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Social Organization and Traditional Agroecosystems

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Social organization can be defined as the manner in which individuals or groups organize themselves in adapting to or securing the material conditions of their existence. "Each type of social organization represents a strategy for subsistence" (Moran 1979). Because of the immense variability in human social organization, there are numerous opportunities to observe the interactions of different forms of social organization with the ecological and material foundations on which societies depend. This chapter examines some of the interactions of social organization with the agroecosystems on which many traditional societies depend for a living.

SOCIAL ORGANIZATION AND THE ENVIRONMENT

Environmental Determinism

Since antiquity scientists have speculated about the influence of nature on the social world in which people live, direct causal links often being sought to explain human activities in terms of environmental factors. Climatic conditions or geophysical aspects of a region were often perceived as determinants of human social behavior. Australian aborigines and Eskimos were primitive nomads because the harsh conditions of their environments precluded their development into complex societies; a tropical climate with easy year-round access to subsistence needs fostered idleness, but the seasonal changes of the temperate regions encouraged the development of advanced industrial societies. As knowledge of various societies in diverse environments around the world expanded, it became easy to refute the broad generalities of environmental determinism. Complex societies with advanced civilizations existed in the American tropics while the natives of the temperate zone to the north remained seminomadic bands and tribes; the island dwellers of the Malay Archipelago, Polynesia, and Britain developed seafaring societies, yet the inhabitants of Tasmania built no ships.

Environmental Possibilism

Arising from the discredited environmental determinism but still persisting along similar lines was environmental possibilism. This approach viewed specific environmental factors as not determining human behavior, but rather circumscribing or limiting the possibilities. Historical and cultural factors were seen as explanations for the actual development of social organization within environmental bounds. Climatic conditions allowed Aztecs but not Eskimos to develop agriculture; geography made it possible for Polynesians to become seafarers and fishermen but prohibited Tibetans from doing so. Human societies developed out of the materials furnished by the environment, but in directions dictated by unique cultural and historical factors.

The concept that came to dominate environmental possibilism was that of culture areas. Discovering that the distribution of cultural traits of North American Indians closely paralleled floral and climatic distributions when plotted on a map, Wissler (1926) stated, ". . . we find such a consistent relation between the generalized culture areas on the one hand and environmental areas on the other, it may be that the form of the distribution [of cultural traits] is . . . in some way based upon ecological relations." Kroeber (1948) expanded on Wissler's idea in producing a map showing what he labeled as ten culture areas. For example, maize agriculture appeared to be restricted to areas with growing seasons having at least four months of rain and without killing frosts.

Possibilism opened the door to the pursuit of cultural and historical factors as explanations for social organization. The concept of culture areas was limited to gross generalizations, but it did serve to demonstrate environmental variables as limiting factors responsible for the *absence* of cultural traits. Environmental determinism states that cultural phenomena can be explained and should be largely predictable by reference to contemporary environments, whereas environmental possibilism states that only the absence of certain cultural phenomena can be predicted by the characteristics of the environment. In the possibilist view there are always alternatives and no guarantee of any particular possibility occurring.

Human Ecology

The term "human ecology" was originally associated with correlations between social variables and spatial distribution in urban regions (Park and Burgess 1921). This form of human ecology applied the biological concepts of competition, dominance, invasion, and succession to human organization and behavior in cities, concentrating on spatial arrangements of social aggregates as a result of competition.

Later there emerged a second form of human ecology, one that took the community as a subject of ecological inquiry: ". . . the form and development of which are studied with particular reference to the limiting and supporting factors of the environment" (Hawley 1950). Based on the concept of equilibrium, this approach analyzed the nature of social adjustment to the environment, drawing heavily upon the idea of homeostasis. It overlooked the dynamic and fluid nature of ecosystems, however, including the social and biophysical processes involved. Both of these forms of human ecology were different from the human ecology perspective presented in this book.

Cultural Ecology

Cultural ecology differs from earlier ecological perspectives in the social sciences by comparing societies across time and space in a search for generalizations about human behavior (Steward 1955). Comparative methods are used to test causal connections between social structure and modes of production. Thus emerged the most valuable aspect of cultural ecology; it was *diachronic*, or looked at changes in time and across societies, as opposed to earlier approaches that were *synchronic*, or concerned with the maintenance of structural equilibrium. Cultural ecology has been defined as the study of ". . . the adaptive process by which the nature of society and an unpredictable number of features of culture are affected by the basic adjustments through which man utilizes a given environment" (Tax 1953). The approach was first to analyze the relationship between a subsistence system and the environment, and then to analyze the behavior patterns associated with a given subsistence technology. The final step was to determine the extent to which behavior affected other aspects of culture.

A central postulate of cultural ecology is that a direct relationship exists between environmental resources, subsistence technology, and the behavior required to bring technology to bear upon resources. It includes the concept of successive levels of sociocultural integration in which simple, or "primitive," societies are more greatly influenced by the biophysical environment than are complex societies because "the immediate impact of environment upon behavior decreased as technological complexity improved the human capacity to modify the environment" (Moran 1979). On the evolutionary sequence from nomadic hunters and gatherers to advanced industrial societies, one is likely to find more environmentally influenced behavior in the social organization of societies at the beginning of the sequence than at the end. Most cultural ecology studies have been on simple, subsistence-oriented societies of hunters and gatherers, shifting cultivators, and rural peasants where the effect of environmental factors on human behavior and social organization is most direct and apparent.

Ecological Anthropology

Since the 1950s the bulk of environmental research in the social sciences, especially anthropology, has fallen within the scope of cultural ecology, but by the late 1960s there arose a movement to bring social research more within the realm of general ecology. Vayda and Rappaport (1968) proposed that anthropologists use the same units of analysis employed by ecologists, namely, populations, communities, and ecosystems. Not necessarily discrediting the cultural ecology approach, ecological anthropology operates at a different and somewhat broader level of analysis. The primary focus

of ecological anthropology is that of the ecosystem rather than discrete cultures. Ecological anthropology advocates multidisciplinary research:

> . . . the validation or invalidation of ecological hypotheses about human populations can perhaps be best provided through coordinated research by workers from a variety of disciplines, for example, zoology, botany, soil science, forestry, nutrition, human genetics, and medicine, in addition to anthropology and other social sciences (Vayda and Rappaport 1968).

The influence of ecological anthropology is evident in the surge of "systems" research projects in recent years, such as the Man and the Biosphere Program launched by UNESCO in 1970 to provide ". . . information and methods for better management of different types of ecosystems or human use systems" (Kartawinata et al. 1977). Farming systems research is another example of a multidisciplinary, ecological anthropology approach. Other examples include the social organization of irrigation, in which irrigation ecosystems are the unit of analysis, and studies in which forest ecosystems or agroforestry systems are the unit of analysis.

Environmental Sociology

While many anthropologists have been involved with environmental issues and research during the past three decades, the same has not happened in sociology until recently. Until the mid-1970s sociology was dominated by a view that has been labeled the "human exceptionalism paradigm," which supposed *Homo sapiens* to be a unique species exempt from ecological constraints because of exceptional characteristics such as culture, technology, language, and complex social organization (Dunlap and Catton 1979). The environmental movement of the 1970s, however, led to a new paradigm in environmental sociology that addressed interactions between society and the environment through the concept of ecological complex, a web-like interdependence among population, organization, environment, and technology. It is the perceived task of environmental sociology to determine (1) how variations in the ecological complex influence the biophysical environment, and (2) how variations in the biophysical environment influence the parts of the ecological complex. While cultural ecology is a micro-level approach and ecological anthropology is a middle-level approach, environmental sociology is generally a macro approach.

ELEMENTS OF SOCIAL ORGANIZATION AND THEIR RELATIONS TO AGROECOSYSTEMS

Land Tenure and Access to Resources

"Land tenure is . . . a system of interpersonal and intergroup relationships through which man's relationship with part of his environment is mediated" (Crocombe 1974). There are always rules, both social and jural, delimiting or otherwise affecting access to land, particularly in agrarian societies. The

degree of elaboration and enforcement of these rules varies among societies, as does the extent to which the rules are socially or jurally prescribed. In areas where land is plentiful, rules of tenure may be characterized by a great deal of social flexibility; in areas of land scarcity or intensive cultivation, rules of tenure may be highly structured and jurally institutionalized.

There is a large body of anthropological literature dealing with land tenure, some of which delves into the interrelations and interactions between human social organization and the biophysical environment. An example of this is the debate begun by Appell (1971) on the land-tenure practices of swidden cultivators on the island of Borneo. Encountering a swidden group, the Rungus Dusun, with a tenure system unlike any other on the island, Appell looked to empirical data on the quality of environmental resources for a possible explanation. Using an environmental determinist perspective, he hypothesized that high annual levels of rainfall (3,368 mm and 3,698 mm) and fertile soils led to the development of permanent individual use rights over swidden land among the Iban and Land Dayaks, while lower levels of annual rainfall (2,313 mm) and poorer soils led to the development of village communal land tenure among the Rungus Dusun. The hypothesis turned out to be false when further analysis demonstrated that all three areas had similar moisture regimes, and the subjective classification of "fertile" and "infertile" soils was not justified by actual soils data (Weinstock 1979, 1981). Nonetheless, it sparked further investigation of the potential influence of environmental factors in shaping land-tenure practices.

The word "land" in "land tenure" becomes the same as "ecosystem" when it is defined as all forms of resources both above and below the surface, including all zoological, botanical, and mineral elements therein. The usual connotation of "land tenure," however, is the right to use a given parcel of soil for agricultural purposes. Although the use of flora and fauna, mineral resources, nonagricultural land, and rights to those resources that compose the rest of the biophysical environment are an important part of human activities, rarely do scientists make the distinction between rights to cultivate the soil and rights of ownership or use of other parts of the ecosystem such as economically valuable flora. A comparison of the agricultural and social systems of Kalimantan and Papua New Guinea highlights this distinction while illustrating the fact that people in different areas may have similar agricultural systems without having equally similar social systems. The peoples of Kalimantan and Papua New Guinea have swidden agriculture in humid tropical forests, and both maintain a perceptual distinction between rights to land and rights to plants, but this distinction has led to different attitudes toward agroforestry. In Kalimantan, agroforestry is well developed due to individual use rights to land and private ownership of economically valuable flora; while in Papua New Guinea, agroforestry is poorly developed due to strongly communal land tenure that discourages private ownership of plants (Weinstock and Vergara 1985).

Population density, agricultural intensity, and land-tenure practices are often mutually associated. For example, in the highlands of New Guinea,

clan tenure usually prevails where population density is low and fallows are long, but individual tenure predominates where population density is high and fallows are less than six years (Brown and Podolefsky 1976). In general, as population density increases, so does the intensity of agricultural production, leading to greater competition for arable land, rising land values, and increasing privatization of land that was formerly a common resource.

Agricultural tenure is sometimes mediated by kinship and descent, with the rigidity of descent rules depending upon the abundance of agricultural resources. On Madagascar, where all the ethnic groups have a common origin from Indonesian traders who settled the islands some 2,000 years ago, the kinship systems today range from strict patrilineal descent among some groups to fluid bilateral descent among others. Where population density is high, competition for land is intense, agriculture is intensive, and "strict adherence to a patrilineal descent rule serves the adaptive function of excluding excess population from the local ecosystem." In contrast, patrilineal descent is not important as a means of exclusion among cattle pastoralists in areas of low population density since competition for land is not intense. Instead, kinship and descent are flexible: ". . . herds rather than land comprise the principal strategic resource (and thus) bilateral kinship calculation links geographically dispersed local groups and permits individual residence shifts on whim or when need arises" (Kottak 1971).

The degree of social stratification sometimes can be linked to agroclimatic conditions and the agricultural productivity they permit. For example, rudimentary social stratification in the form of suprafamilial authority was most highly developed on Micronesian atolls where agroclimatic conditions were favorable for surplus production (Mason 1968). The atolls in Table 8.1 are ranked from the least agriculturally productive, where suprafamilial authority deals with only the most basic concern (i.e., communal sharing), to the most productive atoll, where eight elements of suprafamilial authority are present. It appears that more elaborate social stratification is only feasible where there is sufficient surplus production to support it.

Warfare is often an expression of competition for resources. In considering ecological factors that might affect warfare, Vayda (1969) compared two swidden-based societies historically known for engaging in warfare—the Maori of New Zealand and the Iban of Sarawak. Since it was more difficult to clear primary forest for use in swidden agriculture than it was to clear previously farmed secondary forest land, the Maori and the Iban practiced intertribal warfare in hopes of capturing their neighbor's secondary forest lands. In the case of the Maori, the quest for land occurred due to population pressure, while the Iban, although not suffering from land shortages, used warfare to expand their territory in an effort to avoid population pressure upon available resources.

Population

One of the best-known theories on population and agriculture is that of Boserup (1965), which states that population growth stimulates agricultural

Table 8.1. Agricultural Productivity and Suprafamilial Authority in Micronesia

	Atoll								
	Onotoa	Kapinga	Ifaluk	Mokil	Lukunor	Ulithi	Arno		
Factors affecting agricultural productivity									
Rainfall	Very light	Light	Moderate	Moderate	Moderate	Heavy	Heavy		
Land area	Large	Moderate	Small	Small	Moderate	Moderate	Large		
Drought	Very much	Yes	No	No	No	No	No		
Typhoon	No	No	Frequent	Some	Some	Frequent	Some		
Lagoon	Moderate	Moderate	Small	Small	Moderate	Large	Large		
Elements of suprafamilial authority									
Directs communal sharing	+	+	+	+	+	+	+		
Initiates communal work	–	–	+	+	+	+	+		
Receives first fruits	–	+	–	–	+	+	+		
Accorded usual respect	–	–	–	+	+	+	+		
Restricted from working	–	–	–	–	+	+	+		
Displays rank insignia	–	–	–	–	–	+	+		
Applies force to orders	–	–	–	–	–	–	+		
Distinguished by class	–	–	–	–	–	–	+		

Source: Mason (1968).

Note: + indicates present.
– indicates absent.

development through intensification of production and the creation of new and more sophisticated technology. From digging stick and hoe to plow, primitive humans changed their tools and technology, intensifying production to accommodate an ever-increasing population. The march of technological innovation and intensification of production continues with improved crop varieties and the technologies they entail.

While acknowledging the link between the growth of population and the development of technology, Harner (1970) has pointed out the importance of resource scarcity in sociocultural structure and change. Boserup viewed agrarian change as a continuous and constant process in the development of technology caused by population growth. Viewing agrarian change as a discontinuous sequence, Harner suggested that ". . . before the innovation of domesticated food production, a society may have approximately reached its limit of population density supportable by a pre-agricultural economy . . ." The human population reached its limits before developing a new technology that raised the limits to a new level. The particular social structure of a society is the product of population pressure interacting with the ecological specifics of the situation. When new technology increases the possibilities for food production per unit area of land, competition for resources is temporarily less than previously, and the social structure changes accordingly.

Aside from changing technology, population growth can be accommodated through expansion of territory or intensification of production. Geertz (1963) covered these options in his comparison of two agroecosystems in Indonesia: swidden cultivation in the Borneo rainforest and *sawah* (wet-rice) cultivation on the island of Java. The former is extensive agriculture in an area with low population density and limited productivity potential; the latter is intensive agriculture in an area with high population density but also high agricultural productivity potential.

> Therefore, the characteristics of swidden and *sawah* as ecosystems are clear and critical: On the one hand a multicrop, highly diverse regime, a cycling of nutrients between living forms, a close-cover architecture, and a delicate equilibrium; on the other, an open field, monocrop, highly specialized regime, a heavy dependency on waterborne minerals for nutrition, a reliance on man-made waterworks, and a stable equilibrium (Geertz 1963).

With a constant level of technology and an agroecosystem of limited agricultural potential, the swidden cultivator of Borneo must rely on expansion of territory to accommodate increases in population. High population density in Java precludes this possibility, but the greater agricultural potential of a *sawah* agroecosystem provides another option, namely, agricultural involution. Here, increased numbers of cultivators are absorbed on a unit of cultivated land through intensification, but not necessarily technological advancement, of agricultural production.

This brings up another important concept, carrying capacity. Conceptualized in the work of Malthus (1798), the idea of carrying capacity developed in biology out of a concern for animal and plant populations, and it was

borrowed by cultural geographers and anthropologists. Rather than a simple person-to-land ratio, carrying capacity takes into account environmental conditions, levels of technology, and resource availability. The concept of carrying capacity states that given any set of agricultural technology in a specific agroecosystem, it is possible to calculate the maximum population that can be sustained without ecological degradation. For swidden cultivators in Brazil, Carneiro (1960) devised the formula:

$$P = \left(\frac{T}{A}\right)\left(\frac{Y}{R + Y}\right),$$

where

- P = The sustainable population of the community (i.e., carrying capacity);
- T = The total area of cultivable land that is within walking distance of the village;
- A = The area of cultivated land required to provide the average individual with the amount of food that he ordinarily derives from cultivated plants in a year;
- Y = The number of years that a plot of land continues to produce before it has to be abandoned; and
- R = The number of years an abandoned plot must lie fallow before it can be recultivated.

Allan (1949), Conklin (1959), and others have devised different formulas with different units for the computation of carrying capacity. Although these formulas are straightforward, difficulties arise from the complexity of the calculations necessary to assign numerical values to each unit of the formulas. The use of carrying capacity calculations is limited since they are synchronic rather than dischronic; i.e., they assumed technology and crop patterns to be unvarying and food consumption to remain both qualitatively and quantitatively constant (Brush 1975, Street 1969). The importance of carrying capacity studies lies in their descriptive and heuristic value; they help to discern how resource pressures are perceived and corresponding adjustments made to relieve that pressure.

Ethnicity

Group identity is an important concept for agroecosystems since it frequently plays a central role in the competition for and exploitation of natural resources. Ethnicity is central to the culture area idea of environmental possibilism. For example, certain Indian cultural groups in North America were found to inhabit only environmental-geographical zones that allowed the existence of maize-based agroecosystems (Kroeber 1939). The same approach has been less successful in delimiting culture areas of Asia, where a mosaic of ethnic groups with diverse cultures co-reside within common boundaries (Bacon 1946, Kroeber 1947).

Although studies of specific ethnic groups as isolates have provided rich ethnographic detail and in some cases valuable analysis of discrete ecological

subsystems, more rewarding results have come from analyzing the interrelationships and interdependence of ethnic groups. Rarely do individual ethnic groups live in physical and social isolation from other ethnic groups: "Thus the 'environment' of any one ethnic group is not only defined by natural conditions, but also by the presence and activities of the other ethnic groups on which it depends. Each group exploits only a section of the total environment, and leaves large parts of it open for other groups to exploit" (Barth 1956).

An ecological analysis of three ethnic groups in the Swat district of northern Pakistan used two concepts borrowed from animal ecology (Barth 1956): *niche*, the place of a group in the total environment, including its relations to resources and competitors; and *symbiosis*, the living together in intimate association or close union of two dissimilar organisms in a mutually beneficial relationship. The Pathans occupy the lower Swat River Valley where they practice double-crop grain cultivation, much of which is irrigated. The Kohistanis inhabit the upper river valley where they produce a single annual grain crop and practice seasonally migratory herding, keeping sheep, goats, cattle, and water buffalo on mountain pastures in the summer and moving them to the lowlands in the winter. The Gujars are found in the hills of both the Pathan and Kohistani areas, living as nomadic, migratory herders. Thus within the Swat Valley the residences of these ethnic groups overlap, but the agroecosystem of each group exploits a different niche of the total environment. Barth explains the symbiotic relationship of the three ethnic groups in terms of four principles:

1. The distribution of ethnic groups is controlled not by objective and fixed "natural areas" but by the distribution of the specific ecologic niches that the group, with its particular economic and political organization, is able to exploit.
2. Different ethnic groups will establish themselves in stable co-residence in an area if they exploit different ecologic niches, and especially if they can establish symbiotic economic relations.
3. If different ethnic groups exploit the same ecologic niches fully, the militarily more powerful will normally replace the weaker.
4. If different ethnic groups exploit the same ecological niches but the weaker of them is better able to utilize marginal environments, the groups may co-reside in one area.

Ritual

In the belief systems of all societies there are certain aspects that pertain to perceptions of the environment. Ritual presentation of environmental beliefs are most pronounced in agrarian societies since they maintain a high degree of direct interaction with the biophysical environment in their daily subsistence activities, but even religions of the most advanced societies retain vestiges of environmental ritual. An example in modern Christianity is Easter, when the coming of spring and the rebirth of winter-dormant

flora and fauna is celebrated with signs of fertility in the form of rabbits and chicken eggs.

By focusing on a specific aspect of ritual and belief, that of pig production by the Tsembaga of New Guinea, Rappaport (1969) explained ritual as a means for regulating environmental relations. Rising pig populations are kept in check through mass slaughter and consumption in a ritual context that is usually associated with misfortunes or emergencies such as warfare, illness, injury, or death. A correlation appears between peaks of meat consumption and times of greatest physiological stress—during times of warfare and sickness. Rappaport concluded that Tsembaga ritual, specifically the cyclical nature of pig slaughter, functions as an ecological mechanism for maintaining an undegraded environment, limiting warfare, adjusting person-to-land ratios, facilitating trade, and providing people with high-quality protein in times of need.

Ritual beliefs and agricultural practices may become so tightly intertwined that the ecological justification for certain agricultural strategies becomes subsumed in ritual explanation. When the Luangan of the Central Kalimantan rainforest make a swidden rice field, certain plants are sown along the borders of the field and along footpaths through the rice. Some of these plants, including foxtail millet *(Setaria italica)*, Job's tears *(Coix lacryma-jovi)*, and black-seeded sesame, produce an edible seed; others such as the *gerronggong* flower *(Celosia cristata)* are not edible. Their importance is not as human food but is explained by the Luangan in terms of ritual beliefs (Weinstock 1983a). These plants are the friends of rice and the rice spirit, *Luing*. The pretty stalk flower of *gerronggong* is said to appeal to the female vanity of *Luing*, and its cluster of tiny flowers is symbolic of the blood of *Luing* that became the first seeds of rice. From an agroecological perspective, there is an alternative rationale for placing these plants along the borders of swidden fields. Ripening at the same time or slightly before the rice, these plants protect the rice because they are attacked and eaten first by marauding monkeys and birds from the surrounding forest.

Traditional wet-rice farmers in Malaysia provide another example of ritual belief with an ecological explanation. When a particular farmer was asked why his rice crop suffered a severe infestation of stem borers, he replied that it was due to his failure to follow the appropriate ritual. Traditional belief held that only certain times in the lunar cycle were auspicious for planting. Agroecologically this was correct, since the stem borers infesting his crop were larvae of a nocturnal moth that mates and lays its eggs only during the full phase of the moon. Had the farmer adhered to the planting ritual, his crop would not have been at a susceptible growth stage at the time of the full moon.

Choy (1983) has documented another example of the role of ritual in traditional agriculture. Javanese homegardens provide fruits, leaves, and tubers that are used for religious rituals; and events such as cleansing of a corpse *(mayat)*, burials, wedding ceremonies, puppet performances, and Islamic holiday ceremonies (e.g., *kejaban*) often take place in homegardens. It appears

that the homegardens are not themselves the object of ritual ceremonies, however, a striking contrast to wet-rice cultivation *(sawah)*, for which there are numerous rituals to regulate cultivation activities and seek divine favor for a bountiful harvest. There are ritual feasts *(slametan)* for each major stage of rice production (Geertz 1960): preparing of the rice field, sowing rice seeds in the nursery, transplanting, grain ripening, and harvesting.

Choy believes that the explanation for this difference in the role of ritual in Javanese homegardens and rice fields may lie with the risks involved. It has generally been observed that ritual is directed toward situations over which people have the least control (Malinowski 1954, Netting 1974). With its diversified cropping dominated by perennials, risks from the homegarden as a whole are low, whereas risks due to drought, pests, or storms in a field crop monoculture like rice are relatively high. Failure of a rice crop is considered more serious than loss of a homegarden crop because inputs to rice production are more intensive and the value is perceived to be correspondingly higher. Besides, rice is the most important single food in the Javanese diet. Rituals may be appropriate for rice because it is more of a formal village activity than homegardens. Everyone uses much the same procedures for rice cultivation, and there are numerous and highly formalized social relations and obligations between households such as reciprocal labor and land tenancy relationships reinforced by ritual. In contrast, homegardens are almost exclusively a family activity characterized by considerable variability in homegarden makeup from household to household, few ties between households in the production process, and casual exchange of produce between households.

Organization of Production

The manner in which people organize their agricultural activities is tightly linked to agroecosystem structure, as can be illustrated by comparing two radically different agroecosystems in Indonesia: swidden cultivation in the Borneo rainforest and wet-rice cultivation on the island of Java. Aside from differing capacities to support human populations, these agroecosystems are characterized by different forms of social organization for agricultural production. In Borneo swidden cultivation, the primary unit of production is the household. The members of the household prepare, cultivate, and harvest an individual field. Depending upon the labor available within the household, extra agricultural labor may or may not be required. When outside labor is needed, it typically comes in the form of reciprocal labor exchanges; neighbors provide labor in exchange for return labor on their fields. In Java, the household is also the basic unit of production, but the nature of the agroecosystem of which it is a part dictates the necessity of cooperation with other households in the same irrigation system. The social organization of Javanese wet-rice production requires coordination among households for use of a common resource, water. Unlike the loosely structured general reciprocity of labor exchanges in a swidden system, the common resource base of the Javanese wet-rice system requires the formal structure

of a water-user association. Such an organization often covers an entire village and may even encompass two or three separate communities.

Since not all irrigation agroecosystems are alike, the social organization of production in one may be different from another, as illustrated by comparing irrigation agriculture in two radically different climatic environments. Geertz (1972) compared Bali, with consistently high annual rainfall averaging around 2,000 mm and a fairly constant year-round temperature, to Morocco, where annual rainfall is low, fluctuating between 350 mm and 900 mm, and there are extreme annual and diurnal variations in temperature. Irrigation in Bali is homogeneous and nearly universal; in Morocco, irrigation is heterogeneous, with scattered small systems circumscribed by oases. Balinese irrigation is characterized by strongly communal social interaction and a technologically complex approach to water control and distribution. The social organization of production in Morocco is highly individualistic, loosely adapted, and structurally flexible.

Several studies of the social organization of forest swidden production have included detailed demographic data on the composition of households, communities, and swidden labor groups (Conklin 1957, Freeman 1955, Geddes 1954). Among some of the peoples studied, communal production labor is the norm, while among others individual families work relatively independently. The common denominator indicated by all the data is that the only continually effective, corporate, social group in forest swidden agriculture is the independent household family, which is also synonymous with the swidden work group.

Forest swidden agriculture also can be a form of agroforestry, as illustrated by rattan cultivation in Kalimantan (Weinstock 1983b). After annual food crops are harvested from a swidden field, rattan seeds or seedlings are planted and allowed to grow in the secondary forest fallow. The rattan is harvested for sale or home use when the site is again to be used for food production some eight to fifteen years later. Thus, annual food crops and forest perennials are cultivated in rotation. Labor for producing swidden food crops is organized on a household basis, as is the planting of rattan in old swidden fields, but harvesting of rattan is done by teams of young men on a share basis, with harvesters and farmers sharing the yield.

Where population densities are high, land may be too scarce to allow a rotation between annuals and perennials, so integral agroforestry is practiced, where annual food crops and tree crops are grown together on the same parcel of land at the same time. This may be accomplished by planting alternate rows or strips of annuals and perennials, random planting of perennials amid a field of annuals, or planting perennials along the borders of fields containing food crop annuals (Vergara 1982). Homegardens in Java (Chapter 6) and trees in the paddy fields of Northeast Thailand (Chapter 13) are examples of integral agroforestry.

An example of social organization associated with an intensive horticultural agroecosystem is provided by lontar palm *(Borassus sondaicus)* cultivation on the Indonesian islands of Roti and Savu (Fox 1977). Both islands are

bare and eroded, with erratic and often limited precipitation. Savu received only 379 mm of rain in 1970, all of which came in fourteen days between mid-January and late February; in 1971, 1,724 mm of rain fell over sixty-nine days. Since conventional agriculture is risky under these conditions, the people of Roti and Savu depend on the lontar palm for their survival. Growing wild in superabundance across the islands, the lontar palm supplies subsistence in the form of sap tapped from the inflorescence; meals are drunk rather than eaten. The lontar also provides many other necessities of daily life. Leaves are used for house thatch and woven into baskets, mats, hats, sandals, and other items, and the trunks are used for the construction of feeding troughs and coffins. Thus social organization of subsistence production revolves around the ecology of a single botanical resource. Since sap flow from the crushed inflorescence is heaviest at the beginning of the dry season in April and May, and again toward the end of September and in October, household labor is organized so that during these peaks of production everyone works together to tap and preserve enough lontar sap to provide subsistence needs for the entire year.

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