11

88 - 1/11

Traditional land-use systems
South America, Andes, land-use patterns, Inca period, ecology, colonial system, environment, exploitation of resources, research problems
DOLLFUS, O.
Development of land-use patterns in the Central Andes.
Mountain Research and Development, 2, 1982, pp. 39-48

This paper considers how the natural environmental characteristics and social evolution in the Central Andean region have interacted to produce the present-day land-use patterns of the area. The causes for the relatively low economic productivity of the Central Andes are explored and suggestions of how production could be expanded are considered.
The high-altitude area of the Central Andes, which has been inhabited for at least 15,000 years and contains the oldest relics of human settlement on the continent, was the stronghold of peasant chieftainships and states. It still supports a dense human population today.
This area is economically backward and a large part of the population is emigrating toward the lower land to the east and west.
The Inca state was centred in the Andean highlands, north of latitude 2° N. This state was based on a centralized hierarchical administration, with a double network consisting of a "ruling bureaucracy" and a system of local political and religious official with allegiances to the person of the Inca.
The policy for controlling and utilizing land was administered at two levels:
- State level. This included the construction of paved roadways along which were situated roadside inns (tambos) and state granaries; this network was served by a system of runners (chasqui). The state also made decisions about the displacement of populations which were generally restricted to the same ecological belt but involved great distances (the mitimaes).
The purposes of the displacements were to gain better control over certain geographical areas (border regions), to contain politically unstable populations, and to develop underpopulated territories.
- Chieftainship level. This usually pre-dated the establishment of the Inca Empire and involved the control of several ecological belts. This was accomplished either by sending temporary workers to a particular sector for seasonal labour, or by controlling people in various altitudinal belts in order to control production. The purpose was to guarantee the exchange of products between belts.
The punas were centres for the breeding of camelidae (primarily llamas and alpacas) as pack animals, as a source of wool for spinning, and for meat, often eaten in dry form. These animals were grazed in conjunction with tuber cultivation (oca: Oxalis orenata; ulluco: Ullucus tuberosa; ana: Tropacolum tuberosum). After harvest, the tubers were processed by freezing (chunu

technique), which eliminated acidity and, more importantly, facilitated preservation and transport. In the suni zone, there were also fields of quinoa and canhua (chenopodium), protein-rich plants which need to be washed several times before their seeds are eaten. Canihua (Chenopodium pallidicaulo) is slightly more resistant to cold and was grown at the higher altitudes. The yields from these crops cultivated at the extreme limits of ecological viability were uncertain; cultivation alternated with long fallow period to allow some slight restoration of organic matter. The fields were sometimes fertilized with llama and alpaca dung and were tilled by hoe and digging stick. This cultivation of the punas, in which the great herds of camelidae played an important part, supported substantial local populations, as in the region of Lake Titicaca
The quechua belt of the Andean valleys was the heart of the Inca Empire. Here, agriculture production reached its fullest potential. Maize, the "noble" product, was the most important crop, and numerous varieties were grown with many hybridizations. Maize could be grown on crop terraces (andenes) by preparing the slopes and using rudimentary gravitational irrigation from springs and mountain streams. Maize was sometimes grown with companion crops such as beans and lupins, whose seeds had to be soaked for a long time before they were eaten. Most of the Andean tubers (potatoes, oca, ulluco) also had a place in the crop rotation system. Farming made use of long-fallow shrub-covered fields. Animal fertilizers were not employed; nitrogen was supplied in part by leguminous plants (lupins). The large number of varieties of each species was by no means indicative of high yields. However, the valleys of the quechua belt supported large peasant populations as, for example, the Cuzco region, and produced surpluses which helped to sustain the imperial administration.
The humid yungas on the eastern slopes and valleys were the centre for slash-and-burn cultivation. Land clearing in the dense humid forest, however, was made difficult by the lack of good metal tools. On plots that had been cleared and burnt, the following crops were grown: cassava, maize, tomatoes, cocoa, anona fruits, pineapples, arborescent cotton (Gossypium arboreum), tinctorial plants (urucu: Bixa orellana). In dry yungas to the west and south there was no need for land clearing, but tropical irrigation techniques were necessary. It is this belt that produced a highly prized variety of coca, as well as fruit and cotton. The dry yungas were often in the higher areas of the irrigated desert lands.
The desert with rivers had agriculture with irrigation dating back almost three thousand years. Before this time the lomas (ridges) and the river beds were cultivated after flood subsidence. These areas were often very extensive, particularly those of the Chimu Empire, and were irrigated using bypass channels, gravitation, and sometimes shallow wells. They supported food crops such as maize, beans, gourds, potatoes, cotton and, sometimes, cassava. The yields were probably low, but tilling was facilitated by the light sandy soils. Cultivation was carried out with care, but without improvement or fertilizing of the soil, except in vegetable gardens close to the houses. There seems to have been no

substantial difference between the living standards of the peasants in the river basins and those in the quechua belt. The effects of irregular harvests in the high-altitude areas were perhaps mitigated by the stockpiles in the imperial granaries. It was during this period that the living conditions in the peasant communities throughout the area became more or less uniform, except during periods of war or epidemics.

12 88 - 1/12

Traditional land-use systems
Asia, South East Asia, ecozone humid, book, review, traditional agriculture, soil management, homegardens, socioeconomic factors, agroforestry
MARTEN, G.G.
Traditional agriculture in Southeast Asia: a human ecology perspective .
East-West Environment and Policy Institute, University of Hawaii, USA; Westview Press, Boulder, ISBN 0-8133-7026-4, 1986, pp.,384 , Dfl. 65.00

In this book a group of agronomists, ecologists and social scientists describe the functioning of the traditional agriculture in Southeast Asia. Several chapters deal with the region/subject as a whole, while covering the following items: a) review of agriculture; b) the human ecology perspective; c) socioeconomic factors and small-scale farmers; d) social organization and traditional agroecosystems; e) ethnoecology; f) soil management; g) shifting cultivation; h) the ecology of traditional pest management; and i) agricultural research. The remaining chapters are concerned with particular systems in particular areas or countries: traditional rice production and shifting cultivation among the Bontok in the Philippines, traditional agriculture in northern Thailand, rainfed cropping in northeast Thailand, traditional agroforestry systems in West Java (Indonesia), trees in rice fields in northern Thailand, and the nutritional aspects of farming in West Java. For the development worker this book gives a very good insight into the functioning of traditional farming systems.
Abstracts on Tropical Agriculture

13 88 - 1/13

Traditional land-use systems
Agroecosystems, traditional agriculture, alternative agriculture, sustainable agriculture, cropping systems
ALTIERI, M.A.
Traditional agriculture.
In: Agroecology: the scientific basis of alternative agriculture; Agroecology, 1050 San Pablo Ave., Albany, CA 94706, 1986, pp. 41-44, US$ 11.50

About 60% of the world's cultivated land is still farmed by traditional and subsistence methods. This type of traditional agriculture has the advantage of centuries of cultural and biological evolution that has adapted well to local conditions. Thus small farmers have developed and/or inherited complex farming systems that have allowed them to meet their subsistence needs for centuries, even in adverse environmental conditions (i.e. on marginal soils, in drought- or flood-prone areas, with scarce resources etc.) without depending on mechanization or modern chemical fertilizers and pesticides. Generally, these farming systems consist of a combination of production and consumption activities.
Perhaps one of the most salient features of traditional farming systems in most developing countries is their degree of crop diversity both in time and space. This diversity is expressed through the use of multiple cropping systems or polycultures. For example, in the Latin American tropics, 60% of the corn is grown intercropped. Similarly, in Africa, 98% of the cowpea, the most important legume there, is grown in association with other crops. The practice of polyculture is a traditional strategy to promote diversity of diet and income source, stability of production, minimization of risk, reduced insects and diseases, efficient use of labor, intensification of production with limited resources and maximization of returns under low levels of technology.
Polycultures exhibit a number of desirable features of socio-economic stability, biological resilience and productivity. The many advantages offered by polycultural systems as compared to monocultural agriculture as practised in modern countries are discussed in detail.

14 88 - 1/14

Traditional land-use systems
Central America, tropical lowlands, traditional agriculture, agroecology, Maya period
WISEMAN, F.M.
Agricultural and historical ecology of the Maya lowlands.
In: Pre-Hispanic Maya agriculture (Eds. P.D. Harrison and B.L. Turner), University of New Mexico Press, Albuquerque, 1987, ISBN 0-8263-0483-4, pp. 63-115

Understanding the relationship between prehistoric society and environment is complex because of the passage of time and the number of fragmentary variables to be considered. Although one may indeed know the dynastic rulers of the Maya lowlands of twelve hundred years ago, one cannot yet visualize all of the landscape over which they presided. This paper employs an interdisciplinary approach in an attempt to describe the hypothesized farming systems.
The slash-and-burn agricultural system practised by the Maya has been much discussed. In this paper is presented a quantified summary of the inputs and products of the Maya agricultural system derived mainly from data collected in the Lake Peten region.

Subsistence systems can be divided into two main groups, intensive and extensive systems. Extensive systems use much land, but less labour input. Examples are hunting, gathering and milpa farming, techniques used by the modern Maya.
Intensive agricultural systems may be considered as either biointensive or geointensive. A biointensive system relies upon increased efficiency of energy flow through a modified vegetation composition and structure to increase usable productivity. Less attention is given to the physical environment of the cultivars than to the biotic. Examples of biointensive systems are ramon cultivation and artificial rain forest, few of which leave visible remains.
Geointensive systems alter the geomorphology of the agricultural plot to increase available moisture or to improve physical soil characteristics. Examples are irrigation and raised-field networks. Since they leave obvious remains, researchers have stressed geointensive agricultural methods in reconstructions of Maya subsistence. Such intensive methods are hypothesized due to the disparity between past high population density and present low agricultural productivity.

Intensive milpa

The intensive milpa, a highly productive swidden system, is a biointensive model of Maya agriculture. It employs techniques that allow multicropping with reduced fallow periods. Precipitation regimes restrict the use of this system to zones where few rainless months occur, such as around Poptun, Guatemala. Crop rotation and intercropping have been hypothesized as fallow-period-reducing mechanisms. Perennial species, such as manioc, planted with annuals produce cash or subsistence crops during the fallow period, materially increasing the overall productivity of the milpa. Since increased diversity and coverage insulate against pest and sheetwash problems, intensive milpa is a more stable system than the modern slash-and-burn system. The use of these techniques and the high percentage of time that the land is in cultivation suggest that the term milpa is swidden. Intensive milpas are, in a sense, intensive forms of cultivation, not to be confused with long-fallow slash-and-burn systems.

Artificial rainforest

The most ecologically efficient hypothesized biointensive agricultural system is the "quasi rainforest" that occupies much of the Maya lowland. The artificial rainforest model is an array of tree crops, vine crops, root crops and standard seed crops. The system could have resulted from selective clearing as practised by the modern Maya. The modern Peten milpero does not clear-cut the forest, but spares culturally useful species while eliminating those plants not considered valuable to him or to the society at large. Large, useful trees are considered communal property, and their harvest is accompanied by a local tax. This gives a selective advantage to useful plants, increasing their relative number in the milpa. Favored species gain light, space, and nutrients as a result of reduced root and shade competition from other large productive species and their replacement by small herbaceous cultivars. Simple care in burning protects such trees and shrubs from smoke damage. When the field is fallowed, the non-

selected plants spread again from still-living root systems and seed from surrounding forest, but suffer from competition with more established useful plants and secondary growth.
Plants that may have been used in an "artificial rainforest" include the following species:

Trees

Sapodilla	(Achras zapota)
Sapote	(Casimiroa edulis)
Chirimoya	(Annona cherimola)
Oopochi	(A. reticulata)
Zaramuya	(A. squamosa)
Ramon	(Brosimum alicastrum)
Agucate	(Persea americana)
Sabal	(Sabal sp.)
Coyol	(Acrocomia mexicana)
Cacao	(Theobroma cacao)
Vines	
Pitahaya	(Cereus sp.)
Vanilla	(Vanilla fragrans or planifolia)
Herbs	
Maize	(Zea mays)
Bean	(Phaseolus sp.)
Tomato	(Lycopersicon esculentum)
Squash	(Cucurbita spp.)
Chili	(Capsicum annuum)
Root perennials	
Yam	(Dioscorea trifida)
Sweet potato	(Ipomoea batatas)
Malanga	(Xanthosoma violaceum)
Cassava	(Manihot esculenta)
Yam bean	(Pachyrhizus tuberosus)

The woody trees, shrubs, and vines, already in equilibrium with forest pests, utilize internal defenses that make them steady, dependable sources for food and materials. Insects would still be a problem for stabilizing understorey species, which generally lack internal defense systems. Alternation of maize or other seed crops with manioc or yam (Dioscorea trifida) cultivation in the understorey would decrease changes for attack by the same pest, since their lifeforms and edible parts have different constitutions, environments and parasites. Crop rotation in the annual component in the artificial rainforest would limit incursions of species-specific pests to minor outbreaks. The problem of weed infestation could be solved by hand weeding or substitution of useful species in the "weedy" niche. This could be accomplished by companion planting of, for example, manioc and cucurbits. The cucurbits, shading out the intolerant weeds, would increase the manioc's yield of edible tissue, resulting in maximum productivity.

Arboriculture

The ramon tree (Brosimum alicastrum) has been proposed as a species used in a monocultural orchard system, as it is capable of sustaining high yield. A high correlation of ramon trees on archaeological sites has been noted. This curious distribution may be an evidence of ramon orchards that surrounded the sites when they were active, but edaphic factors such as better drainage, increased available phosphorous, or different soil type may also account for this correlation. Ramon is not the only species exhibiting this curious distribution; also guayo, aguacate, mamey, and other fruit trees as occupying archaeological sites, suggesting a more complex orchard system than ramon monoculture. Implicit in intensive models is the use of fertilizer to allow these terraced zones to be highly productive. Without mulching or fertilizing, the terraces would be little more efficient than the abundant flatlands in the central Peten. The main use of terraces is centripetal in nature, as is the drained field; that is, it increases the amount of land available for agriculture in a way that avoids limiting factors such as erosion and chemical weathering. Terraces are good evidence for almost total land use, since all arable lowland would be under cultivation before the expense of terrace construction was undertaken. Silt trap terraces may be considered localized high-productivity sites, but they are more than offset by the xeric nature of the rest of the slope (which would best be planted with drought-hardy cash crops such as Bursea, Agave, or Yucca).

Raised Fields

The most difficult system to describe is the raised field (or chinampa) system. This geointensive system is best suited to swamps and river floodplains, which constitute approximately 21% of the central Peten. Although much has appeared in print concerning its supposed efficiency, there are few data amenable to a simulation scheme, for either amount of work necessary to construct drained field systems, or their potential productivity. The figures on the support capacity of highland Mexican chinampas are almost certainly too high to be applicable to a Maya agricultural situation, owing to the sporadic nature of "bajo inundation".

15 88 - 1/15

Traditional land-use systems
Asia, India, land use, ecology, slash-and-burn agriculture, traditional weeding, weed biomass, crop mixtures, recycling resources
SWAMY, P.S. and RAMAKRISHNAN, P.S.
Ecological implications of traditional weeding and other imposed weeding regimes under slash-and-burn agriculture (jhum) in northeastern India.
Weed Research, 28, 1987, pp. 127-136

Herbaceous weeds are the predominant component of fallow regrowth after slash-and-burn agriculture. Continuous imposition of a short jhum cycle (length of the intervening fallow phase between two successive croppings on the same site) of 5 years or less tends to exaggerate the weed potential in the cropping system. Weed management regimes under slash-and-burn agriculture are, therefore, dependent upon the jhum cycle. As the perennial vegetation reestablishes with long fallow periods, weeds are suppressed to a large degree and this is reflected in the reduced weed potential

during the cropping phase. Preliminary observations suggest that weeds play a positive role, to a certain extent, in these traditional agricultural systems. The present study aims at an evaluation of the traditional weeding practices of the jhum farmer and an assessment of the effect of the residual weed population on agroecosystem functioning.
By comparing the weed management practice with total weeding and no weeding, the economic and ecological efficiency of this agroecosystem has been assessed. It is concluded that traditional weeding has little effect on the yield potential of the crop mixture compared with total weeding but it could lead to conservation of soil resources. Indeed, harvested weed biomass put back into the system is an efficient way of recycling resources under stress.
An important outcome of this study is the role of weeds under traditional weeding practices of the jhum farmer. With retention of about 20% of the weed biomass in the crop system, the loss of sediment and a labile element such as potassium loss through runoff is reduced by 20%, when compared with total weeding. Similar reductions in losses of other elements are also observed.
The results presented here on the integrated weed management concept of the jhum farmer suggest that the economic and ecological efficiency of the system is not much affected by retention of a part of the weed biomass. With the harvested weed biomass traditionally being put back into the system, even the harvested component is recycled into the agroecosystem. In fact, the residual weed population contributes to conservation of soil and nutrients. It is believed that a deeper understanding of the nonweed concept offers possibilities in terms of better weed management of temperate and tropical agroecosystems and that this needs to be further explored.

16 88 - 1/16

Traditional land-use systems
Book, review, bibliography, development, traditional agriculture
CARLIER, H.
Understanding traditional agriculture: a bibliography for development workers.
ILEIA, P.O.B. 64, 3830 AB Leusden, The Netherlands, pp. 114, Dfl. 19.50

Many believe that traditional agriculture methods were appropriate in the past but that population growth, changing aspirations and technological developments now require a completely different approach. They advocate that such systems be replaced by agriculture production relying on modern technology.
Unfortunately, the reality of small farming households is more complicated. Many farmers are unable to profit from modern science and technology due to financial constraints and differing ecological conditions.
This analysis led the Information Centre for Low External Input Agriculture (ILEIA) to publish an extensively illustrated book

entitled: `Understanding Traditional Agriculture'. It is designed to help re-orient development agencies and workers on traditional agricultural systems in the hope of providing many small farmers in the tropics with a better basis from which to develop sustainable agriculture, stressing the complementary of traditional knowledge and modern technological developments.

17 88 - 1/17

Traditional land-use systems
Asia, Malaysia, tropical upland forest ecosystems, traditional land use, shifting cultivation, improvement
HADI, Y. et al.
A systematic approach towards improving shifting cultivation in Sarawak.
Proc. Regional Workshop on Impact of Man's Activities on Tropical Upland Forest Ecosystems, Serdang, Selangor, Malaysia, 1986, pp. 519-536

Shifting cultivation has been recognized as a traditional land-use practice by the indigenous population in Sarawak. To date, about three million ha of the total state and land area has been cleared for shifting cultivation, especially in the interior upland region where hill padi forms the major crop component. It has been practised for centuries over large areas of primary and secondary forests, with serious consequences to the natural forest ecosystem. Major impacts include surface runoff, nutrient leaching, and changes in species composition and pattern of forest succession. A reforestation programme which has been carried out by the Forest Department in the fallow areas has been slow and, at the same time, left the farmers with limited area to farm. There is an urgent need to design a systematic approach towards improving the present practice where both parties can achieve the intended goals. This practice cannot be totally eliminated due to the complex nature of the social and institutional system. However, several appropriate technologies could be designed and introduced to improve the present practice. The chosen technology must be based on the present and future needs of the people involved. As such, a problem- and action-oriented approach based on Diagnostic and Design (D and D) Methodology is strongly recommended. It takes into account almost all aspects of the system in implementing the proposed technology.

18 88 - 1/18

Traditional land-use systems
Africa, Kenya, Sudan, Tanzania, review, traditional techniques, agroecology, meteorology, microclimate, project
STIGTER, K.
Traditional techniques of microclimate improvement: the TTMI Project.
ILEIA Newsletter, 3 (3), 1987, pp. 7-8

The TTMI Project was established mid-1985 on earlier experience with M.Sc. research on some traditional techniques in Tanzania. It exclusively works with co-supervision of local Ph.D. research and associated M.Sc. research at universities in developing countries. The research umbrella is formed by the traditional techniques of microclimate improvement found to need priority attention: shading, mulching, wind protection, and surface modification.

Shading: alley cropping and trees in tea growing

Alley cropping is one of the recently developed farming systems in which experience of traditional agroforestry practices has been integrated. The limits of alley cropping for semi-arid regions are presently being considered, with the support of organizations like ICRAF, which is also a consultant for the Dryland Agriculture Research Project in Machakos, Kenya. The trees in alley cropping provide shade/competition for light to the adjacent plant rows. Therefore, the alley directions are of prime importance. The contour lines at the National Dryland Field Research Station in the semiarid area of Machakos are such that the tree rows of Cassia siamea are in a north-south direction. This means that the trees, kept from 50 cm to 1 m high, cast shade `sideways' on adjacent maize rows (at a distance of 90 cm) until the maize has reached about that same height as the trees. This shading, which will occur in the relatively early morning and late afternoon for the short periods of low tropical sunlight, will influence yields if it causes differences between rows in the duration of stomatal closure. Therefore, stomatal resistances have to be quantified. Indeed, simply to determine whether competition for light should be considered as a possible explanation for yield differences observed between rows, rather complicated measurements have to be made.

Wind protection: trees, sand and mechanical damage

Traditional desert or near-desert farmers know the value of scattered trees. Where rivers such as the Nile cross deserts or oases, the value of tree belts is well known. They protect crops and other property from burying and scouring wind-borne sand. In Sudan in the northwestern part of the Gezira gravity irrigation scheme, sand started a decade ago to invade canals and fields, which then had to be taken out of production. FAO and the local Forestry Department established several kilometers of irrigated Eucalyptus in a belt from 250-500 m wide along the Sihaimab minor canal. Eucalyptus has proven to be a valuable and suitable tree in the Gezira: it keeps the sand out, and the canal has been rehabilitated. However, it is not known how the mechanism of sand transport reduction by a tree shelter belt actually works. Certainly, wind speed is reduced and the sand is visibly settled in front of the belt and between the windward tree rows, where it accumulates. But neither such a wind speed (reduction) pattern under conditions of wind-borne sand nor sand transport (reduction) and sand accumulation have been quantified anywhere near and within such a belt.

Surface modification: irrigation and labor

The final example illustrating the approach in the TTMI Project is again from the Sudan Gezira Scheme. The tenants there have, in the course of time, abandoned their traditional labor-intensive method of irrigating their field subplots, guiding the water in full attendance. They now prefer to have an unattended free flow of water, either day and night or only during part of that period. The administration of this scheme, also responsible for extension, blames the tenants for wasting costly water in this way, but there are no actual figures to show such claims to be justified. Moreover, such wastage, if any, should be compared with evaporative losses from the storage lake at Sennar, the hundreds of kilometers of main canal sand and the thousand of kilometers of minor canals and field channels. Deep percolation losses are very small in the Gezira, but surface seepage from the canals does occur.

19 88 - 1/19

Traditional land-use systems
Asia, Java, traditional agriculture, farming systems, agroforestry, shifting cultivation, integrated systems
ALTIERI, M.A.
Javanese traditional agriculture.
In: Agroecology: the scientific basis of alternative agriculture; Agroecology, 1050 San Pablo Ave., Albany, CA 94706, 1986, pp. 46-47, US$ 11.50

In Java, Indonesia, there are many traditional agricultural systems that combine crops and/or animals with tree crops or forest plants:

Talun-kebun

Talun-kebun is an indigenous Sundanese agricultural system that appears to have derived from shifting cultivation. It usually consists of three stages - kebun, kebun campuran and talun - each stage serving a different function. Kebun is the first stage and is usually planted with a mixture of annual crops. This stage has a high economic value since most of the crops are sold for cash. After two years, tree seedlings have begun to grow into the field and there is less space for annual crops. The kebun gradually evolves into a kebun-campuran, where annuals are mixed with half-grown perennials. The economic value of this stage is not as high, but it has a high biophysical value, as it promotes soil and water conservation. After the annuals have been harvested, the field is usually abandoned for 2-3 years to become dominated by perennials. This stage is known as talun, the climax stage in the talun-kebun system. The talun has both economic and biophysical values.
After clearing the forest, the land can be planted to huma (dryland rice) or sawah (wet rice paddy), depending on whether irrigation water is available. Alternatively, the land can be developed directly into kebun by planting a mixture of annual crops. In some areas kebun is developed after harvesting the huma by following the dryland rice with annual field crops. If the kebun is planted with tree crops or bamboo, it becomes kebun campuran (mixed garden) which, after several years, will be dominated by perennials and become talun (perennial crop garden). It is not uncommon to find talun-kebun composed of up to 112

species of plants. Of these plants, about 42% provide building materials and fuelwood, 18% are fruit trees, 14% are vegetables and the remainder constitute ornamentals, medicinal plants, spices and cash crops.

Pekarangan (homegarden)

The pecarangan is an integrated system of people, plants and animals with definite boundaries and a mixture of annual crops, perennial crops and animals surrounding a house. A talun-kebun is converted into a homegarden when a house is build upon it. Instead of clearing the trees of cultivated field crops as in talun-kebun, the homegarden trees are kept as a permanent source of shade for the house and the area around it, and field crops in the homegarden are planted continuously beneath the trees.
A typical homegarden has a vertical structure from year to year, though there may be some seasonal variation. The numbers of species and individuals are highest in the lowest storey and decrease at successive heights. The lowest storey (less than 1 m in height) is dominated by food plants, e.g. spices, vegetables, sweet potato, taro, Xanthosoma, chilli pepper, eggplant and languas. The next layer (1-2 m in height) is also dominated by food plants, e.g. ganyong (Canna edulis), Xanthosoma, cassava, and gembili (Dioscorea esculenta). The next storey (2-5 m) is dominated by bananas, papayas and other fruit trees. The 5-10 m layer is also dominated by fruit trees, e.g. soursop, jackfruit, pisitan (Lansium domesticum), guava, mountain apple, or other cash crops such as cloves. The top layer (10 m) is dominated by coconut trees and trees for wood production, e.g. Albizza and Parkia. The overall effect is a vertical structure similar to a natural forest, a structure that appears to optimize the utilization of space and sunlight energy.
The most common plants are cassava (Manihot esculenta) and ganyong (Canna edulis). Both of these plants have a high calorie content and are very important as rice substitutes.
There are definite patterns in groups of plants that tend to be found together. For example, wherever gadung is found in the homegarden, it is probable that patai (Parkia speciosa), kemlakian and rambutan, and possibly guava (Psidium guajava) and suweg (Amorphophalus campanulatus) will be there as well.
An important plant association consists of rambutan (Nephelium lappaceum), kelor (Moringa pterygosperma), rose (Rosa hybrida), mangkokan (Polyscias scutelaria), gadung (Dioscorea hispida) and grapefruit (Citrus grandis). Each of the plants in this association provides the farmer with something useful. Rambutan fruit is sold and eaten; rose is grown for pleasure; mangkokan is grown as an aesthetic plant and is used occasionally for hedges and hair tonic; kelor is used as a vegetable and is also believed to be a magical plant. Gadung is a food plant that can also be used as a weather indicator because the rainy season can be expected to begin a short time after its leaves start to grow. Grapefruit has a similar function, and when its fruits start to grow, the season of annual plant cultivation begins. These weather and planting-time indicators are important for deciding when to plant, and many farmers believe agricultural failures are due mainly to improper planting times.

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88 - 1/20

Traditional land-use systems
Europe, Portugal, Alentejo, field trials, land-use system, mechanization, history of development, soil productivity, traditional tillage, cropping system, cost reduction, cereals, fodder, sunflower, soil parameters
BASCH, G.
Alternativen zum traditionellen Landnutzungssystem im Alentejo, Portugal, unter besonderer Berücksichtigung der Bodenbearbeitung (Alternatives to the traditional land-use system in Alentejo, Portugal, with special reference to soil tillage).
Göttinger Beiträge zur Land- und Forstwirtschaft in den Tropen und Subtropen, 31, 1988, 188 pp.

The present paper deals with the problems of the land-use system currently applied in Alentejo which have arisen since agriculture has been mechanized. A review of the history of development of land use in southern Portugal gives the background for understanding the severe problems that agriculture in this region faces.
In field trials on two sites with different levels of soil productivity, a comparative study of the traditional tillage and cropping system, with two alternatives each, was made. The choice of alternatives aimed reducing the costs for cereal production and exploring the possibilities for improving fodder production in cereal crop rotations. For this purpose, conservation tillage methods, on the one hand, and clover and forage crops, on the other, were compared with the traditional tillage and cropping system. Supplementary investigations of soil-related parameters, herbicide use and cultivation methods for sunflower provided additional information about the possibilities and limitations of the reduced tillage methods.
The most important results are:
On average over the three experimental years, the different tillage treatments (ploughing, scarifying and direct drilling) had little effect on cereal yields and forage and pasture dry matter production. However, marked differences in cereal yields between tillage treatments could be detected for single years, weed infestation being the main factor in producing these differences.
In contrast to the sandy soil, the triple-disc direct-drilling system revealed some problems in assuring a satisfactory cereal plant stand on the heavy clay soil. Yet it was on the light-textured soil where the reduction of tillage intensity tended to produce slightly lower yields.
The triple-disc system proved not to be an appropriate direct-drilling unit for the seeding of sunflower on heavy clay soils. An adequate plant density could only be achieved with seedbed preparation. However, in a trial in which seeding was done by hand without preceding tillage operations, it was found that the direct -drilling method itself can be successful in producing sunflower on clay soils.

Early sowing of sunflower is possible and may result in a considerable yield increase. Early sowing in winter, however, is possible only on non-tilled soil. Variation in plant density proved to have little effect on sunflower yield. No differences in the yield of sunflower were observed between fertilized and non-fertilized plots.
Certain crop rotation effects could already be observed after three years of experimentation by considering the effects of the preceding crops on the following ones. To some extent, these effects varied between tillage treatments. On the more productive clay soil, it was mainly the forage crop that showed positive effects, due to the suppression of weeds, whereas on the sandy soil it was the following wheat crop, mainly after ploughing.
The regrowth of the green fallow was dependent not only on the soil tillage treatment but also on the herbicide level used on the preceding cereal crop. After one or two years of cereal production, ploughing resulted in a pronounced delay of pasture regrowth and in a reduced total dry matter production. The plant group most affected by ploughing were the legumes.
The higher the herbicide level, the lower the total dry matter production measured. The reverse was true for legume yield.
A considerable decrease in surface runoff and an even greater increase in eroded soil was observed in small erosion trials when tillage intensity was reduced.
The investigation of physical, chemical and microbiological parameters of the soil as affected by the tillage method revealed, in some cases, large differences between tillage treatments.
Reduction in soil tillage led to a marked decrease in the nitrate content of sandy soil. The reverse was observed with respect to the soil respiration rate in the top surface layer. Oxygen concentration in the atmosphere of the topsoil under water-logging conditions was found to be less under direct drilling. However, no correlation could be found between oxygen concentration and plant growth.
Small or no differences between tillage treatments were detected in the root development of wheat, bulk density, soil temperature and soil water content at the end of the vegetation period of wheat.
The results are discussed with regard to the comparison of the traditional tillage and cropping system with the chosen alternatives and in the context of results obtained in tillage studies reported by other authors. The study concludes with a comparison of the economics of the different tillage methods, indicating an increase of soil productivity if reduced cultivation or direct drilling are properly performed. Finally, prospects for changes needed in plant production in the Alentejo are given, and further research subjects, such as weed control and the suitability of other soil types for reduced cultivation, are proposed.