespread (e.g. CEC, 1992; Conacher & Sala, 1998). Land degradation in the Mediterranean has been known in millennia - mentioned in the Iliad (approx. 850 BC) and well-known is the description in Critias, the Platonic dialogue (approx. 400 BC - eg. Poncet, 1973).

The Mediterranean zone is climatically transitional with a graduation North-South and locally modified by elevation - just like other climatic zone, but as it is comparatively small this heterogeneity is commonly perceptible. The climate is becoming warmer and dryer from North towards South - the Mediterranean zones is transitional between temperate and tropical, and between humid and arid. In Tunisia, for example, there is a shift from a typical Mediterranean climate over semi-arid, arid to a proper desert climate over a distance of less than four hundred kilometres. A transect of the Mediterranean region clearly demonstrates the climatic shift, the deeper and longer drought period when going southwards (Figure 2). In addition to this general pattern the Mediterranean region is mountainous, and due to elevation the local climate may shift over even very short distances, in some cases few kilometres from typical Mediterranean in the coastal zone to temperate in the high areas - in Liguria, Calabria, Dalmatia and many other areas.

What matters for agriculture is not some formal classification of the climate. These are generally based on average values, which only indirectly represent the climatic optima and extremes, which are decisive for the plants - the demand and tolerance of the crops. Therefore the distribution of the Mediterranean agriculture, however defined, does not in detail agree with formal climatic classifications, and preferable would be a classification of poten-

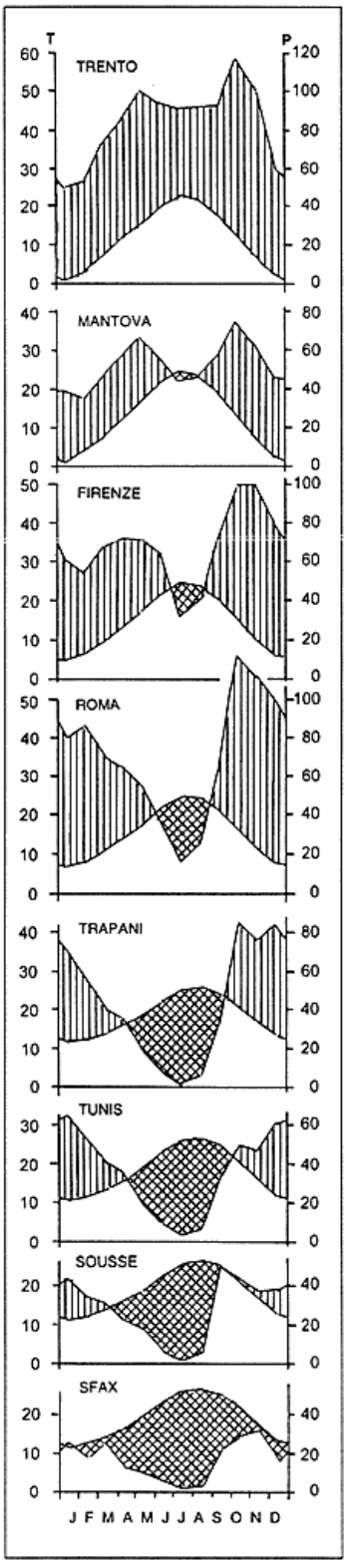

Figure 2: Hydroterm diagrams for a transect of the Mediterranean from North to South, from Trento in the Itallian Alps to Sfax in Tunisia. Source: Walter & Leith, 1960. The principle of the diagrams is that of Bagnouls-Gaussens (1957). The vertical scales represent precipitation (P, left) and temperature (T, right) with P = 0 °C ~ T = 0 mm and 10 °C ~ 20 mm. As a rule of thumb and for Mediterranean stations the period where the curve for temperature is above that of precipitation (cross-hatched), is a broad indication of the period with precipitation deficit (not the size of the deficit). This method gives good results for Mediterranean Climate (Wallen, 1966), cf. also Lauer (1960).

tial crops. Important here is that the winter is so mild that temperate crops are able to grow, many heat demanding crops are able to grow in summer, and from North towards South it is possible to cultivate more crops - providing sufficient water. The variability of rain causes comparable high variable yields for rainfed crops, and the variability and the risk of crop failure are increasing, too, from North to South, from humid to arid. Important is the distrbution of the precipitation in relation to the vegetative cycles of the crops. By rainstorms a large share of the rain may run off at the surface and does not contribute to soil water. A scanty rain optimally distributed may lead to better yields than maldistributed, abundant rain.

Crucial for agriculture is the available water, the water balance, and the duration of the drought period. This could be illustrated by average values for the temperate part and a typical Mediterranean area in the sequence above (Table 1). The precipitation deficit is of minor importance in temperate areas - of great in the Mediterranean.

Olive

Olive is the Mediterranean crop *par excellence*. Other crops may be perceived as true Mediterranean crops (e. g. almond, carob, fig), but they are by far not grown to the same extent. The general distribution of olive cultivation agrees quite well with most formal classification of the Mediterranean climate and vegetation as well as the typical Mediterranean soils. Thus, olive cultivation or the possible cultivation of olive could be suggested as an indicator of the 'Mediterranean'; the distribution of olive cultivation is shown in Figure 3. The Northern limit is due to winter temperature and towards South by aridity - with elevation complicating the distribution in mountainous areas (Birot & Gabert, 1964). The Northern limit for olive agrees generally with approx. + 5 °C mean temperature for the coldest month. Olive tolerates some frost in short periods, but depending of variety and the duration of the expositon temperatures below -7 °C are damaging, and below -10 to -15 °C are fatal. Frost spells may seriously damage the cultivation (e.g. Provence in 1956, Toscana in 1985). Olive is sensitive to humidity, demand summer drought, but benefit from supplementary irrigation. Southwards the limitation is determined by aridity and 220 mm annual precipitation is mentioned, however, in semi-arid areas (<300-400 mm) the cultivation is performed by different kinds of impluvium techniques; in Saharan oasis olive is cultivated by irrigation - Cufra is likely the southernmost. The altimetric limit in Liguria is 600-700 m a.s.l., but for general cultivation just 250-300 m, at tM. Etna, Sicilia, olive is found up to almost 1 km and in the Atlas up to 1300 m.

Mean values for	*Pre-Alps*	*S. Sicilia*
Potential evapotranspiration	*800-900 mm*	*1200-1300 mm*
Annual period of precipitation deficit	*June-Sept.*	*March-Oct.*
Max. annual precipitation deficit	*<200 mm*	*> 800 mm*
Max. annual precipitation deficit July-August-Sept.	*<200 mm*	*> 400 mm*
Max. ann. precip. def. in growth period of winter wheat	*< 50 mm*	*> 300 mm*

Table 1: *Precipitation deficit for a temperate and a typical Mediterranean area in the Mediterranean region. Based on Brockhuizen (1965). The values are calculated by the Turc-method developed on experiences from the Mediterranean zone and agree well with other values (eg. Korzoum, 1977).*

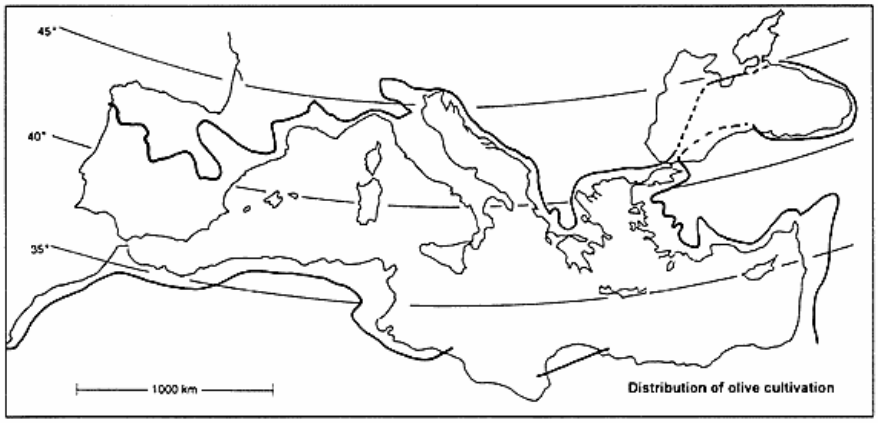

Figure 3: *The distribution of olive culture. Based on Morettini, 1972.*

Mediterranean agriculture

The Mediterranean agriculture sometimes is perceived by a kind of formula. Such one is the Roman trilogy *ager-saltus-silva*, known from the classical Roman authors, summarize the system of utilization - literally the rotational land, the grazing, and the woods. The three components are not to be interpreted in a simple way. Saltus, the grazing being somewhat ambiguous as it included common rangeland, woods and orchards as well as strubble and fallow when used as grazing. Silva comprises the forests as well as the permanent tree crops and has in traditional Mediterranean agricultural society furnished timber (building materials, agricultural and household implements, furniture), firewood and charcoal. Much of traditional Mediterranean agricultural practice is extencively described by classical Roman authors: eg. Cato, Columella, Varro (Skydsgaard, 1968; White, 1970; Smith, 1979).

Wheat, wine, olive is commonly interpreted as the Mediterranean triad, the emblem of Mediterranean agriculture, and these are the most important Mediterranean crops; Philippson (1904: 164) spoke of 'Urkulturen' (primeval crops). Wheat is the most important field crop; wine is widespread, two thirds of the production is Mediterranean; but just olive is the exclusively 'Mediterranean'.

The matter is more complex, however. Mediterranean agriculture is a strategic complex of four components: i) Rainfed annual crops based on the winter rain. - ii) Permanent crops, treecrops surviving the dry summer. - iii) Transhumance avoiding the dry summer. - iv) Irrigation compensating the lacking (summer) precipitation. The irrigation offers the possibility for more than one annual crop, for termophile crops, and for fruit, citrus, introduced from subtropical E.Asian with summer rain.

The four components in the strategy

Winter annuals

The winter crops are sown in the autumn, and harvested late spring - early summer and thus utilize the winter rain and avoid the summer aridity. Of the arable land half is occupied by cereals and half of this by wheat. Due to demand and EU subsidies wheat has gained importance over barley, the other classical Mediterranean cereal crop, and oats; the latter is losing importance because of mechanisation and the diminishing stock of equines. More than two thirds of the wheat area is bread wheat, the rest is durum wheat located in the dryer parts - the southern parts of Mediterranean Europe and in N.Africa. Barley is more and more confined to semi-arid areas, e.g. in S.E.Spain, N.Africa, Near East - because of the comparative tolerance to drought. Maize is sometimes is mentioned as a typical Mediterranean crop, but accounts for just one eight of the cereal area and is located in the sub-humid areas of the Mediterranean, e.g. Northern Portugal, and where irrigation is possible. Legume crops have a significance generally in the rotation (nitrate fixation), as fodder crops (lucerne, vetch, sulla, a.o.), and for human consumption (broad bean, chickpea, lentils - important sources of protein in the traditional Mediterranean food). Depending on the local climate and soils, industrial crops like cotton, sugar beet, sunflower, and tobacco are cultivated frequently with supplementary irrigation. Also vegetables are cultivated as field crops to a fast growing extent - a wide selection of temperate in winter and more termophile in summer. The arable farming is predominantly located on level land and terrain with moderate sloping (i.e. < approx. 12° CEC 1992). From time to other economic subsidies have prompted cultivation of terrain otherwise too steep for arable activity - and thus inflict erosion.

The cereals are grown in rotation in rainfed agriculture posssibly with legume crops, and to some extend with fallow. The rotation might be simple biennial e.g. wheat > fallow; wheat > barely, oats or legume - triennial e.g.: fallow > wheat > barely, oats or legume; wheat > barley > legume; quadrennial: e.g. fallow > wheat > legume > barley. But many more complex rotations exist - depending on the agricultural system (e.g. with or without animal husbandry), soils, duration of drought period, local tradition. Maize, sugar beet, tomato etc. may be used as renovation crops in the rotation.

Fallow has been an important element in Mediterranean agriculture in millennia (the wheat-fallow system was recommended by e.g. Theofrastos and Xenofon in the 3rd to 4th century BC). It contributes to rebuilding exchangeable plant nutrients in soils with low content of organic matters and generally with very limited possibilities for adding animal manure (cf. below). However, in any case fallow represents a waste of arable land; and worked fallow is seriously exposed to erosion (runoff and wind) - for example in a biennial fallow system the soil may be exposed to erosion up to 16 months. On very clayey soils too much or little rain makes the surface either very sticky

or hard, and therefore sowing in time might be impeded or even impossible. This could lead to enforced fallow, however, this risk is removed by mechanisation. Gradually fallow is substituted by some crop, provided the fallow has no function as grazing - and even if so commonly a grazing or hay crop is profitable compared with green fallow. In Greece, Italy and Mediterranean France the share of fallow around 1990 was 5-10 %, in Spain 10-25, and even approx. 30% in Portugal (Van Hecke, 1991). In semi-arid areas, in the so called "dry farming systems" worked fallow contribute to the storage of soil water for the following crop; the share of fallow is comparably high in marginal areas in SE.Spain, the Eastern part of the Mediterranean region and North Africa - e.g. in Tunisia fallow is about half of the arable.

Permanent crops

Permanent crops are tree crops able to survive the dry summer period. Due to extended root systems trees can better utilize soils, which are too shallow, stony and steep for arable agriculture; and the roots are ready when the rain comes - whereas the annuals have to develop the roots in a short period. Treecropping is performed in almost any type of terrain. However, treecropping is frequently the the possibility for cultivation of the more sloping surface and of shallow and very stoney soil, and therefore the trees are widely located in such areas if there is any option, and the arable cultivation performed on the level land and the better developed soils. Especially in intensive treecropping, the soil in periods is held free for herbaceous vegetation; thus the surface is exposed to surface run off and erosion - a risk being worse in those sloping areas where tree crops are often located.

Generally and also compared with temperate Europe the permanent crops are important in Mediterranean agriculture - for land use and economically mirrored by the share of the agricultural area and income related to the farmtype 'treecrops' (Table 2 & 3). Olive and wine, by far the most important, figs and almond are widespread and locally carob, pistachio, apricot, and others. The treecrops are also a source of firewood and charcoal and in traditional agriculture building material, the brushwood from grafting as supplementary feedstuffs.

Animal husbandry

In the Mediterranean climate the possibility of producing green fodder is rather poor because of the summer drought. Animal husbandry has generally a comparatively small importance in traditional Mediterranean agriculture, but is primarally performed at two lewels: i) one at household and farm level: a few hens, a small stock of sheep or goats, maybe a single cow and some draught animals. These animals were fed by household refuse, foliage and brushwood from the grafting of tree crops, and local grazing like stubble, fallow, along roadsides and watercourses, etc - and cultivated feed for the draught animals. The animals were held as draught animals for fieldwork and transport, for home supply (eggs, milk, and a little meat) and maybe some sale on local markets. ii) The other, on an economic scale, was the small ruminants, sheep and goats, raised by transhumance. In the humid winter half-year the stocks utilize the grazing possibilities mentioned above - and in

	Andalucia		*Valencia*		*Sardegna*		*Sicilia*		*Peleponessos*		*Kriti*	
	A	*SDB*	*A*	*SDB*	*A*	*SDB*	*A*	*SDB*	*A*	*SDB*	*A*	*SDB*
Field crops	*34*	*33*	*5*	*3*	*8*	*15*	*25*	*13*	*2*	*1*	*0*	*0*
Horticulture	*1*	*15*	*2*	*7*	*1*	*8*	*1*	*13*	*1*	*2*	*2*	*11*
Treecrops	*26*	*25*	*66*	*71*	*7*	*14*	*33*	*51*	*67*	*76*	*38*	*46*
Grazing	*15*	*6*	*11*	*2*	*61*	*38*	*17*	*9*	*8*	*5*	*33*	*19*

Table 2: *Farm types share (percent) of the agricultural area (A) and standard gross margin (SGM) in six Mediterranean regions. Calculations based on Eurostat (1995). The farm types are defined by dominating production (>2/3 of SGM). The regions serve as examples and pretend not to be representative.*

	Basse-Normandie		*Picardie*		*Languedoc*		*Provence*	
	A	*SGM*	*A*	*SGM*	*A*	*SGM*	*A*	*SGM*
Field crops	*12*	*29*	*72*	*65*	*9*	*7*	*17*	*7*
Horticulture	*1*	*5*	*0*	*3*	*1*	*9*	*4*	*36*
Tree crops	*0*	*1*	*1*	*4*	*40*	*68*	*26*	*39*
Grazing	*72*	*65*	*9*	*8*	*39*	*6*	*35*	*5*

Table 3: *Farm types share (percent) of the agricultural area (A) and standard gross margin (SGM) in two temperate and two Mediterranean regions in France. Cf Table 2.*

the dry summer in elevated, milder, humid mountain areas with more prosperous pastures. If topography offered the opportunities, the transhumance was practised over rather limited distances 10-20-50 km, but in many cases the distances were much longer several hundred kilometres (e.g. from Tavoliere di Foggia in S.Italy to the Abruzzi and even more than 500 from S. to N.Spain - cf. Müller 1938; Evans 1940; Sprengel 1971). The transhumance widely has used organized systems of established tracks (fenced and partly paved) sometimes dating from at least the Roman era (Skydsgaard, 1974).

Locally the transhumance may have some importance for the circulation of plant nutrients, but generally domestic animals have been of little importance for the Mediterranean agriculture - primarily as utilization of residues, and of local or remote marginal areas. The relative importance of the animal husbandry is generally greater for land use than for the economy mirrored by the share of the agricultural area and income related to the farmtype 'grazing' (Table 2). Transhumance is difficult to perform together with modern, intensive farming and is therefor almost abandoned or fast on retreat - and primarally survives in marginal and economically lesser developed areas. Where it still survives, rail and road transport has taken over the transportation of the stocks between the pastures. Stationary raising of dairy cattle on a commercial scale and based on local cultivation of fodder (grass, oats, barley, legume for grazing or hay) or imported feedstuffs is an increasing practice.

Irrigation

The obvious solution to the summer drought is irrigation, by which it is not only possible to utilize the arable land in a longer period, but also to take advantage of the high potential plant production in the summer period. However, irrigation is no simple solution and depends on suitable terrain and available water (run off or aquifers) as well as of technological level. In millennia the irrigation has been gravitational based on water from rivers, springs and wells frequently sustained by dams and by water lifting implements driven by water, wind or draught animals. The irrigated areas generally made up a very small share of the agricultural land, on very level terrain in valley bottoms and coastal zones. The irrigated areas were dominated by very small farm units with very intensive cultivation of fruit (citrus, etc.) and vegetables; they were garden- or oasis-like, e.g. the Spanish huertas.

Technological progress has shifted the picture fundamentally since the middle of the 20th century. Large scale projects with dams and vast systems of huge canals and pipelines, effective pumping facilities, mobile and stable sprinklers, aluminium and plastic tubes, etc. have expanded the possibility and flexibility of the irrigation. Therefore irrigation is no longer limited to the very level areas, but is also possible on certain types of undulating and steep terrain. The importance of irrigation has increased generally, and the position or function within the Mediterranean type agriculture has changed. Besides irrigation has expand to largescale field irrigation vegetables: tomato, sweet pepper, aubergine, artichoke, fennel, cucumbers, melons, etc, but also many common, temperate kinds - as well as industrial crops: tobacco, sugar beets, cotton. Supplementary irrigation is further also extensively used for traditionally rainfed cereals and treecrops to stabilize and improve the yields.

The statistic statement of irrigation, and so the evaluation of the relative importance of irrigation for agriculture is difficult, and it depends on the registration of different type of areas: areas with equipment, areas temporarily irrigated by movable equipment, the actually irrigated area, and the amount of water utilized.This information is not simple to establish, and irrigation is not necessarily relevant or possible everywhere. As an example, though irrigation could be a potential solution for improving agriculture in a typical Mediterranean region like Sicilia, just an eight of the agricultural area is irrigable - a share, which could hardly be raised to much above a sixth (Fierotti, 1975). On a national scale in the Mediterranean basin the share of irrigated area in relation to cropland (arable and permanent crops) range from more than the half in Israel to less than a tenth in e.g. Tunisia (Cf. FAO Production Yearbook).

Strategies and systems

The four components are parts of a general strategy in the scheme (Figure 4 - examples of detailed agricultural calenders cf. Brögger, 1971; Davies, 1973; Smith, 1979). The different cycles of the components offer the opportunity of making fine adjustments of the available area and labour (working hours) by the selection of crops - e.g.:

cereal sowing > legume sowing > olive harvest > planting, pruning, grafting of trees > legume harvest > cereal harvest > wine harvest > cereal sowing ... etc.

Between these procedures it is possible to make the other necessary work: soil preparation, weeding, spraying, fertilizing, etc. Further, by irrigation it might be a possibility to have two crops successively on the same field: after an early harvest of grain or legume and before the next autumn-sown crop (wheat, oats, barley, legume) to grow an irrigated crop: several vegetables or maize (possibly green for fodder). By a specialization in vegetables with short growth cycles from planting to harvest it is possible to have even more than two crops.

The strategic components are used on farms of any size - in specialized or in some combination. Mixed cropping by utilization of more of the components is practised by different manners and intensity at farms of any size. However, there is a tendency that extensive cereal farming is performed on rather large farms - previously run by absentee owners by bailiffs and short time hired labourers (latifundia). Whereas small peasants (tenant or owners) have practised more intensive, mixed farming (possibly also intecropping). Mixed cropping as intercropping with treecrops and arable on the same field are widespread in the Mediterranean. The trees moderate the evaporation from the arable land by shade and shelter, and the trees benefit from the better soil preparation and possible irrigation. The different types of crops utilize different strata of the soil and are not seriously competing. Compared with arable utilization the risk for erosion is high in intensive, specialized treecropping, thus, well-managed intercropping could be recommendable strategy. However, intercropping is difficult to perform by mechanisation and often regarded as old-fashioned. In Italy around 1960 two thirds of wine and olive and nine tenths of fruit were grown by intercropping; since the share has been very reduced because of specialization, but no precise data is readily available.

Mixed cropping including intercropping could be regarded as a *fifth component* in the Mediterranean agriculture especially for the very abundant small farms. It has been used in a strategy for spreading the risk and for subsistence and in combination with off farm work - in agriculture and since around 1960 in other occupations. Arable-livestock systems lead to greater importance of feed crops.

A special type of arable-livestock-treecrop systems, unique in an European context, is the Spanish 'dehesa' in Estramadura ('montado' in the adjacent Portugese Alentejo) (Parson 1962; Balabanian 1980; Vacher 1984).The farmland looks quite savanna-like with scattered oak trees and in some areas olive trees; especially in the Portugese area cork oak is important, and the cork production is important for the farms - and on a national level as well. The soil between the scattered trees is held in herbaceous fallow fifteen to twenty years and then farmed four to eight years in a cereal-feed rotation. The fallow is used as grazing for sheep, cattle and hog - where the trees are oak, the acorns are important feed for sheep and hog.

It could be questioned if some technical improvements are just techniques or could be considered as systems or sub-systems. Irrigation is dealt with above - two others are terrace cultivation and covered cropping.

Terracing is widespread in the Mediterranean and has been so in millennia and used to improve the cultivation in the generally difficult topography, too rugged and steep for common cultivation, or simply to make cultivation possible. It is a measure to improve infiltration and against surface runoff and erosion. Terraces are labourious and expensive to establish and maintain; therefore in the last third of the 20th century terracing has been a declining activity in two kinds of areas: In marginal agriculture due to rural-urban migration of labour force and where also the eco-

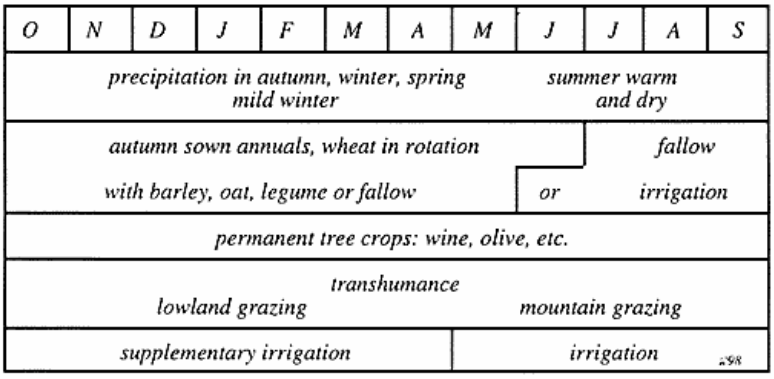

Figure 4: The components in Mediterranean agriculture during the agro-ecological year beginning October.

nomic surplus is too low. The later type of area is close to urban areas, where the competition from other business is too fierce. The lacking maintenance and cultivation of the terraces make the maquis invade and possibly increase the risk for erosion. An other risk of land degradation is brutal mechanisation, as the terraces are not constructed to stand heavy machinery and possibly collapse.

Covered cultivation, necessarily combined with irrigation, is used to enforce the climatic advantage for the production of vegetables, fruit (incl. grapes), and flowers. This is in contrary a rather new activity - fast growing in the last third of the 20th century. In the first decades tomato was by far dominating with aubergine and sweet pepper, in time the production is becoming more diversified. Plastic tunnels is predominant, not glasshouses, as the equipment has to be cheap, because greenhouse cultivation is just profitable six to eight month due to the climate.

Modernization and changes

Mediterranean agriculture is an adjustment to bio-physical conditions, however the selection of crops is tied to market conditions. For example, after the middle of the 19th century overseas import to Europe changed the market for wool and grain, important in the European production, and induced widespread changes of the agricultural production and thereby changed land use and agricultural systems. In the Mediterranean this led to a growing significance of permanent crops - first in Languedoc (wine) and Provence (fruit & vegetables), a development sustained by a groving market (urbanization) and improvements of transport (railway), and later in many other areas.

Some features of the recent change and modernization of the Mediterranean agriculture have been mentioned including some disadvantages. The general tendencies of the modernisation process, which are experienced in other areas: industrialization, concentration, specialization (cf. Bowler, 1992) are seen as well in the Mediterranean, though the process is slow in marginal and economically unfortunate areas.

The growth in other economic sectors has not given the capacity to pick up the surplus of agricultural labour force. This is an important reason for the continuous burden of very small farms, which are not able to give a reasonable output - if it is not possible to intensify and specialize, preferably with irrigation. Different land reforms have not really been a solution to the very abundant problems with very small and divided farms. For example, the Italian land reforms so to say increased the number of too small farms (King, 1973).

Within the EU the social aspects of the CAP have artificially held alive the otherwise unprofitable cultivation of cotton, tobacco, sugar beet, as well as the production of low-quality bulk wine. In a way the same could be said about wheat: the yields in the Mediterranean are comparatively low and unstable, the total area is globally small; so at least small-scale wheat farming is not profitable without the support. A common problem is that a large share (two thirds of value) of the agricultural production in S.Europe is 'sensible' in EU terminology, i.e. alternative, profitable production is desirable.

The potential for the Mediterranean agriculture is in the production for the urban market and for Central and Northern Europe - the intensive production of primarily vegetables, fruit and wine, but depending on the ability to maintain and improve the quality.

New crops have been introduced especially after the end of the 1960s. Important among arable crops are soya, especially in Italy, and more widespread sunflower; among new fruit crops are kiwi and avocado. New crops are not simply alternatives to the existing arable or fruit cropping thus simply leading to greater diversification of the cropping, but may also lead to changes of agricultural systems. An example is sunflower cultivable with common machinery and so an alternative to e.g. wheat. Sunflower is thus also cheap to produce compared with the laborious olive oil, and therefore more competetive on a market characterized by demand for cheap offers. On level terrain sunflower may be an economically actractive alternative to olive leading to the change from treecropping to arable (e.g. Breuer 1985).

The transformation process has to be sustained by improvements of resource management (irrigation methods, water reclamation, measures against land degradation, etc. - e.g. King & al., 1998 and Conacher & Sala 1998). What happens and how it influences the local agricultural systems, the structure of productive structure and farm structure depends on the national and international policies. The international concern of Mediterranean environmental problems is mirrored in the CORINE and MEDALUS projects (CEC, 1992 & Mariota, 1998).

Landscape complex

Geography is the study of regional characteristics, change and systems. '*. .the whole content of geography lies in the analysis of landscape*' (Sorre 1913: 10). One of the most important components of landscape is land use. '*Landscape may be said to reveal the social and economic history of a region* (Houston, 1963: 49)'. However, it may be added as well that the rural landscape reveals how the physical landscape, the resources, influences the economic history. The landscape is not understandable without taking in consideration the agricultural systems; the rural landscape is, so to say, a regional expression of agricultural systems. Similarities and dissimilarities and their change within the rural landscape and of the agricultural production are not fully understandable without considering the natural environment and its functional interactions with farming. Isolated a land use pattern may appear as solely a product of economic forces - in a greater perspective the influences from resources emerge. Agricultural systems arise in the interaction between at on side the system of physical resources and at the other that of socio-economic factors (e.g. Rasmussen & Reenberg, 1980; Mørch, 1987).

Lebeau (1969) was possibly the first to make a synoptic, cartographic presentation (book page scale) of European rural landscapes and stresses the diversification of the Mediterranean rural landscape and notices for the Mediterranean four main landscape types:

i) The arable open field - occasionally with treecrop zones, which covers the greater share of the Mediterranean Europe; - ii) The huerta, the dispersed small areas, intensively cultivated with irrigation - so to say niches in valleys and at coastal zones; the total area making up very small percentage; - iii) the central Italian coltura promiscua landscape from the river Po in North and a line Viterbo-Pescara southwards; and iv) - The dehesa-montado landscape (cf. above). On this, Meeus et al. (1990) and Meeus (1995) elaborate and classify the latter three as 'regional landscapes' and include further a 'delta'-landscape mainly in the lower parts of the larger river-systems. The delta type is commonly marked of some underlaying, general reclamation project: a rectangular lay-out of fields and networks of roads and irrigation systems and uniform farmhouses and service towns - quite similar the NV-European polder-landscape. The delta-type, so to say, is a modern largescale huerta, intensively cultivated predominantly with vegetables and fruit - with irrigation and thoroughly mechanized.

There is, indeed, within the area claimed to be dominated by open field in the studies above (Cf. Lebeau, 1964: Figure 14) wide areas dominated by arable cultivation and openfield landscape, e.g. on the Spanish Meseta. However, even taking in consideration the level of generalisation, the scale of the cartography, there is over-simplification. Within the area claimed to have openfield landscape the attached arabel utilization is not at all predominant - treecropping or some other utilization in fact might be more important (e.g. Tab. 2 & 3 Languedoc, Peleponessos, Sicilia). The 200 km in Bas-Languedoc from Montpellier to Perpignan is almost complete with vineyards; the 200 km in Puglia from Canosa to Mesagne is completely closed by olive groves. At least a specialized, closed tree-crop landscape is lacking in the typification. Another reservation could be put forward in connection with the intercropping landscape by name of 'coltura promiscua', which is solely confined to Central Italy (Emilia, Marche, Toscana, Umbria). By doing so coltura promiscua appears to be solely connected with a special, intensive type arisen in close connection with a regional system of share-cropping (Desplanques, 1969). Intercroping is much more widespread in the Mediterranean, and in Central Italy large shares are dominated by some other type of utilisation. The Central Italian type of coultura promiscua and the attached type of landscape are fast in change due to marginalisation, mechanisation, and change of tenantship (Vos & Storfelder 1992). Birot & Gabert (1964) on the same scale of generalisation identifies ten to sixteen different land use types depending of how the Mediterranean area is delimited, and the abundant areas with little or no cultivation are also shown. Houston (1964), Smith (1979) and many other mirror the great diversification, too. The point is: though it is possible to find simple, dominating landscape types like those mentioned - the complexity of the common landscape is just as characteristic e.g. depending on topography or shifts in soil structure - further a kind of heterogeneity added to those mentioned preveously. A sequence of agricultural systems and the attached complex landscape is widespread: i) the coastal zones and valley bottoms with irrigation (huerta and delta landscapes) and common rainfed arable utilization; ii) the slopes and piedmonts with a dominance of treecropping (wine, olive, almond etc) and mixed cropping; and iii) the mountain areas with forestry, pasture, and some arable cultivation - possibly not Mediterranean. It is a sequence in fundamental changes: a) extensivation and land abandonment in the remote, elevated, economic

marginal areas hit by off-migration and intensivation, and b) specialization and urbanisation in the low-lying, irrigable, accessible areas (e.g. Growe & Rackham 1998).

Conclusion

The Mediterranean region is an area of heterogeneity. Depending on the matter in question the Mediterranean has to be given a specific definition. Consequently the Mediterranean agriculture has just a specific meaning as a conception of an agro-ecological strategy, an adjustment to some specific climatic conditions. The economic peripheral position, the abundance of very small farms and other features having great importance for agriculture, and which Mediterranean areas share in common, are not specifically 'Mediterranean'. The Mediterranean type climate has comparatively mild, humid winters - and hot, dry summers. The climate is transitional between tropical and temperate, and between humid and arid. In an European context the precipitation variability causes comparable higher insecurity in rainfed cropping. The general strategy is to avoid or survive the summer drought, and the components in the strategy are:

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