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CULTIVATORS AND THEIR CROPS

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Virgil, in his *Georgics*, marvelled at mankind's intelligence to discover agricultural crafts and thereby have stalks grow from the earth. Modern man still marvels. Science has generated new technologies, generating in turn 'seeds of plenty' as Pearse (1980) has aptly called them. But why is it, as Pearse suggests, that these seeds of plenty carry in them the characteristics to be seeds of want?

Economists and other social scientists have analysed the effects of introducing new agricultural technology to various parts of the world. In a host of publications, both the efficiency and the equity issues associated with the new technologies have been discussed.

In this chapter we propose a sociological approach towards the study of cultivators and crops. The ideas we work with have arisen during field-work and during discussions with our colleagues from Wageningen Agricultural University and elsewhere. They have not completely matured yet, but still we feel it worthwhile to present some of them and hope they will stimulate discussion.

After an introduction in which some of the relevant literature is reviewed and the central concepts of our analysis presented, we give two case studies. On the basis of Box' work on cassava, the cultivation system of the Amerindians is discussed. Followed by a review of changes in the rice cultivation patterns of North Columbian peasant-farmers as studied by Spijkers. In conclusion, we suggest some implications for the contribution of agricultural sociologists to the development of technologies relevant for food-producing peasant cultivators.

1 INTRODUCTION

A new orientation in agricultural sociology is gradually emerging from a host of approaches and disciplines. It differs from rural sociology in that it takes "agricultural man" as its starting point and not the rural community which has been so dominant in traditional rural sociology in the U.S., strongly associated with community and adoption studies (Rogers, 1960), in Europe with urbanization and industrialization and in the USSR with class and stratification (Cox, 1979:85).

Mendras notes a change in rural sociology and relates it to the development of adjacent disciplines (Mendras, 1976:218), particularly with the changes in ethnology, which have become more and more oriented to the study of peasants in the context of the modern market and state structures. The dividing line, so carefully drawn in the 19th century, appears to vanish in some respects.

The influence of ethnology, or of economic anthropology in particular, is real and has provided a fertile orientation.

Within sociology, differences are stressed between "rural" and "agricultural" sociology. For Planck and Ziche (1979: 11-12), agricultural sociology is the subdiscipline which takes as its object the social phenomena in the realm of agriculture, the social organization of agriculture and of its relations to other sectors of economy and society. They conclude that agricultural sociology has been rather limited in its problem orientation and highly concerned about applicability. Like Redcliff (1975:22-33) and Benvenuti, Galjart and Newby (1975:3-21) they stress the need for greater theoretical depth, instead of reporting more and more facts with an ever decreasing degree of generality. Saint and Coward attempted to do this by reviewing first the dominant paradigm in the sixties with regard to agricultural development in sociology and other behavioural sciences. They criticize the diffusion model, as it has been used in an extremely reduced and narrow way, and compare it to an "emerging orientation" which stresses that "technology and social organization are viewed as variables that exist in an interactive relationship" (Saint and Coward: 1977:734). They view agricultural technology in a long-term perspective and stress the need to view technology in terms of the associated agricultural systems. Traditional technology needs to be studied in terms of social and economic constraints in the respective types of agriculture. Modern technologies also need to be studied as the outcome of research processes which in themselves should be the object of inquiry. Except for the last two addenda this has of course been the traditional anthropological view, especially from those who started from a

materialistic-evolutionistic viewpoint. Vessuri (1980:315), who basically arrives at the same conclusions as Coward and Saint, points out that "neo-evolutionists" like Childe, Steward, White, Ribeiro, Sahlins and others "indicate a continuing interest in these topics, with new theoretical questions being asked about old problems". Like Vessuri and McC.Netting, Saint and Coward emphasize the need for regarding natural and social processes as being intertwined, and note the link between environment, crop, producer and the crop-producing community (idem 735). McC.Netting, whose literature review covers nearly three hundred studies, many of which are empirical case studies, concludes that the processes of agricultural change cannot refer solely to technological innovation, recognizing at the same time that the "systematic relationships are fascinatingly clear" (McC.Netting, 1974:24).

The theme is elaborated by Saint in The Social Organization of Crop Production: Cassava, Tobacco and Citrus in Bahia, Brazil (1977). Since this is one of the more recent studies which analyses agricultural communities in terms of dominant cropping patterns, we will review the argument briefly. Another recent "crop sociological" study, which traces the structure and social organization of a peasant community through the "entrance" of a crop is: Hanks, Rice and Man, 1972. His argument is an elaboration of Boserup's thesis on the demographic changes causing intensification of the agricultural system, by studying the history of a small Thai community moving through stages of more intensified rice production.

Saint's general thesis is that "an understanding of organizational and institutional factors inherent in crop production systems is necessary in order to develop agro-technologies which will not increase inequality" (Saint 1977:310). Taking technology as a social product, and assuming that the farmers choice of crops is a "major technological decision", Saint suggests an analysis of peasant farming systems in terms of the social organization of crop production. He then proceeds to build a theoretical model, derived from Marx' notion on the mode of production, which he translates in terms of crop production systems (idem 19). A crop production system is defined in terms of the dominant crop, such as cassava, tobacco or citrus.

On the basis of survey data and in-depth interviews, Saint shows that there are considerable differences between the three systems in one municipality in north-eastern Brazil.

Labour requirements were quite different, and so were the types of technology applied, the social relations of production and exchange, position in social stratification and relevant government policies with regard to

the respective crops (idem 311-314). Saint associates these differences with life-quality differences among various types of producers and notes a high measure of correlation. In addition, he shows how cropping decisions are affected by family life cycles, and in turn affect migration patterns. He concludes that "switches in the predominant crop (....) occur as adaptive responses to emigration patterns arising from stagnation factors and (are) related to stages of family life cycle" (idem 291).

Saint concludes by indicating emerging transformations in the agricultural system he studied. He notes changes in the traditional mode of production, with tenant farmers being subsituted by wage workers, patronage relations by piecework contracts.

What is new in this approach? In our view it is the attempt to link the characteristics of particular crop production processes to ecological and social factors such as equity (see Box 1980a). Cultural ecologists and ecological anthropologists have argued largely along the same lines, but have not taken the argument as far as Saint and Coward do. Geertz for example also shows the relation between equity, ecology and cropping production systems but stresses adaptive responses, as Saint (1977:6) notes. In the following model (part 2) and in the case studies (parts 3 and 4), we try to extend Saint's approach and analysis. The historical relations between technology and social organization of particular crop production systems are analysed. We introduce the notion of genetic management of crops, and show how different stages in crop cultivation need to be distinguished based on anthropological and archeological data.

We also extend the model into the agricultural research process itself and ask ourselves what the value of a sociology of crop cultivation could be in the generation of technologies which are relevant to the problems of peasant farmers (cf. Van Dusseldorp, 1977).

2 CULTURE, CULTIVATORS AND THEIR CROPS

Geographers and ethnographers have long since drawn out attention towards the extremely complex and highly varied agriculture of the tropical food cultivator (Sauer, Gourou, de Schlippe among many others). Some of these authors have also indicated the more or less systematic relationships which they found to exist between the technological aspects of a given agricultural complex or system, and the social and cultural forms or structures based on this agriculture. Cultural ecology, as proposed and elaborated by Steward, has offered in this respect the most explicit and most refined theoretical orientation in the social sciences, by advancing a specific frame of reference for the analysis of these relationships (Steward, 1955:87-92). A major criticism ventured by Sahlins (1976) of cultural ecology and ecological anthropology in general rightly reproaches a too close embrace of these theories with biological environmentalism and nineteenth century possibilism.

However, by leaning heavily on the "cultural" concept, Sahlins himself does not entirely escape from the dangers of denying one of the main motivational forces of any cultural system or subsystem, viz. adaptation. We propose to study crops, cropping systems, domesticates, agricultural techniques and technologies, agricultural knowledge and practices as being basic elements of a cultural system. Furthermore, we suggest that these are very specific, theoretically distinguishable elements within the cultural system.

This approach will allow us to take a broad historical view on agriculture as a social process, help to formulate new hypotheses about the onset of agriculture and about the gradual and sudden qualitative changes within agriculture during its various stages; it may also provide us with a basis for future contributions of sociology and cultural anthropology towards the development programmes of innovation in agricultural research.

By providing an analytical framework on the relations between man and characteristics of crops we will argue that plant domesticates, as a specific historical form of "cultural artefacts" have structuring effects on the social and economic contexts of primitive, peasant and modern agriculture and, conversely, that such contexts determine the choices for the primitive or modern crop cultivator. Thus we can compare the prehistoric swamp dweller who gathered the sparse grains from plants grown on his nearby refuse heap where seeds were occasionally discarded, with the twentieth century farmer who skillfully masters his hundred hectare track with aerial sowing techniques and combined harvesting.

Both have to organize their lives somehow around the crop they produce, both have to resolve the major problem of distributing their resources of time, labour, capital, knowledge, etc. with regard to acquiring the seed, getting it into the ground, nursing the crop, harvesting it and deciding what use to make of it. Both are dependent on the best planting season, on the duration of the cropping cycle, on plant productivity, on the ease of harvesting, on the fierceness of competition with surrounding weeds and other characteristics of the crop. In other words, what they have in common is the crop, where they differ is in the ways in which they solve their problems.

Crops are elements of cultural systems, which in a specific way cause structural influences on the other elements of the system. Crop domestication has to be seen in our view as a marginal historical case. It can be compared with the invention of writing or the introduction of pottery (Levi-Strauss, 1961:28ff), but not with other main elements of culture like art, kinship and religion, which are less of an "artefact" nature and are, moreover, not cumulative in performance. Our characterization of agriculture comes closest to the type of reasoning put forward by Leslie White in his idea of energy-harnessing capacities at different stages of human civilization, but differs from it in its deterministic Tylorian approach.

"Agriculture is merely the name we give to various ways of increasing man's control over the lives of plants. And the significant thing about this increase in control is that it may increase the amount of food produced per unit of human labour" (White, 1959:285).

In the first place, we start with a rather functionalist perspective in studying crops: that is, we ask ourselves the question to which "needs" the cultivation of crops responds to. These needs are located in the economic sphere (food, construction materials, clothing) but also outside it: health care, religious and aesthetic needs are met through the products or by-products, provided by the cultivation of crops. We also mention that in many cases one crop meets several needs. We also note that the several crops which make up the total agricultural system maintain certain functional relations.

This can be observed in the agricultural cycle; during the agricultural year the various crops are arranged to fit into one coherent complex with regard to growing cycle duration, labour needs and product availability in such a way that the total outcome can be perceived as one well-balanced strategy of social and economic optimalization.

Typically, the traditional food cultivator produces more than one crop, and furthermore he will have a particular crop represented by more than

one variety or strain. This makes it possible for the cultivator to spread his labour in a way which corresponds with his situation. "Situation" has to be conceived here rather broadly: it comprises both external factors of a physical and socio-political nature, as well as internal factors like habits, beliefs and culturally defined minima to be met. In other words, agriculture is seen here essentially as an adaptive process.

Cultivators

Centrally in our model, figures the cultivator. Cultivation is seen as the production and reproduction of living matter for the satisfaction of social needs. The living matter produced is called a crop.

As Harlan (1975:63) has pointed out, anything that can be harvested could be called a crop, varying from a rice crop to a crop of calves. We restrict our definition of crops and refer to the particular varieties of plants which are made useful to man, who closely controls their production and reproduction. This control is reflected in the process of domestication, or the historical sequence of events resulting in the adaptation of wild plants (or animals) to a man-made environment. Domestication of species therefore implies an ever-increasing human control over production and reproduction and, thereby, an ever-increasing dependence of the variety on human intervention in the environment (see Zeven, 1977:6; Bray in Megaw 1977:232).

Sauer has constructed a useful classification for ordering cultivates to their degree of "domesticatedness".

"Cultivated plants may be classed under four groups, though the knowledge is inadequate at present to allocate many, if not most, of the plants under cultivation: (1) the unmodified wild species which is planted for convenience of harvesting or for increase of producing units, or which may be allowed to increase by protecting a wild stand. The number of such plants is almost indefinitely large, especially among woody species. Here, man serves only to enlarge the local population of the given species or to extend its range by carrying it to settlements and clearings where it did not grow originally. (2) Domestication takes place when, in addition to the care and planting of the wild species, local improvement races are created. These may replace the unmodified wild form in certain areas, but not in others. Here, man definitely appears as an agent of selection. (3) Full domestication is achieved when the wild form, though still existent, is discarded for purposes of cultivation, and only improved mutants or hybrids are grown. (4) Finally, there are the cultigens of which the wild ancestors are lost, and which

in most cases depend on the care of man for their continued existence. In numerous cases these have lost the capacity to produce seeds or are otherwise unable to maintain themselves" (Sauer in Steward, 1955:488). We call selection the process in which the cultivator is continuously looking for and choosing the "best" sample from a crop population for reproduction purposes. The mechanisms which govern these social processes are, as yet, not well understood. The apparent or inapparent motives vary widely and include, among many others, food yield, ease of storage, beauty, taste, shattering avoidance, and good luck (Harlan, 1975: 126-127).

We also introduce the notion of "genetic management of crops", which is of a more general level than selection and domestication. It includes all conscious and unconscious human activities which cause certain distributions of crops and genetic distributions within crops over geographical areas (fields, villages, regions, continents). Genetic management implies that cultivates become increasingly dependent on human care and pampering. At the same time, this implies another dependency, vice versa: man becomes dependent on crops. Man has become more and more dependent on the very results of mastering nature. This is a crucial observation when studying the cultural and social meaning of crops.

If, in the course of the Neolithic Revolution for instance only perennial crops had been "chosen" for domestication, we might speculate that settlement patterns would have been quite different; urban formations might have been established much more rapidly (cf. Sauer, 1955:17-18). Another speculative question might be added on the differential consequences of heliophilic and heliotropic plants. Would the fact that most of our crop plants are heliophilic (Sauer, 1969:17-18), have been decisive in any degree for early village formations? One could argue that the need for open clearings, required for heliophilic plants, would necessitate larger work groups, as opposed to the situation of planting small patches of land among shade-providing woodlands, which furthermore offered additional opportunities for hunting.

And if, in modern times, particular varieties are generated which imply a certain level of human intervention, interdependence becomes even more evident. Lathrap formulated this quite sharply by saying that this mutual dependency is "nowhere more obvious than in Central Illinois today where the farmer is in bondage to the insatiable appetite and immense vulnerability of his monstrous hybrid corn" (Lathrap, 1977:715). It is certain that early agricultural man, by his options for the new food acquisi-

tion systems, was forced into tighter cycles of labour, with more exigent, and stricter, labour organization patterns.

He also had to develop new cognitive systems for the interpretation of nature: when to plant, when to harvest, how to proceed in cases of crop failures, how to avoid pests, how to improve his crops, how to select the best seeds for the next cropping season, how to process his products, and how, in more general terms, to adjust his newly obtained knowledge into his belief systems regarding religion, solidarity and conflict management with his fellow men.

We may conclude that historical choice processes exist on two different levels. The first level includes the choice of domestication of particular plants.

"Of the 200.000 or more species of flowering plants known, only 3.000 or so have been used to any extent by man for food, and of these about 200 have become more or less domesticated, of which only 12 or 13 are of major importance" (Heiser, 1973:67).

From a range of some hundreds of thousand of plants, neolithic man only domesticated a few hundred, limiting his scope of action in one way or another by the "permitted" width of those artefacts.

Braudel once put it this way:

"Wheat, rice and corn represent three definite choices made very long ago. The predominance of one grain in a civilization is the result of a countless succession of experiments that, as a result of 'drifts' over a period of many centuries, gradually eliminated all other alternatives" (Braudel, 1977:12).

The other level of decisions we find in the refinements, adjustments and other changes within the domesticated species or cultigens, as realized by the cultivator's intervention. These decisions are also of an historical order, in the sense that they are taken only once and possibly never again.

During this process of refinement and change of crops by human action, the whole of society was adjusting itself, and had to adjust itself, through the continuous creation of institutions through which the new needs, also shaped by the characteristics and properties of the new crops and cultivation system could be met.

At this point, it seems appropriate to clarify the nature of the "causality" suggested here. Of course it would be an exaggeration to suppose that a particular property of a crop "determines" a social phenomenon in an exclusive way. We prefer to use the term "to structure" which refers to the contribution in the shaping or forming of social order. Also, as already mentioned, the process is essentially a two-way affair. For analytical reasons it may be worthwhile to separate the two directions of "causation". This may be illustrated by a case described by Kelly

concerning the maize-growing Totonac Indians in Vera Cruz, Mexico.

Totonac cultivators have a particular variety of corn which they have grown for hundreds of years. During investigations into why the Totonac had not changed from these traditional varieties to the improved, higher yielding maize it became clear that these varieties lacked the big, ear-enveloping leaves which their own maize has. These leaves were (and are) locally used as a packing device, and apparently so central or so important to Totonac culture that no new variety with small ear leaves could replace them (Kelly, 1952).

It is a chicken-or-egg problem, whether the leaves were selected for packing purposes felt as a need in the Totonac economy, or, vice versa, that large leaves were later discovered to be especially suitable for wrapping. Whatever the case, the implication for agricultural researchers who want to improve maize yields among Totonac cultivators is to take account of local cultural needs (if they do not want to advise sending a truckload of plastic bags together with the improved maize seeds).

On the most general level we propose that choices in domestication and selection of crops are among the main structuring activities for human society. We also propose that the choices necessarily imply limitations in other future activities. Domestication of predominantly annual food crops may imply the non-domestication of perennials. Selection by Amerindian cultivators for starch content of cassava roots may imply the non-selection for dry-matter leaf content. Modern rice breeding which looks for a small, high nitrogen-absorbing rice plant which can be planted in higher densities per area unit, implies the non-selection for ease of manual harvesting (Barnett, 1969:287). But also, more importantly, as we will discuss below, it brings into existence new, formerly unknown dependencies with ramifications of direct concern to the cultivator in his immediate surroundings as well as to global food and input markets far beyond his imagination and control.

In order to get a more comprehensive grip on the process of increasing dependencies of man and crops and how the process may be related to social institutionalization and social articulation we present, as a hypothesis, a historical framework in which the concept of "genetic management of crops" is related to the socio-political organization of agrarian societies.

It is acknowledged that the term has some ambiguity. Domestication is very difficult to place in our historical calendar. It might well be the case, as proposed by Lathrap and others that the process of domestication has covered a period of more than 40.000 years, which may throw what hap-

Fig. 1 Levels¹ of genetic management of cultivates associated with social order characteristics.

Levels	Characteristic of cultivation pattern	Characteristic of social order
Minimal	Collection of wild species	Tribal orders of hunters and gatherers
Incipient	Elementary intervention in reproduction leading to domestication 2)	Tribal orders based on settled agricultural populations with a rel. low division of labour
Advanced	Advanced intervention in reproduction reflected in availability of varieties domesticated elsewhere	Social orders with increasing division of labour, resulting in specific agricultural population
Maximizing	Complete intervention in reproduction, reflected in varieties purposely adapted to specific technological requirements	Complex social orders integrated in modern world system, depending on science for the generation of technologies and with a high division of labour, also within an agricultural population.

- 1) Levels do not necessarily correspond to historical epochs and do not imply a unilinear development. Genetic management may decline in particular periods in given areas and follow a circular course.
- 2) Domestication is used here in the conventional sense (Sauer, 1952, Heiser, 1973).

pened afterwards, in the period after Neolithic Man, somewhat offbalance. But, on the other hand, virtually all the data at our disposal are post-neolithic. Some arguments in favour of the view that domestication is still around (late domesticates, modern plant breeding) also weaken the concept. Others (e.g. Evans, 1980) point out that domestication should be seen as a "reluctant evolution", rather than a unique event. Sociologically speaking however, we hold that with domestication a new decisive stage was reached, and as such was "unique".

The model leaves aside questions regarding the (multiple) origins of agriculture versus the one centre theories (Heiser, 1973) but is primarily concerned with the relations between cultivation patterns and social orders. The first historical movement discernable through the stages of crop management consisted of a gradual proliferation of crops and crop varieties, together with diffusion movements of crops and cropping systems from their centres of origin through varying geographical locations. A subsequent movement could be characterized as role reduction of the cultivator: where during the preliminary stages of agriculture all functions pertaining to the agricultural process were exercised by the same

cultivator, these functions became so specialized, that later on distinct institutions had to be created to respond to new needs. (The most decisive one was of course arrangements of markets, when peasant agriculture had to respond to urban food demands, and the choice of which crops to grow was heavily influenced by outside forces).

The first historical movement, expressing crop proliferation, would be expected to concern only a few crops at the beginning phase of agriculture. During the tribal society "phase" the number of crops would slowly increase, proliferate widely at the so-called paleotechnic level (Wolf, 1966), gain impetus by global diffusion processes of food and other crops, become slowly reduced during the next stage, and really become constricted with the emergence of western, highly mechanized agriculture. Furthermore, with the internationalization of agricultural research, a new contribution to this constrictional movement was realized. It should be added that this was accompanied by a contrary movement (at least the creation of a potentially contrary movement), namely the installation of massive storage and study of "old" genetic materials in gene banks.

We must of course distinguish between the number of varieties within given crop species and between the crop species themselves. Our hypothesis holds that both have parallel movements during the mentioned evolutionary periods, especially during the first stages. Once the pattern was "set", the proliferation of crop species into thousands of locally adapted cultivators could start.

We have thus set the stage for the analysis of two cases: one on cassava cultivation and domestication among Amerindians, and one on changes in rice cultivation among peasant cultivators in Colombia. Cassava cultivation is studied in terms of phases II and III of genetic management as depicted in Figure 1. The analysis of rice cultivation in Colombia starts in the 'Historical' phase, with domesticates being imported from elsewhere. The analysis continues with the implications of modern technological divisions of labour for rice cultivation in the area, and for the social orders in the respective communities.

3 CULTIVATION OF THE BITTER CASSAVA BY THE AMERINDIANS

Introduction

Cassava (Manihot esculenta Cr.) is a tropical root-crop, growing under a wide variety of ecological conditions and with a number of characteristics which make it a particularly popular crop among peasants. It can be grown on poor soils, resists extended periods of drought, and can be kept on the land after maturation. This means that peasant-farmers, cultivating poor plots with uncertain rainfall and considerable market uncertainties can grow cassava as a risk-aversion crop.

It is also an efficient carbohydrate producer. De Vries, Ferwerda and Flach demonstrated in 1967 that cassava produces more starch per hectare, more than many other tropical crops. Its food value is, however, limited to carbohydrates. It is low in protein, low in particular vitamins and also low in minerals. Therefore, when used as a staple, it has to be supplemented with other food.

In the tropics, some 200 million people get most of their calories from cassava. This is a very rough estimate since fairly little is known about actual human consumption of cassava and its various derivatives. It has been estimated, however, that future human consumption will increase, particularly in Africa, where forty per cent of the total calory intake is provided by cassava. In South America, on an aggregate basis about twelve per cent of total calory intake comes from cassava.

One of the interesting characteristics of the crop is the fact that it is a typical peasant crop. Although large-scale capital-intensive cultivation has occurred in the former British, Dutch and French Colonies, no radical innovations have been introduced in cultivation patterns. This has not occurred over the past twenty years, during which time considerable changes in other crops have taken place; rice cultivation in northern Columbia for example.

In fact CIAT, the major centre of cassava research in the world, has not delivered new cassava varieties, or relevant agricultural practices which have been adopted on anything like the scale found in rice cultivation. The curious phenomenon is that cassava is being cultivated in Latin America in more or less the same way as it was when Columbus first set foot on Hispaniola. Vasquez de Espinoza (1948) noted:

The common or main type of bread which is eaten there is 'cazaba', made of a root called cassava (yuca) which is like a Galicean

turnip. To make this bread or cazaba they grate the cassava and extract the sap which is deadly poisonous, but once cooked it is the principal sustenance of the Indians.

Of course changes have occurred since then: insecticides are used, land preparation is mechanized in certain cases, and under certain conditions fertilizers are being applied. But on the whole cassava cultivation is at the paleotechnic level, as Wolf calls it. That is, cultivation relies on human and animal energy and not on machines; traditional knowledge outweighs special bodies of "scientific" knowledge (Wolf, 1966: 19-20; 35-36).

This may be even stronger in the case of bitter cassava cultivation, such as Vasquez de Espinoza described, than for sweet cassava cultivation. Since this system has not been studied very extensively, and since it is still of importance in countries like Colombia, the Dominican Republic and Brazil, it might be worthwhile to pay some attention to it. In fact three types of cultivation systems can be distinguished:

- the traditional, as described below for the Amerindians.
- the Peasant type, on which some research has been done in Colombia (Diaz & Andersen, 1977; Doorman, 1978).
- The modern type, employing available technology developed in (inter) national research institutions. (For comments on cassava research and development, from a sociological perspective, see Box, 1980b).

In each type of cultivation system, different characteristics of the crop may be singled out for selection. In the traditional cultivation system around the Amazon, selections were made resulting in varieties which could be processed into cazabe, as will be discussed below. In peasant agriculture constrained by land-shortage, as in the Dominican Republic, varieties are selected for example for their capacity to grow on depleted soils. And, in the national and international research centres, other characteristics are fostered to support a modern type of cassava cultivation system; characteristics like high yield per ha, disease resistance or ease of (mechanized) harvesting.

One reminder. The following is not an argument for a return to Amerindian modes of cassava cultivation. It is intended more as a contribution to the social history of a crop, showing the particular interrelations between social context and crop characteristics.

Amerindian cultivation of cassava¹

It is rather the exception than the rule that a widely dispersed food crop can be studied in the ecological and socio-economic contexts in which it was cultivated for thousands of years. Contemporary cultivation practices among Amerindians are not very different from the ones Columbus found when he first saw cassava in Hispanolia. And contemporary peasant cultivation systems in South America show a great deal of similarity with Amerindian production and processing practices.

The differences between contemporary cultivars, and the ones grown 500 or even 5000 years ago, are likely to be much smaller than in the case of maize (see Mangelsdorf et al., 1971:484-485), or wheat (Jarman, 1972). In this respect, cassava may be more like taro, sago and indigenous Andean potatoes; all starch-producing crops which have not become part and parcel of western diets, and which have not been the object of large scale research and development programmes.

Amerindian agricultural practices have been studied in great detail over the past half century, by anthropologists and others. Fairly accurate reports are available from early travellers, missionaries, etc. From this, a general picture can be drawn of the social organization of cassava production and reproduction among South American Indians, the differences between groups and the changes which may have occurred.

Early cultivation and domestication

What do we know about the earliest cassava cultivators? Very little. Unlike the pre-domesticates of maize found by Mangelsdorf and his colleagues, no cassava pre-domesticates have been located. Pollen analysis cannot be done since cassava was and is reproduced vegetatively, and plants are generally harvested before they flower. Few cultural artefacts remain which can give archeologists an adequate idea of how, and when, earliest cultivation took place. Graters have been located at various sites (Lathrap, 1973:175) and so have oven plates or burenes which could have been used for baking casabes or unleavened round cassava bread. But were these exclusively used for processing cassava?

¹ This selection is based on research done by Barbara Lasocki-de la Rive Box to be published as Man and Manihot: anthropological literature review of cassava cultivation among Amerindians (Wageningen, Agricultural University, Department of Rural Sociology of the tropics and subtropics, 1981).

Renvoize (1972:354) has argued that the oven plates cannot be considered sufficient evidence for cassava cultivation, since very similar plates were used to bake maize-breads in the respective areas.

There is no answer, therefore, to the question of who domesticated cassava where and when. Spath (1973:62) concludes from his own data and the available literature that the type of intensification in cultivation we usually associate with domestication took place in four areas, and possibly at different times. He suggests as likely primary hearts of domestication: the Guatemala-southern Mexico region, the coastal savannas of north-western South America, eastern Bolivia and north-western Brazil, and another in eastern Brazil. In other words: not in the Amazon region, but rather to the north, the south-west and the south-east of it.

Renvoize in her review of the literature, comes with a different distinction, based on bitter versus sweet cassava (to which we return below). She follows the ideas of Mangelsdorf and his associates who suggested that each "had a separate and local history of cultivation".

She argues that:

"sweet manioc was first domesticated in Mesoamerica as one item in an assemblage of vegetatively propagated crops (). When only the sweet varieties occur, they characteristically form part of a crop complex dominated by maize (). Bitter manioc, on the other hand, is likely to have first come under cultivation in northern South America (Renvoize, 1972:358-359).

Renvoize incorporates a wider variety of data than Spath as to the original loci of cassava domestication, including the work in Central America. Considering the available literature it seems plausible, however, to select two major hearts of cassava domestication, one in central America for sweet varieties forming part of a cultivation system including maize; another in South America savanna regions associated with a cultivation system in which bitter cassava was the dominant crop (cf. Schwering, 1970:26-27).

As to the time of domestication, no one answer can be provided here either. Spath (1973:63) suggests that the "actual domestication of manioc in a number of localities can be conservatively placed in the 8000-6000 BC range, though intensive agriculture systems do not appear until about 3000 BC". But what is meant by cassava domestication? It refers to the way of reproduction: it is only when vegetative reproduction takes place, through cuttings with several nodes, that plant and tubers emerge. Plants grown from seed do not produce tubers, but form a tap root (Spath, 1973:53, Rogers, 1973:14). Domestication, in this case, therefore, primarily means the selection of cultivars which, under vegetative reproduction, will produce the desired tubers.

The species is not known in a purely wild state (Rogers & Appan, 1973: 29), and has a "weedy" character (Spath, 1973:54). Frequent hybridization of cultivars with local wild cultivars occurs (Rogers & Appan, 1973:8) leading to a great variety of material to select from, which is well adapted to local conditions.

Cassava domestication therefore has different characteristics than domestication of other food plants such as cereals. It is intimately tied up with vegetative reproduction of a weedy plant; moreover, the species has not lost its capacity to disperse seed, a characteristic closely associated with cereal domestication. Whether we may speak of domestication is in fact a question in itself; intensification of its cultivation can be noted, strongly associated with the emergence of countless "wild" hybrids forming an unintended consequence of cultivation which may be used in their turn for the selection of prospective cultivars. Man uses nature as a vast hybridization experiment, from which he draws his valuable cultivars.

Contemporary Amerindian cultivators of bitter and sweet varieties

Even though we only knew very little about the botanic and social ancestry of cassava domestication, we know quite a lot about the offspring. The species has been the subject of extensive botanical research (see Rogers and Appan, op.cit.). The cultivators have been the subject of a plethora of professional and amateur anthropological investigations. A few studies have dealt explicitly with cassava cultivation among Amerindians in historical times, such as Saake's Der Maniok bei den Urwaldstämmen Südamerikas (1950/1943); Schwerin's The bitter and the sweet; some implication of techniques for preparing manioc (1971) and Spath's The toxicity of manioc as a factor in the settlement patterns of low-land South America (1971) and Renvoize's Manioc (*Manihot esculenta* crantz) and its role in the Amerindian agriculture of Tropical America (1970).

These studies are based on a host of other studies on Amerindians, none of which was aimed at studying the crop as such, but rather its cultivators. Schwerin's very useful survey has a suggestive title: the bitter and the sweet. Indeed, much of the discussion on South American cassava cultivation has dealt with this distinction. Although plant scientists have discarded the distinction, anthropologists continue to be faced with the fact that among Amerindians and South American peasants, the distinction between sweet and bitter varieties is made and is associated with different cultivation systems. For the biological side, Bolhuis (1954)

concludes that "expert views are sufficiently in agreement to justify abolishing altogether the conceptions of "sweet" and "bitter" cassava, and classifying the varieties exclusively according to their degree of toxicity (184). Rogers and Appan (1973:32-33) take the middle position and note that in local names the bitter and sweet distinction is used and that "these names (or some equivalent sound) seem to have been in use by natives in the Western Hemisphere tropics(33)". Bitter refers to those cultivars considered poisonous in a given habitat. Toxicity, however, varies strongly not only with cultivar, but also with type of soil, climate, harvesting date. On top of this, variations occur among the tubers of one plant. In other words: a relatively non-toxic cultivar, called sweet in one place, may turn out to contain a lethal dose of HCN (prussic acid) in another.

One of the key questions one might ask with regard to Amerindian cassava cultivation is: why did they cultivate toxic varieties at all? Why is it, that in the face of both sweet and bitter cultivars, they did not turn ostensibly to the sweet one, being less risky and requiring less labour? The answer has been given many times, but no definitive study appears to have been made (see also Spath, 1971). Lathrap (1973:174) suggests that the "cultural significance of bitter manioc lies in its higher starch content and in its crystalline structure of the starch. It is simply a better basis for bread and flour production". Since he does not document the statement, it is hard to check the sources. On the starch production, no definitive data exist: under certain conditions relatively toxic varieties do have a higher starch content, under others they do not. No confirmation could be found for the relation between crystalline structure and HCN content.²

Other factors which have been mentioned are the greater resistance of toxic varieties to pests, and their capacity to grow on poor, sandy soils.³

Be that as it may, the fact remains that bitter cultivars are commonly associated with their better starch for special purposes (such as casabe or cassava-bread making). Sweet varieties are grown for use as a vege-

2 Current research by L. Box among (bitter) cassava cultivators in the Dominican Republic indicates that "sweet" tubers can and have been used for bread production. Taste differences are minor, but perceptible; bread strength appears to be somewhat weaker in the case of "sweet" cassava, which may be related to the relatively high water-starch relation in the tubers used. (Field notes L. Box).

3 Based on field interviews with bitter cassava cultivars in the Sierra region, Dominican Republic (Field notes, L. Box, 1979).

table and are eaten in stews, or boiled.⁴ Given the importance of bitter-cassava products, these cultivars appear to have been the favourites of many Amerindian communities: the advantage of these products being their storage quality, and the associated value in trade or as a means of exchange as such.

Production and reproduction of bitter cassava among Amerindians

In the Amazon basin, cultivation of bitter varieties is dominant. Saake (1950:2) notes that the bitter type is the only cultivated plant "which really affects economic and social relations in this area". The following description is based on Saake's account.

Location of planting is determined by soil fertility, soil humidity and settlement proximity. Time of planting is determined by the dry season, allowing the burning of the essential wood-lots. Clearing of trees and shrubs was done with stone axes and machetes made of hardened wood and more recently with metal implements. The heaviest work in this respect, done by men, is the felling of trees which could take as much as two months per tree. After leaving the cut wood to dry for some time, it is set on fire. Large trunks are left on the land after burning to provide some soil cover and prevent excessive drying of the soil. They also shelter the young plants against the wind and may serve as pathways through the fields. Planting is done in the ashes, since they are known to have fertile qualities.

Stakes are generally planted pell-mell after loosening the soil, which is not otherwise worked, making holes with digging or planting sticks. Some Amerindian communities make small hills or mounds which are especially frequent in the savanna regions of the Antilles; other communities make planting beds. Planting is done by the women. Weeding is also generally done by women and girls, if it is done at all. It is done by hand and requires a few weeks work per lot. Weeds in the vicinity of the plant are pulled out, mounds are kept weed-free and young shoots are eliminated. Harvesting is done by women and girls after one or two years, with considerable variation depending on location and need. The women do it every other day or so to gather what is needed for household bread, beer or boiled tuber consumption. Harvesting and transport may be heavy chores, performed by the women and their daughters (Saake, 1950: 3-10).

⁴ Schwerin notes that the distinction cannot be made in all cases on the basis of processing technique, since both bitter and sweet cultivars can be used for various products, such as casaba, farinha seca, and farinha de aqua.

most of the work, however, is in the processing of the tubers which is also traditionally done by the women. The cassava has to be peeled, washed, grated, pressed, sifted and baked to make casabe bread or farinha seca (the course meal). Schwerin (1971) has given an elaborate review of all documented cassava processing techniques; he describes seventeen different processes among Amerindians and finds it strange that only four or five of them are ever thought of. The reason may be the prevalence of some processes over others: casabe and farinha making, together with kashiri making (the fermented beverages from cassava). According to Schwerin, casabe is reported for 34 aboriginal groups, farinha seca for 17, and kashiri for 32 groups; all other uses have far less prominence (in the literature).

Neither Saake, nor Schwerin have given us an adequate account, however, of the amounts of time involved in the production or processing of the crop. Paul Aspelin has done this and his work can be used to analyse the quantitative aspects of the division of labour.

Aspelin offers the most complete information yet available.⁵ He has studied the Mamaindê of Mato Grosso, Brazil and provides data on one cassava-producing village. In Aspelin's village, the cultivation of bitter cassava is dominant. In Table 1 the distribution per crop is given.

Table 1 Crops cultivated on Mamaindê village food-plots in 1971*

Crop	Number of mounds	Estimated prod. in kg	prod./mound in kg.
<u>Cassava</u>	<u>2600</u>	<u>8371.2</u>	<u>3.22</u>
Sweet cassava	53	113.4	2.14
Bitter cassava (<u>xixi</u>)	1137	2956.2	2.60
Bitter cassava (<u>beiju & xixi</u>)	1379	5185.0	3.76
Bitter cassava (beiju)	31	116.6	3.76
<u>Other roots</u>	<u>463.5</u>	<u>2646.2</u>	<u>5.71</u>
Arrowroot	19	101.3	5.33
Yams	256.5	1717.7	6.70
Yautia	188	827.2	4.40

* Derived from Aspelin 1975:97,101

⁵ see for comparable data Hurault, 1965 - La vie matérielle des Noir Boni et des Indiens Wayana du Haut-Marani (Agriculture, économie et habitat).

Bitter cassava occupies four out of every five mounds in the village. The sweet cultivars are only grown on 1.7 per cent of the mounds, and produce less in kilograms than any other crop. It is interesting to note that of the bitter cassava cultivars, the ones grown for beiju (type of cassava br.) produce significantly more than the other cultivars. Bitter cassava is cultivated because it solves the problems of seasonality and capital stock. Aspelin explains:

"The season of the non-manioe roots (March-June) is relatively short, and since their vines die with the heat of the dry season, they cannot be left indefinitely in the ground until desired, as can unharvested manioe roots. It would not be feasible for the Mamaindê to rely exclusively on the non-manioe root crops, given their state of their arts of preservation of foodstuffs. Likewise there is the problem of capital stock. A manioe plant produces enough shoots (its branches) to reproduce itself many times in the next season without affecting the quantity of its product used in the present season (Aspelin, 1975:107)".

Even though the Mamaindê wish to increase their plantings of other root-crops, they are forced to rely on cassava. They probably know that cassava gives them less fresh-root weight per mound, and must be aware of the fact that it requires much more labour to process. Aspelin (1975: 106) has calculated that 2.02 kg per hour of cassava were processed into edible product, against more than double (5.18 kg) of non-cassava roots. This is confirmed in Table 2 which gives data on food production labour requirements for the different crops planted.

Table 2 Total food production labour requirements in hours for crops planted in 1971 in a Mamaindê village*

Activity	Division of labour Male/ Female***	Cassava	(%)	Food crops Non-cassava roots	(%)
Cutting brush	M	318.9	(10.7)	(incl.with cassava)	
Burning	M	8.5	(0.3)	(incl.with cassava)	
Storing root stock	F			63.9	(2.1)
Planting & clearing branches	M/F	123.5	(4.1)	84.9	(2.9)
Cultivating**		-		-	
Harvesting	F	502.3	(16.9)	158.8	(5.3)
Processing	F	1506.8	(50.6)	203.6	(6.8)
Totals		2460.0	(82.6)	511.2	(17.1)

* Derived from Aspelin in 1975:98

** Fields were rarely weeded (Aspelin, 1975:88)

*** Children are not included

Of the total time spent on cassava production and processing, women contribute a little less than three quarters. About half the total time is spent by women on processing this crop, which is in addition a very tiring job.

The labour requirements in Table 3 refer to total food labour-requirements for the village. To get an idea of what this means per person, Aspelin converted the data into average daily hours of food production labour per man and per woman. Total time spent on food production is rather limited, according to these calculations. For men it varies between 2 to 2.5 hours per day, for women between 1.5 to 2.5 hours per day. These figures are quite low, for example when compared to peasant farmers colonizing areas which are comparable to the Mamaindê village Aspelin studied.

Table 3 Daily food production labour among resident men and women in a Mamaindê village (1971)*

Activity	Average daily hours of food production labour			
	per resident man		per resident women	
	wet season	dry season	wet season	dry season
Food production on food plot	0.21	0.46	1.64	0.82
Hunting	1.80	2.03	-	-
Gathering	-	-	0.95	0.74
Totals	2.01	2.49	2.59	1.56

* From: Aspelin (1975): p. 116

On the whole, differences between men and women are not great as far as food production is concerned: in the wet season, the women work half an hour more (taking care of the food plot), in the dry season the men work an hour more (hunting).

Goldman (1963:58), in his study of the Cubeo of the north-west Amazon (Columbia) draws a different picture. He stresses the drudgery women must experience while working their cassava plots and processing the harvest. "Hers is the steady routine of plantings, scraping, grinding, operating the tipiti press, and, finally, forming the manioc cake and baking it". Women spend on average nine hours per day on cassava (Goldman, *ibid*). This varies with Aspelin's two hours, and suggests that further research is needed to establish real production-time require-

ments under different circumstances. From Aspelin's data, however, a good impression may be obtained of the division of labour among the sexes. Cassava cultivation is essentially a woman's affair. Leaving aside cutting the brush and burning it, she does the work. She decides what to plant and where: "the decision as to which crop to plant in which area is largely that of the woman since it is she who comes along behind the man with the basket of roots and shoots to plant and she, ... thus decides what to put in each mound." (Aspelin, 1975:95).

In other words, she does more than just work. She is the agronomist-avant-la-lettre, or the precursor of the modern cassava crop scientist (see also Goldman, 1963:60-61). Within the Amerindian cassava cultivation system, she is the one who knows about different cultivars, about soil fertility, about potential and real yields. She selects the cultivars, and decides on the particular mix of half a dozen or so, to be planted in different places. And she forms part of the exchange networks, which may extend for thousands of kilometres. Goldman discovered that one group of Cubeo cultivated a variety obtained from Indians below Manaus (1200 km away as the crow flies, or about double that distance when going by boat).

In fact, very little is known about the social organization of cassava reproduction. Cultivars have their local names, and no survey has as yet been done to classify all local varieties among the remaining Indians. Yet such research could give valuable insight into the genius of aboriginal crop development. At this point we only know that over the ages, women must have traded stakes with neighbours, or with visitors. Through this continuous experimentation and through the selection of hybrid cultivars resulting from crosses with wild or 'feral' plants, they established a highly adapted and quite stable calory supply.

Sociological implications

At this point, the following sociological observations can be made: Bitter cassava cultivation occurs within relatively small production units, which generally coincide with the family household (Saake:33-36). A strict division of labour exists, in which the woman is responsible for all production decisions and activities with the exception of clearing the brush and burning. She is also responsible for the processing, thereby controlling the provision of calories and fermented beverage (Saake: 36-41; Goldman:58-65). Since cassava cultivation is the major economic activity among most groups, the woman controls the household economy. It is a major economic activity, because it is one of the activities

which may create a surplus to be traded for other goods. It is the woman who controls it, since she has certain rights over the products of her work (Saake:51).

Over the ages, these relatively isolated groups have maintained contact through trading relationships. Cassava products, such as farinha were traded over great distances and could also be used as a means of exchange (Lathrap:173-176)(v. Luetzelburg:1940:296).

Amerindian man, or rather woman, selected cultivars which allowed a way of life characterized by a very efficient food production system. The plant has maintained so called 'weedy' characteristics, which allow it to co-exist with other tropical forest vegetation with a minimum of weeding or extra cultivation practices. Important characteristics of the plant are further associated with its capacity to produce starches which could be the basis of casabe or farinha production, kachiri (or xixi) production, or any of the other uses mentioned above. Characteristics which are not mentioned in the literature as being of importance are tuber size, or plant productivity as such. Speed of tuber production could be a factor, but is not explicitly mentioned as such: on the other hand, capacity for storage on the ground is mentioned as a significant characteristic (Goldman:60; Aspelin:107; Spath, 1973:54 ff). Taking these factors together, bitter cassava cultivation among Amerindians appears to be closely associated with a society built around the family household unit, in which the woman plays an important part. Surpluses arise from cassava cultivation and have formed the basis for long-range trading networks, allowing for occasional contact between riverine communities. In the course of these contacts plant materials may also be exchanged, allowing for great dispersion of genetic material.

A final observation regarding the efficiency of this food production system. If Aspelin's Mamaindê really do spend only two hours on food production, it is indeed surprisingly little. Considering the fact that the Mamaindê, or for that matter most aboriginal Amerindian groups in the Amazon region are considered to have a rather well-balanced diet, it is even more remarkable. Denevan (1971:515) has concluded with regard to cassava cultivation among the Campa of Western Amazonia (Peru) that theirs is

"a simple, labor-saving way to provide calories, while a man's greater physical efforts are directed toward hunting for the more basic food element, protein".

He confirms that this suggests a "considerable agricultural sophistication, much more than of the average non-indigenous settler in tropical Peru (ibid)". It is indeed that remarkable adaptation which strikes each observer. Whereas cassava-cultivating peasant-farmers in Brazil, Colum-

bia, and Peru are known to have unbalanced diets, and therefore suffer from malnutrition, Amerindians have learned to live quite well with cassava-based diets, which in addition they do not consider to be inferior to other ones.

4 RICE IN COLOMBIA

The genetic and cultural management of crops is an often forgotten role of peasants. Only during the last 150 years, since the first agrochemical experiments of Justus von Liebig, or maybe even later, viz. when the Laws of Mendel were purposefully employed for the first time by plant breeders, this role has been shared by public and private research institutions. This role is sometimes acknowledged by modern agricultural researchers:

"Progress was not rapid but the total contribution of the ancient agriculturalists rivals that of modern professional plant breeders" (Lennings, 1976:181).

Agricultural man has continuously realized plant selection, diffusion and local adaptations to micro-environments of climate, soil, weather, plagues, etc. One example of how a crop has gradually moved from one level of "genetic management" to other levels is the case of rice in Colombia, which will be described in a way relevant to our discussion.

Rice - Oryza sativa L. - is the world's most important crop for human consumption: it is the basic staple food for more than fifty per cent of mankind (Heiser, 1973:87). The exact origin of the cultivate, one of the 25 species of the genus *Oryza*, is still subject to scientific debate (see for details Gorman, 1974:322), but there is not much doubt about the Asian origin. Only the time and place of rice domestication remain under discussion: the opinions vary from northern China (Gorman, 1974:322) to southern China (ib. 323) and from between 7000 B.C. (Higham, 1974:404) to 3500 B.C. (Sauer, 1852:33).

Rice is an annual grain crop, although its immanent perennial characteristics permit cultivators to harvest rice from the same plant for more than one consecutive season (Sauer, 1952; Jennings, 1961). It is grown all over the tropical zones of the world, but also in temperate zones where the highest yields are obtained (Crist, 1964:10).

Asia provides more than 90 per cent of the world's rice, but also outside that continent one finds important rice production and consumption regions. One of these is Latin America which accounts for four per cent of the total world production (an estimated twelve million tons per year as in 1974 according to FAO statistics (FAO, 1974:114). Today "in Latin America rice is one of the most widely produced crops. It is grown in virtually every country of the region and under a wide range of ecological conditions" (Scobie, 1977:2). It is highly probable that rice was introduced to Colombia by the Spaniards in an early phase of their colonial rule. During the second half of the sixteenth century, the colonial

authorities included the crop in a decree which regulated the products the Indians had to grow (Colmenares, 1968) and an important gold mining centre in northern Antioquia became the first rice-growing district, chiefly to supply food for the miners (cf. Vasquez de Espinosa, 1948: 231, 235, 236). We also know that in the sixteenth century rice was produced in frontier zones like those in Tolima where it was probably used as a transitoral crop: a function it still has in colonization regions all over tropical Latin America (for details on the history and diffusion of rice in Colombia see Spijkers, 1981). Probably during the eighteenth century, but certainly before the middle of the last century, rice had become a widespread subsistence food-crop and a generally accepted food item in the lowland tropics of Colombia.

Techniques of rice cultivation have varied across the region from early days onwards. Some regions had irrigated rice fifty years after the Spanish occupation, but lost this custom until it was reintroduced more than three centuries later (see Patiño, 1969:80 and Jennings, 1961:20). Transplanted rice existed alongside upland cultivation. Sowing was sometimes done by enclosing cattle in a fenced field to work the soil and bury the seeds. Ratooning as it is done today seemed to have been practised as early as the seventeenth century. Harvesting practices included plucking ("milking") the ears with thumb and forefinger, and cutting stalk for stalk with a small knife. It is highly probable that the north coast of Colombia became a focal point for a wide diversification of land races. Nowadays, more than one hundred types of rice are distinguished by local cultivators in that region. This resembles certain areas in French Guyana and other lowland tropics of South America (see, for instance, Hurault, 1965:37).

Until the nineteen-thirties, rice was a typical peasant cultivator crop. It was cultivated mainly on two well-defined ecological niches: annually inundated regions, especially in deltaic riverine areas on the north coast and other sites subject to flooding. The other ecological situation is found in the hillside junglelands where colonos, in a process of slash-and-burn agriculture with a subsequent turning into pasture of these cleared sites (that is after one or two rice harvests) were and are pushing the agricultural frontier away from the urban centres. Commercial farming, with the use of new techniques like water control by irrigation works and mechanized land preparation, had its beginnings mainly in the more developed interior departments of Colombia. This happened about sixty years ago in the Huila department, especially in Campo Alegre, and later on, during the forties, in the Tolima-department.

But rice agriculture was only in a position to acquire an impetus of its own after a determined state intervention. It was thus to escape the fate of other tropical crops, characterized by Leurquin: "the typical patterns in the evolution of agricultural production".

"A boom in crop production develops in one place or another in an atmosphere of contagious optimism. People move in, large stretches of new land are planted, and output increases. Then comes a second phase. Concentration of production in areas where there is no cold season of dormant vegetation provides breeding grounds for parasites insects, weeds and fungi; monoculture tends to deplete specific plant nutrients in the soils; seeds introduced from abroad may degenerate. Attractive prices often do not last long. Rates of net income on farms decrease gradually; enthusiasm for expansion of output fades; and the farmers migrate or turn to the production of other commodities. This pattern of alternate boom and decline has often been observed in Colombian agriculture. In the rice industry, however, a third phase has followed: one of recovery, with massive application of improved inputs and methods, leading to considerable progress" (Leurquin, 1967:220).

State intervention in Colombia primarily consisted of a favourable price policy towards the producer and in an active support by the government towards agricultural research. These two policies were initiated during the early thirties and were largely responsible for the considerable progress described by Leurquin.

But what did the starting situation look like? For an understanding of the change processes from one level of crop management to another we need more insight into the intricate complex system of rice cultivation within an appropriate unit of analysis. In the section to follow we will indicate briefly how in one rice-growing village on the Colombian north coast, the farmers make use of different types of rice, how they grow them, how they distribute them in the fields during the growing season, how a very broad range of rice materials is used in a particular farming system, and indeed how Costeño farmers are active managers of genetic materials.

The village we chose - Los Monos - is situated between the Sinú river and the Ciénaga Grande near the township of Lorica, about 100 miles south-west of Cartagena. This has been an important rice-growing region for at least the last 300 years (cf. Leurquin, Patiño, Sanchez Juliao). In Los Monos, rice is grown essentially as a subsistence crop, although sometimes part of the produce is sold. Other crops of some importance are maize, frijol or frisól (Vigna species) and cassava.

Rice has been grown as long as the farmers can remember. They distinguish between two main systems of rice-growing: arroz criollo and arroz forastero. These names suggest that criollo (indigenous) rice was grown first, and that forastero (foreign) rice only came into the system at a

later date. The distinction refers basically to planting and water regime differences, but parallel to those are, for example, the differences in soil types, labour requirements, occurrence of pests (especially birds).

Although the farmers distinguish between types of rice, *criollo* or *forastero*, a *forastero* type is sometimes grown under *criollo* conditions and vice-versa.

Forastero types, then, are sown in seedbeds and transplanted about four to six weeks later (sometimes longer) with a digging stick (called chuzo, palanca or espeque) in flooded or floodable fields, very often in swamps or on river banks. The strategy is to have the seedling ready for transplanting as soon as the swamps or rivers have filled up sufficiently and the floodings start (for this reason the seedbeds are normally kept dry to check the growth of the seedlings). The transplanting normally occurs in June, about two months after the beginning of the rainy season, but may also take place later, depending on the start of the floodings.

Criollo rice types are also sown with the *chuzo*, but they are sown directly on higher terrains and depend on rainfall for their water supply. Where jungle conditions still exist on the Colombian north coast (which is no longer the case in Los Monos), *criollo* rice types are grown between the burned stems and trunks in slashed and burned fields, often for only one or two cropping seasons, before turning the field into pasture.

Weeding is important for *criollo* rice: two to three weedings are normal; this is not the case for *forastero* rice, where after a first weeding the rice plants compete successfully with other aquatic plants. Normally the weeding is done by hand, although occasionally chemical weed killers are used.

Both rice types are harvested with a small knife, a cuchilla, whereby each stalk is cut individually. The harvester cuts one handful of stalks, which he calls a bajada, or manotada. Two or three bajadas form a puño, a fist. Harvested rice volumes are referred to in terms of puños, or in botijas, one *botija* equalling 25 puños. The puños are hung up under the ceiling of the farmer's house, preferably in the kitchen area where the smoke is said to protect the rice against insect attacks.

After the harvest, when the farmer's ceiling is covered with rice puños he can lean back and be satisfied: his rice store assures him of sufficient food till next year's harvest.

Once every few days the farmer's wife will unhook a puño from the ceiling and thresh and dehusk the rice in a big wooden mortar. Sometimes the threshing is done separately with a stick, beating the grains loose onto the surface of a few sacks, sewn together.

After this husking, the rice is ready for consumption: the taste will sometimes be improved by boiling the rice in rasped coconut meal for the favourite Costeño dish: Arroz con coco.

For those villagers who have no land to grow rice on, or who cannot find land to work on in a share-cropping arrangement, there are three ways to obtain rice for their consumption: buying, receiving gifts of rice or working as a rice harvester. Especially the latter is important in Los Monos, like it does along the whole north coast of Colombia. In the rural communities, a certain social pressure is exerted on the rice farmers to have their rice cut by family members, friends and acquaintances, and to pay the harvest labour in rice shares. The amount payable is a fixed portion of the rice: one fifth of the harvested puños. In emergency cases this rate may be as high as one third, as it is in some parts of the northern Chocó and other parts of the Pacific Lowlands of Colombia. Here a one-third share is common, for reasons of labour scarcity. This is an important food distribution system on the village level, and especially attractive to poor landless people.

As mentioned above, not all rice types are sown and harvested at the same time. Subsistence farmers tend to spread risk, labour and cash expenditures throughout the year and one of the options for the rice farmers is to grow more than one type of rice. Indeed, most farmers of Los Monos grow than one variety of rice (often two or three or more) and at village level one is confronted with a broad range of varieties. Some varieties are grown for special purposes: an "arroz setentano" (seventy day rice) is known as a poor yielder, but ripens from seventy to ninety days, just quick enough to beat the veranillo (a short drought period of two to three weeks in August) which might cause a crop loss. Other precocious varieties, like mono ligerito, can be sown twice a year and also provide the villagers with rice early in the season. The variety Arta muchacho, only rarely found in Los Monos, is a "filling" rice, especially for young boys who eat a lot and therefore do not feel hungry "again", shortly after the meal. Each variety has its own taste, and the farmers take this into account when deciding which rice to grow.

Economic considerations are of importance with regard to production costs: criollo rice is more expensive to grow in Los Monos than forastero rice, as the land on which it is grown has a higher rent. Criollo varieties have to compete here with other food crops like maize and cassava, whereas forastero rice does not have such an opportunity cost. Also, weeding costs are lower for forastero varieties. One of the more popular types of rice in Los Monos is a forastero: Gallilón. The advantage of

this relatively new rice is its resistance to deep floodings, an important asset, as it enables farmers to put more marginal swamp lands under cultivation, which is necessary for an increasing population. Twelve years ago this variety was practically unknown, and it shows the active changes made by the farmers within their agricultural system. In other words, Los Monos farmers have selected a number of varieties to suit their needs, taking ecological and economic factors into account. Changes in varieties are made, and in little more than a decade the total composition of the varietal distribution appears to have been modified considerably. In so doing, these cultivators engaged in what we have called the genetic and cultural management of crops.

Rice research in Colombia

Cultivators were not alone in performing such genetic management. Public and private institutions gradually emerged, and engaged in research and development. Three institutions have contributed to the impressive amount of rice research which has been undertaken in Colombia. These are: research activities initiated by the Colombian Government, private initiatives by the Rice Growers' Federation and a recent internationally supported programme. These three together have also undertaken joint research activities and one can now speak of a fertile mutual exchange of scientific information on rice agriculture in Colombia.

The first attempt to establish a rice research programme in Colombia was undertaken in 1930, as part of a general import-substitution policy. Although the impact of these first efforts remained small, some results were obtained in varietal improvement, diffusion of imported varieties and bulk selection of seed. Leurquin (1967:248) notes that government aid was casual in both research and extension. A regular government sponsored rice research programme was started only at the end of the fifties: this was the National Rice Programme, stationed in Palmira, with later extensions in different locations all over the country. The Rice Growers' Federation Fedearroz has, strictly speaking, not embarked on its own rice research programme; but because of its strong ties with the government programme (ICA) in regional testing, information gathering and reporting (for example the outstanding weekly rice journal), it has been categorized here under research. The third institute to be mentioned is the rice programme of the international centre CIAT, which started a rice research programme at the end of the sixties. Through CIAT, new rice varieties were introduced in Co-

lombia, and after testing released with the help of the already established networks of ICA and Fedearroz. These research programmes taken together have contributed considerably to important changes within Colombia's rice industry.

In a somewhat distorting historical reality, it is possible to distinguish two post-war periods with respect to rice agriculture. The first period could be called a period of steady growth (1950)-1968) and the second a period of drastic change (1968-present).

Between 1954 and 1968 the country's rice acreage increased from 175.000 to 277.000 hectares. Meanwhile, the yield per hectare rose from 1.6 tons per hectare to 2.8 tons per hectare. The total production of Colombia rice increased from 294.000 tons to 786.000 tons in 1968 (Fedearroz, annual statistics reported in: Arroz), a year in which the old dream of exporting rice took shape again in the columns of Fedearroz's journal "Arroz".

The rice growers have, several times, declared themselves satisfied with the agricultural credits offered to them, but when the interior demand for rice is met, they start to look for export opportunities. In 1968 they intervened successfully at the agricultural exporters meeting, but refused to have rice included in the ALALC (free trade) list to maintain former privileges, which were denounced by the Minister of Agriculture: each rice export dollar would cost the national economy 25 pesos in comparison with a dollar price of 17,75 on the free market. The only way out of this situation would be yield improvement, which, according to Peter Jennings, a US expert, would be feasible on a middle term basis. It would have to happen by searching for higher yielding new varieties (Gilhodes, 1974:151).

And this actually happened. With the introduction of new varieties from Asia (IR-8, IR-22) yields started to increase even more than in the past successful years. In 1975, the average rice yields for Colombia had increased to 4.43 tons per hectare, and within the irrigated sector as high as 5.4 tons per hectare. The total area sown with rice increased to 369.000 hectares and the production figure exceeded 1.630.000 tons during 1975.

Another interesting phenomenon was the gradual shift of rice cultivation from one geographical region to another. At the beginning of the fifties, 35 per cent of the country's rice was produced in the interior districts of Tolima and Huila. Especially after 1960 new areas were taken into rice production, notably by the Llanos piedmont area and the northern lowland departments of Cesar, Bolivar, Sucre and Córdoba. These had traditionally been rice-producing zones, but the grain has been grown there under small-scale, subsistence conditions. In fact, rice there came to be one of the motors of rural capitalism in a formerly latifundio-minifundio economic society.

Social consequences

What have been the more important social consequences of the technological changes in the Colombian rice industry? Some of the results of field research have been reported elsewhere (CIAT Annual Reports 1976, 1977). Some consequences have also been published in an economic study by Scobie and Posada. In Colombia, rice is basically grown under four different systems. These are:

- mechanized irrigated rice
- mechanized dry rice
- swamp rice
- upland rice.

The percentage distribution in acreage of the systems has changed considerably during the last years. One of the reasons has been the introduction of new varieties, as these have a comparative advantage over the irrigated sector "displacing upland production" (Scobie, 1977:99). It is extremely difficult to arrive at reliable estimations of the areas of the several systems; Fedearroz statistics usually lump swamp rice and upland rice together under "arroz de secano", and mechanized irrigated rice and mechanized dry rice under "irrigated rice". Nevertheless, it is certain that the number of swamp rice and upland rice farmers have decreased enormously during the last decade and a half. These were nearly always small producers who often grew rice for subsistence reasons with a surplus for the market. Due to their size they nevertheless made an important contribution to the total rice production (this is a similar situation found with other food crops in tropical America). Another consequence has been the increase in the average enterprise (Scobie, 1977:35). The organization of labour in rice production is related to this phenomenon; more people are engaged in irrigated rice farming and less in both upland and swamp rice farming. The activities, their distribution through the growing seasons and their remunerations have changed drastically. Rice distribution within villages, formerly based on harvest labour shares is giving rise to scarcity of rice in villages where not everybody has access to land. These changes are partly related to the type of rice which was introduced. The new varieties are not harvested any more stalk by stalk as was formerly done, but with a combine-harvester or with a sickle. Payment systems shifted immediately with the change from long straw to short straw rice. The varietal change has also done away with the cultural variety inherent in the traditional technologies. Where formerly dozens of rice types were available in one village, with characteristics suited to different soil types, different labour distri-

butions, different tastes, different risk capacities and so on, now it may be that only one or two rice types are grown in a village and that cash income to farmers' families is reduced to once or twice a year. Rice research and rice extension networks, now available to the middle- and large-scale rice producers, are not yet geared to the changes within the small-scale rice-cultivator sector. The main social consequences of the technical changes of Colombia's rice agriculture appear to be two-fold; on the one hand a deterioration in the position of the small-scale rice-cultivator and of his village. Social and cultural losses, which are not directly discerned from national statistics, but which nevertheless are real for the cultivator's families and their neighbourhoods: seasonal shortages of rice for those families who have not disposed of land (and who formerly participated in rice distribution mechanisms which operated within villages) are now real, and can be observed.

Moreover, the new varieties, due to their very design and architecture, can never fulfil all those functions which the locally adapted landraces could. In strict agricultural terms this means that the new varieties (CICA-4, CICA-6, CICA-9) do not have the essential, but not yet realized full resistance against diseases like rice blast (Piricularia). Sociologically, this means that research and extension institutions have to produce and distribute every one and a half to two years a new, - moderately resistant - variety in order to keep abreast of increasing demands for good seed and appropriate knowledge about these seeds. This gives an impetus of its own to the incipient research and extension institutions, a dependency of rice farmers to rely more on research, extension, credit and input supply than before and another push in the direction of the formerly mentioned Illinois corn farmer (see page 272).

Unfortunately, however, where institutional capacities in the U.S. and the rest of the Western World are more or less attuned to technological developments, in Colombia this is far from true.

5 DISCUSSION AND CONCLUSIONS

Crops can be studied sociologically, insofar as their cultivators are part and parcel of cultures and societies. Each crop is the result of countless decisions made by cultivators over thousands of years. At the outset, such decisions related to what to collect and what not. Gradually man settled and opted for other ways of food procurement or production. He must have selected seeds, roots or other plant material which suited his needs, tastes and environment. Agricultural revolutions occurred. A first in the neolithic period, with a remarkable development in domestication. A second upon the introduction of inanimate sources of labour, during the industrial revolution. A third is occurring now with the rapid introduction of new varieties, which radically alter both the characteristics of cultivates and the social order existing among those who produce and reproduce them.

During the early phases of crop development, production and reproduction decisions were in one hand. As we have shown for the case of cassava, Amerindians developed a remarkably efficient food production system. They continuously selected new cultivars, stemming from local populations thousands of kilometres away. Peasant cultivators essentially produce and reproduce their rice in the same way. They continuously adapt new varieties to local needs and conditions. They are careful to maintain a certain diversity, corresponding to the diversity of needs and conditions.

Spijkers found in northern Colombia that there were about 100 known rice varieties in one region; each of these could be associated with particular socially desirable characteristics (Spijkers, 1981). Box, in one village of cassava cultivators in the Dominican Republic, discovered that there were at least 16 known varieties of cassava, most of which were still available, though sometimes only in very small numbers (Box & Van Baalen, 1979).

Crop research and development has expanded tremendously over the past three decades. This means that a radically different division of labour has emerged with regard to crop cultivation. Production and reproduction decisions are not in the hands of the single cultivator, as we have shown in the case of rice in Colombia and with Amerindians and their cassava crop. Production decisions are to an increasingly larger extent affected by market forces or state policies, neither of which are well

understood by traditional food producers. Decisions with regard to reproduction are made within international and national research centres. Communication between traditional food producers and researchers is generally absent, and mutual understanding is therefore lacking.

Havoc may result when traditional food producers are asked to cultivate the new varieties, as countless critical studies of the Green Revolution have demonstrated (For a review see Pearse, 1980).

Some of the problems can be associated with increased misery among peasant cultivators, due to increased exploitation by traditional and newly-formed elites. But other problems relate to the fact that virtually no understanding exists among highly specialized crop scientists of the conditions traditional food-producing peasants have to face. Research has been largely oriented to the conditions of large-scale, capital intensive agriculture (see PROTAAL, 1980 for Latin America; see Box, 1980b for cassava research).

In our view, future research in traditional food-crops like rice and cassava should take the conditions of peasant cultivators into account. It should start from the premise that until very recently production and reproduction decisions for such crops were taken with a fair degree of success by these peasant cultivators. The disjunction between their knowledge and the knowledge generated in modern research centres is evident. In the case of cassava, for example, it has meant that the foremost international research centre has not been able to generate a variety which has been found acceptable to cultivators, be they traditional or modern, in either Colombia or the Dominican Republic (Box, 1980b). The 'modern' varieties simply did not respond to the production conditions of cassava cultivators.

Social scientists may play their role in this field by correcting the disjunctions which a rapid development in the division of labour in crop cultivation has generated. One of their contributions is to signal these disjunctions. Another is to prevent them, through close collaboration with crop scientists in developing research and development programmes. In this way, sociologists may contribute to the development of 'seeds of plenty', and may reduce the probability of 'seeds of want', by producing knowledge of relevance to both crop scientists and crop cultivators.

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