26. Contemporary Agriculture at Chalcatzingo

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The close physical proximity of the present village of Chalcatzingo to the archaeological zone reflects a continuity of prehistoric and contemporary agriculture. Despite the influx of new technology, subsistence farming has changed little since the Formative period. Oxen, plows, and fertilizer have added to the farmer's repertory and production has increased, but the constraints of land, labor, and crops still limit the farmer's ability to change. Even more important, today's farmers are part of an international economy which ultimately determines the success or failure of their adaptive strategies.

The present agricultural system at Chalcatzingo is the outcome of a long history of individual decisions made as farmers attempted to provide food for their families and supply their other needs. In any one year there are new and different problems, which may be met by innovative solutions but which are usually solved through traditional means. This chapter examines the character of the agricultural system in terms of the constraints on farmers' decisions. These constraints are, in turn, selective of certain adaptive strategies or "the patterns formed by the many separate adjustments that people devise in order to obtain and use resources and to solve the immediate problems confronting them" (Bennett 1969:14).

Aspects of both environment and culture are considered as factors of a single system, subsistence agriculture. These elements form the "socio-environmental stresses" or constraints in Kent Flannery's (1972:409) terms. These constraints determine the decisions which a farmer must make throughout the course of the agricultural cycle. Decisions, however, are not all of the same importance. Two levels, the tactical and the strategic, can be defined. The first involves adjustments to variations in climate, labor supply, and household needs, while the second involves goal-setting and choices between different adaptive strategies. The pattern of daily activity results from tactical decisions, but the overall character of the agriculture system is the result of strategic choices.

Because choices on different levels have different constraints, these levels must be distinguished during analysis. Therefore, the chapter proceeds from a discussion of those factors which constrain tactical decisions to an analysis of different adaptive strategies and their selective constraints.

LAND

In 1926 a grant of 901 ha of land (Fig. 26.1) was made to the village of Chalcatzingo by the Mexican government as a result of the land reforms begun by the Revolution of 1910–1916. Control of the land is vested in the *comisario ejidal* and his assistant, elected officials of the *ejido* of Chalcatzingo. Of the land in the grant, 8.7 ha are irrigated today and the remainder is *temporal* or unirrigated land. The average holding by members of the *ejido* is 2.89 ha with a range from 0.5 to 7.5 ha.

Three classes of land were included in the grant. The *fundo del pueblo* is private land and consists of houseplots in the village, a small number of unirrigated fields, and a section of privately owned irrigated land along the stream between the village and the site. This land can be bought, sold, rented, or sharecropped without restriction. Some plots of private land have recently been sold to people living outside the village, but there is strong pressure to keep the land under village control.

The irrigated land west of the village is *ejido* land, which cannot, in theory, be bought or sold, but which is frequently sold or rented. It may be rented by non-*ejido* members, but there are social sanctions against selling land to outsiders. The irrigation system is fed by canals from a reservoir at Monte Falco (ex-hacienda Santa Clara). The reservoir is, in turn, fed by canals originating on the Río Amatzinac above Zacualpan. The system has only minimal value, however, because water is so heavily utilized by villages closer to the source that no water reaches the reservoir during the dry season. Chalcatzingo has protested to the state government, but lacks sufficient political power to get changes made. As a consequence of the limited irrigation water supply, farmers tend to grow valuable cash crops on irrigated land, using irrigation to supplement rainfall to insure a good crop.

The majority of the *ejido* land is *temporal*, usable only during the rainy season. There are two named areas, La Joya just south of the village and La Esperanza to the east across the Río Amatzinac. Among the thirty-four people who presently have fields in La Joya, the average holding is 2.0 ha, with a range of from 0.3 to 2.5 ha. The land in La Joya is of variable quality but is generally better than that in La Esperanza. That coupled with the fact that La Joya is closer to the village makes it more desirable. La Joya was completely irrigated during the hacienda period, but the reservoir and canals have fallen into disrepair and no longer function. A small section, less than 10 ha, of La Esperanza is irrigated by a new reservoir, but this system functions only during the rainy season.

The remainder of the village land is *cerril*. This section includes the highly prized terraces of the archaeological zone, the steep and rocky masses of the Cerro Delgado and Cerro Chalcatzingo, and the fields of the Tetla zone. With the exception of site terraces and the Tetla fields, this *ejido* land is used primarily for grazing and for collecting.

SOILS

The farmers of Chalcatzingo use a hierarchical classification system for ranking the potential production of agricultural land. The two major categories of land, *tierra amarilla* and *tierra negra*, are distinguished on the basis of their soil color, which reflects both the mineral composition of the soil and its organic content. Within the *tierra negra* class of soil there are two further types which are recognized by farmers: *arena* (sand) and *barro* (clay).

Tierra amarilla or yellow soil consists of coarse light brown to yellow soils which have low organic content and poor moisture-retention capacity. It is the least productive soil under normal conditions but can exceed that of the other types in years of extremely high moisture. The majority of La Esperanza and parts of the hillslopes of La Joya consist of *tierra amarilla* soils. Corn and peanuts are the preferred crops on this soil, as they have low moisture requirements and grow well in friable soils.

Tierra negra or dark soil is a highly organic, fine-grained soil with good moisture-holding capability. *Tierra negra* is about twice as productive as lighter soils due to its greater fertility and ability to maintain moisture during short dry periods. The disadvantage of *tierra negra* is that it may become waterlogged during periods of prolonged heavy rains.

Sandy soil is better for crops when there is a great deal of rainfall, since water percolates through it more easily. It has good moisture-holding capacity but does not become waterlogged as easily as clay. Its production is somewhat less than that of clay in normal years, but its overall long-term production is higher. Thus, it is the most consistently productive soil type. Sandy *tierra negra* is preferred for tomatoes, since they are harmed by too much moisture as well as too little.

Clay is heavy and hard to work, but is the richest soil and performs well during drought. Clay soils are preferred for corn because of their normally high productivity, but they are susceptible to waterlogging if there is heavy rain at the beginning of the season. In the worst possible year, one which is too wet during the early summer and dry during the remainder of the growing season, corn production on clay soils can be as low as 500–750 kg/ha.

Of the land within the *ejido* of Chalcatzingo, 60 percent is *tierra negra de arena*, 20 percent is *tierra negra de barro*, 10 percent is *tierra amarilla*, and another 10 percent consists of trails, streams, and other uncultivated areas.

Soil and crop preferences represent a system of cultural adaptation of crops to given soil conditions which reflects both the moisture and nutrient requirements of the crops and the characteristics of the soil. Although most farmers recognize the ideal strategy of planting crops in all three types of soil, they do not always have access to them. Therefore, they must contend with production which varies from year to year depending on climatic conditions. They try to remember rainfall conditions from past years and use these data to predict succeeding years, usually with little success, as also found by Anne Kirkby (1973) in Oaxaca.

Table 26.1 shows the three main soil types and the crops which are preferred for them based on informants' responses. Since not all farmers have access to all soil types, the table represents a desirable, but not necessarily actual situation.

Corn will grow well in all soils, but the preference for clay soil indicates that farmers try to fit the higher moisture requirements of corn with the good retention capacity of clay. This preference also indicates that drought is a more typical condition than an excess of moisture and that farmers try to minimize its effects by planting on clay soil.

Beans and squash when planted as separate crops require high moisture and are not preferred on *tierra amarilla*. Peanuts have lower moisture requirements, are easier to harvest, and grow better in the more friable soils. Tomatoes are the most sensitive crop and are planted only on sandy *tierra negra*.

As part of our research, soil fertility was measured on fourteen sample plots with a Sudbury testing kit. This test is not as accurate as some others but was the most practical. It gives results in the form of percentage of deficiency from an arbitrarily defined optimum and provided an objective measure of the relative fertility of the different soil types at

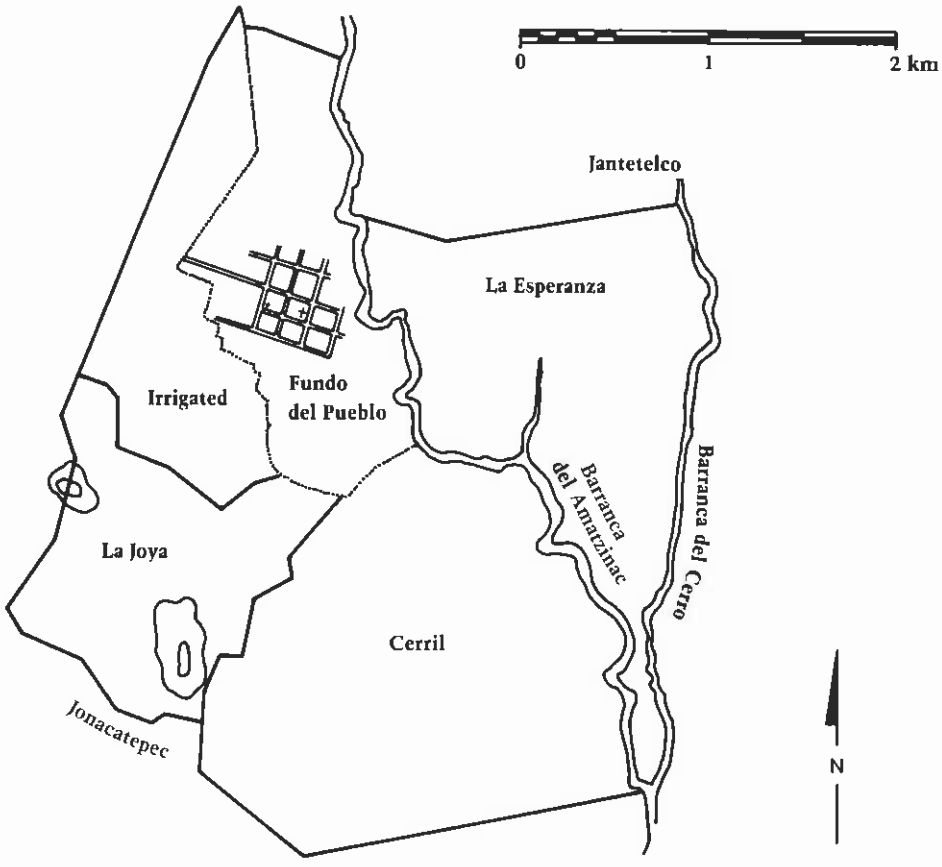

Figure 26.1. Land grant map of village of Chalcatzingo.

Chalcatzingo. The data are presented in Table 26.2 as average deficiencies for nitrogen (N), phosphorus (P), and potash (K). This table shows the greater fertility of *tierra negra*, especially in respect to phosphorus as well as to nitrogen, an important nutrient for corn.

In spite of the limited conservation practices which modern farmers utilize, the soil at Chalcatzingo is relatively fertile. Apparently the differential fertility of *tierra amarilla* and *tierra negra* soils, coupled with their different water-retention characteristics, leads to differences in production between the two.

Table 26.1. Preferred Crops for the Different Soil Types

	Crop				
Soil Type	*Corn*	*Beans*	*Squash*	*Peanuts*	*Tomatoes*
Tierra amarilla	(+)	–	–	+	–
Tierra negra					
Arena	(+)	+	+	+	+
Barro	+	(+)	+	–	–

Plus signs indicate preferred crops. Plus signs in parentheses indicate acceptable conditions. Minus signs indicate unacceptable conditions.

Table 26.2. Average Mineral Deficiencies in Chalcatzingo Soils

Soil Type	*Nitrogen*	*Phosphorus*	*Potash*
Tierra negra	4.0	8.0	4.0
Tierra amarilla	5.0	10.9	4.6

CROPS

Although some differences in the ecological requirements of various crops can be determined from the interrelations of plants and soils, detailed studies of each crop are necessary to relate the tolerance ranges, productivity, and problems of each crop in the traditional agricultural system.

Corn

In recent years hybrid corn has been planted experimentally by a number of farmers, but it has not met with a great deal of success. While its potential productivity is ultimately greater than that of the indigenous variety, it is difficult for the Chalcatzingo farmer to achieve that potential. Although hybrid varieties were not seen in the Chalcatzingo fields, they were being grown in irrigated fields elsewhere in the valley.

Most Chalcatzingo farmers stated that they did not plant hybrid corn because they did not like the taste or consistency, but there are other reasons for its lack of success. For optimum production, hybrid corn needs careful attention to water requirements and fertilization. Irrigated land is a practical necessity, and chemical fertilizers must be used to insure maximum production. Fertilizers are expensive, complicated to use, and difficult to purchase and transport; therefore, they are not used on a large scale.

Most corn today is planted without prior fertilization, but fertilizer may be applied after the plants reach 0.5–1.0 m in height. The farmers do not fertilize the soil, but fertilize the individual surviving, healthy plants. Small (single pinch) applications of fertilizer applied to each plant reduce costs and insure that none of the fertilizer will be wasted on plants which will not produce.

The failure of hybrid corn to compete with local varieties indicates the importance of the *strategy* of the farmers at Chalcatzingo. This strategy is not optimization of production, but "satisficing" (Simon 1957). That is, the farmers try to meet a preset production goal with a minimum of inputs. The goal is not maximum production, but only enough to meet the farmer's needs.

Hybrid corn requires optimization, for it demands high inputs of fertilizer, labor, and irrigation to achieve maximum productivity. If these inputs are not provided, the yield of hybrid corn is less than that of the traditional variety. Farmers therefore find that hybrid corn requires a different and unacceptable strategy. Since most farmers attempting to use hybrids cannot meet the increased input demand, their production decreases and they soon return to the traditional variety.

The indigenous corn, *maíz criollo*, is ultimately less productive than hybrid varieties, but is more broadly adapted and will produce better under adverse climatic conditions. Production figures for *maíz criollo* are given in Table 26.3 and Figure 26.2. *Criollo* is related to *pepitilla* (Wellhausen et al. 1952) and is common in Morelos and Guerrero. The cobs average 15–20 cm long and are slightly tapered from butt to tip. Rows average fourteen or more, but a few twelve-rowed ears are found. Kernel color is white to light yellow, with some blue or black kernels. The kernels end in a turned-over apex or beak which is a distinctive feature of this variety. The rows are widely spaced, straight, and not interlocked.

Criollo differs from the corn at nearby Tepoztlan. Edgar Anderson (1951) felt that the corn there was derived from west Mexico rather than central Mexico. The corn at Chalcatzingo shows little evidence of genetic connections with west Mexico, perhaps indicating the existence of different cultural interaction spheres within Morelos.

Archaeological samples of corn preserved in Cave 2 at Chalcatzingo are of a completely different variety than *criollo*. Samples were collected from mixed deposits dating from the Postclassic to the early historic period. Only three kernels of beaked corn (*criollo*) were found in the sample of thirty-one kernels. The archaeological sample cobs have a mean row number of twelve and are significantly different in morphology from the modern type. They are related to the *nal-tel–chapalote* complex, an ancient variety common to southern and eastern Mexico.

Beans

Two types of beans are grown today at Chalcatzingo. *Enrededor* is a pole bean, much like "Kentucky Wonder." The seeds

Table 26.3. Average Corn (*maíz criollo*) Production (kg/ha) for Differing Soil Types and Rainfall Conditions

	Rainfall Conditions		
Soil Type	*Wet*	*Normal*	*Dry*
Tierra amarilla	1,500	1,000	500
Tierra negra			
Arena	1,500	1,500	1,000
Barro	1,000	2,000	1,500

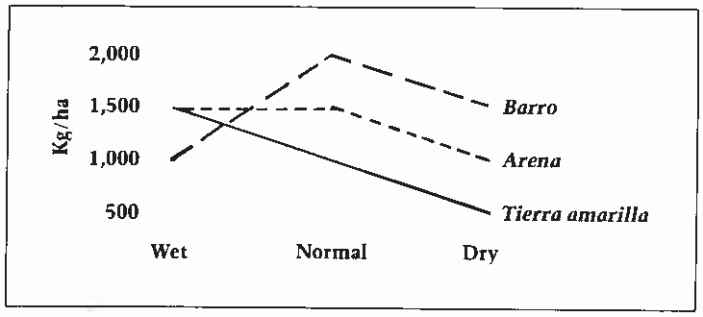

Figure 26.2. Average corn (*maíz criollo*) production (kg/ha) for differing soil types and rainfall conditions.

are light brown. Although there is no standard pattern for planting, beans are mixed with the corn at a rate of about 1 plant per 10 cornstalks, or about 200–300 plants per ha. One interplanted hectare yields about 175 kg of beans.

Frijol chino, a highly productive bush bean, is also planted, usually alone, not intermixed with corn. One hectare produces about 1,750 kg of seed. Most farmers do not plant *chinos*, since they require a great deal of additional labor and their harvest tends to coincide and interfere with the harvest of corn.

Squash

Three types of squash are planted. The most common, *calabasa champolla*, is interplanted with maize. This squash is grown only for its seeds, which are toasted and eaten. *Champolla* produces about 300 squash per ha which yield about 150 kg of seed.

The two other kinds of squash are grown in small numbers. *Calabasa dulce* is kept through the dry season for use as a boiled vegetable, served with a thick honey syrup. *Calabasa castilla* is grown by a few farmers for the blossoms, which are used in soup. Only a few plants of both types were seen in the fields during 1975.

Peanuts

Peanuts are the major cash crop for most farmers. They are planted in May, just before the beginning of the rainy season, and are harvested in November before the corn harvest. Planting and cultivation of the crop require a minimum of labor, but the harvest is arduous and time-consuming. At harvest the field is first plowed, and the plants are uprooted and stacked. The peanuts are then picked from the vines. Although it takes five days for the harvest of 0.5 ha, the work is simple, so all members of a family usually participate. Production is approximately 1,750 kg/ha, and at 1975 prices of 2 pesos/kg, 0.5 ha produced enough to fill half of the cash needs of an average family.

Tomatoes

Tomatoes are grown as a cash crop, in either irrigated or *temporal* fields. Farmers plant commercial hybrid seed. *Temporal* crops must be staked to prevent the fruit from touching the moist ground and rotting. Therefore, they require a large investment in stakes and wire. Stakes can be cut on the *cerros* or may be bought locally or from peddlers who cut them in the upland forests.

Irrigated tomatoes are grown in La Esperanza on some of the better soils. These crops are planted in August and are harvested in November or December when prices are higher. The late crop does not need to be staked, as the ground is not moist then. Although most crops are sold in nearby markets, some farmers have taken their tomatoes to markets in Cuernavaca, Puebla, and Mexico City.

Tomatoes are a difficult crop because they are very sensitive to variations in moisture, temperature, and soil fertility. There is also trouble with disease, but this can be mitigated by repeated treatments with fungicide. Yields are high, however, with 0.5 ha producing 4,700 kg of tomatoes over three harvests during and after the *temporal* season. Irrigated tomatoes commonly yield less, due to the scarcity of water in late November and December.

In 1975 a yield of 4,700 kg of tomatoes sold at 10,800–13,500 pesos. From this amount must be deducted the wages of field workers and costs of fertilizer, stakes, wire, fungicide, and insecticide. The net income from 0.5 ha of tomatoes amounted to 5,000 pesos or about one-half the value of the crop.

Other Crops

Other crops which are sometimes planted are onions, chiles, *tomatillos* (husked tomatoes), and watermelons. None of these are common, although some farmers plant them every few years or so. Chiles are grown on *temporal* plots by only one farmer in the village. Onions are occasionally grown on irrigated land. Melons and *tomatillos* are sometimes grown on *temporal* land, or may be planted in small quantities in irrigated fields. None of these crops, with the exception of chiles, are of major economic or subsistence importance.

TRANSPORT

The transport of the harvest from the field to the house plot and from the house plot to the market is an important consideration in village agriculture today. With a normal harvest of sufficient size to maintain a family, a farmer may spend ten days transporting the crop from the fields to the house. More important, transport to the market is usually in the hands of an intermediary who owns a truck and sometimes a stall in the market. The cost of transportation is high and almost entirely outside the farmer's control. The only possible lever-

age which can be gained by the farmer is by establishing a personal relationship with a trucker, either on the basis of friendship, *compadrazgo*, or long-term economic relations.

STORAGE

Storage is, of course, essential for household units, given the periodicity of the harvests. Household supplies of corn, beans, squash seeds, and fruits are stored in a *cuexcomate*, a circular clay structure with a thatched roof (Fig. 26.3). The *cuexcomate* is built atop a stone base which allows for the circulation of air. It is an efficient storage structure which allows the corn to dry fully and protects it from insects and mildew. Corn is shelled before storage and may be drawn out either from the top or from an opening on the side. Corn withdrawn from the *cuexcomate* six months after harvest usually has no visible insect damage.

Efficient means of storage such as the *cuexcomate* represent a marked increase in the stability of peasant agriculture. Their occurrence in the archaeological record should mark an important shift in the strategy and capacity of the subsistence system, with decreasing emphasis on gathered foods and more dependence on agriculture. However, to date no definite examples have been found archaeologically.

Cuexcomates continue to be made at Chalcatzingo, although there are now only two men who are considered to be experts in their construction. The efficiency of the *cuexcomate* for corn storage insures a continuing demand.

AGRICULTURAL CYCLE

The agricultural cycle is largely determined by the seasonal nature of the climate. With the exception of irrigated crops, farming activities occur just before, during, and after the summer months. Harvests are from November until the end of December. Within the constraints imposed by the environment, there is a rigid schedule of activities during the farming season.

Figure 26.4 shows the annual agricultural cycle for the major crops at Chalcatzingo. There are two corn harvests. The first, when the corn is still green, strips the stalks of the leaves (to use as fodder), but the ear is usually left to dry (although sometimes harvested green for immediate use). The second harvest is of the dried ear of corn.

It can be seen that the schedule for the basic crops, including peanuts, minimizes conflict. Peanuts are planted earlier than corn and are harvested between the first and second corn harvests. *Temporal* tomatoes also fit the schedule of corn, providing an alternative cash crop but one which involves more investment and risk. Irrigated tomatoes seem to fit the schedule, but as they require high labor inputs at the same time as the second corn harvest, when labor is in short supply, they are not necessarily a viable alternative.

Scheduling of agricultural activities is a major constraint on the agricultural system. The present schedule minimizes conflict but does not permit a large number of viable alternatives. Farmers who desire more cash income cannot produce more of the traditional crops without incurring labor shortages and scheduling conflicts; therefore, they are faced with a situation in which a shift to an entirely different strategy is necessary.

Figure 26.3. *Cuexcomate* in house yard in the village.

LABOR

At the most basic level, labor is organized along kinship lines. As Eric Wolf (1966) has pointed out, the family is the unit of production and consumption in a peasant society. In Chalcatzingo, however, there is a rather fluid boundary between the kinship units which are important for economic relations. The nuclear family is possibly the most strongly bounded unit, but beyond that the kinship units which are actualized in economic relations are highly flexible.

The critical labor periods are planting and harvest. Planting must be accomplished within a relatively limited period, or the entire schedule can be thrown off. Although one person can manage all of the jobs alone, time pressure causes conflict in the scheduling of activities.

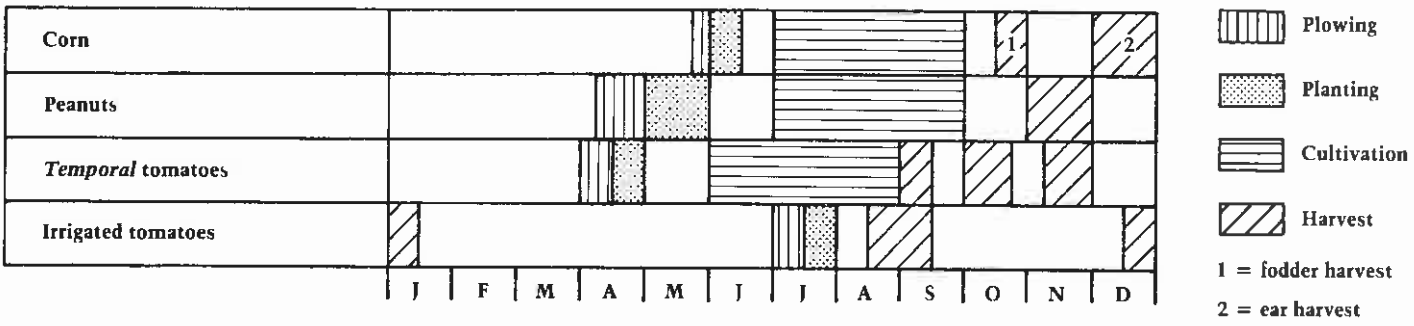

Figure 26.4. Annual agricultural cycle.

The minimal unit for farming is said to be two people, but this is a baseline which applies only at certain times. In fact, work groups of less than three persons are rarely seen in the field.

The most common task group is a man and his brothers or sons. One man plows and the others clear the weeds or sow the seeds. Often two or more brothers share both the labor and the harvest of a field. These arrangements are made on the basis of verbal agreements. The produce from the field may be pooled or divided, depending on the living arrangement and the type of storage facilities available.

Beyond the family unit, other kin ties may be called into play to accomplish given tasks. Often more distant relatives agree to a share of the crop in payment for labor for part or all of the season. This arrangement, called *en medias*, has benefits for both parties. On the one hand, the owner of the plot does not have to pay a fixed amount if the harvest is poor, and he is assured of the fact that his laborers will have an interest in the jobs. On the other hand, the worker who may be without land has the opportunity to invest his labor without the chance of disastrous loss. If this form of contract is possible, it is preferred by most parties. Another important fact is that the relationship between the workers is not one of employer-laborer, but is more reciprocal and equal. Such relationships are generally preferred over wage labor.

Contract wage labor is the third form of organization. In this case, a verbal contract concerning the type of work and the amount of pay is agreed upon before the beginning of the agricultural season or before the particular task. In 1975, payment ranged from 35 to 45 pesos per day, depending on the skill of the laborer and the job to be done. Although workers can be hired at any time, the most common need for labor is during the harvest season in December. Due to the rigid schedules which govern most of the farmers in the village, there are often shortages of labor during this period. In cases when labor is insufficient, the completion of the job must be delayed, causing further schedule conflicts or delaying the sale of the crop.

Consideration of the available labor supply and the timing of activities can be used to differentiate traditional and cash farming. The activities of traditional farming are scheduled so that conflicts are minimized. However, cash farming, especially of irrigated tomatoes, results in overlaps between the periods of traditional farming activity and those for the cash crop at the critical harvest period (see Fig. 26.4).

CONSUMPTION

Anne Kirkby (1973:89–90) determined that the average household of five persons in Oaxaca produces 2.4 metric tons (2,400 kg) of corn per year, half of which is used for subsistence and half as a "salable excess." At Chalcatzingo, the average consumption for a family of five (two adults and three children) is between 800 and 1,000 kg per year of corn. This figure was arrived at by questioning farmers as to their subsistence needs and by asking their wives how much corn they needed per day and then calculating the yearly consumption. Both estimates were almost the same within a family.

To the consumption of corn can be added a minimum of 175 kg of beans, 100 kg of squash seed, and chile in amounts which were not precisely determined. At Chalcatzingo, peanuts, rice, and other foodstuffs should be considered, as they make up an important part of the yearly consumption.

As Kirkby's estimates show, peasant agriculturalists do not only produce for consumption but must also meet other demands, such as a replacement fund (seed for the coming year), funds to maintain social relations, and funds for rent (Wolf 1966).

In 1972 and 1973, the average family of five at Chalcatzingo spent 3,000–5,000 pesos per year on food, clothing, and other items. Most expenses were not fixed but varied widely from family to family and from time to time. Given the average landholding of 3 ha, with a production of 1,500 kg/ha of corn, the average production was about 4,500 kg per family. If 1,000 kg was consumed and the other 3,500 sold for 1,000 pesos per metric ton (1972 prices), the family had a cash income of 3,500 pesos and had minimally met its needs. In addition, wage labor, the sale of fruits or other gathered products, or the sale of craft items can produce an income in excess of needs.

At worst, given the same amount of land and the minimal production rate of 500 kg/ha, the average family still produces 500 kg of corn beyond its subsistence needs. Therefore, in times of extreme stress, the family remains secure in meeting its subsistence needs but not its cash needs. During such times, family members seek wage labor outside of the village in order to meet their cash needs. If this is not possible, they try to reduce their expenses.

The Chalcatzingo data emphasize the contrast between the "breadbasket" state of Morelos and other Mexican states. The average family at Chalcatzingo consumes directly less than one-third of the agricultural production of its land, and the surplus is available for the support of additional persons through trade, taxes, or other means. Even in the worst of years some surplus is available, and with the reactions of different types of land

to differing climatic conditions, careful management through spatial averaging or alternative agricultural strategies can provide even more. Although the productivity of agriculture is a function of the environment, the crops, and the technology, it is clear that a major factor in determining the ultimate production is what Wolf (1966:77) calls the "social imperatives."

DECISION PROCESSES

The present agricultural system of Chalcatzingo represents the outcome of a long history of individual decisions. At one level, agriculture can be viewed as a complex, goal-oriented, homeostatic system, but at the personal level, agriculture is the result of individual decisions made on the basis of personal goals and constrained by factors in the perceived environment. Although the latter perspective is largely beyond the reach of archaeological data, the individual decision-making procedures do have important consequences for the interpretation of prehistoric subsistence and settlement systems.

The goal of most farmers at Chalcatzingo is to provide their families with food and the required necessities for maintaining their households. To achieve this in the face of the changing productivity of their land takes considerable knowledge and planning. The important constraints on the individual farmer can be determined by an analysis of the decisions which are made and the alternatives which are available.

The diagram of the sequence of decisions and their consequences is shown in Figure 26.5. Beginning with the primary decision—the setting of the production goals for the year—the succeeding decisions are indications of the constraints on production. As described previously, land, labor, and capital are the critical factors which determine the amount of land cultivated. The individual farmer must compromise his goals with what, in reality, is possible. If land, labor, or capital are lacking, the farmer must either acquire them or must reset his goals accordingly.

As long as agricultural activities remain confined to the household, there are maximum limits on the amount of land which can be worked. With most families, land is the critical variable in the system. The average landholding is about 3 ha, but it is possible for a farmer to cultivate 4 ha without undue difficulty. Therefore, the problem for most farmers is to either acquire more land or reset the production goals.

Labor requirements are easier to meet, as there are numerous means available for sharing or hiring labor. Labor inputs are, of course, variable throughout the agricultural season but tend to be minimized at the planning stage. Careful planning plus the rigid scheduling system tends to minimize labor problems. Similarly, capital is not a major problem for traditional farming since a minimum of capital investment is involved.

Comparison of the decisions made at Chalcatzingo with those made by farmers in Oaxaca (Kirkby 1973:56ff.) shows points of similarity and difference between the two areas. Oaxacan farmers also are not oriented toward maximal land use but tend to satisfy fixed goals. There, farmers calculate the amount of land needed, the amount to be fallowed, and the distribution of the crops. However, in Oaxaca the farmer also decides on the date of planting, the density of the crops, and the varieties of corn planted. At Chalcatzingo, none of these latter decisions are made; rather the Chalcatzingo farmer makes decisions at the strategic level.

As indicated by the diagram, the goal-setting decision is influenced by a number of factors, many of which tend to change from year to year. The farmer's strategy, however, is a major factor in determining the agricultural goals, and is not significantly influenced by yearly variation in the contributing factors. Therefore, it is possible to determine two logical levels of decision making, a higher "strategic" level resulting in the setting of goals and the "tactical" level involving the means of achieving those goals. With the exception of the goal-setting decision, the majority of decisions in Figure 26.5 are tactical, as they involve the means for achieving the goal once it has been set.

Strategic decisions are determined by the amount of subsistence production necessary, the sociological imperatives, and the sociocultural constraints which are in operation. Four distinct choices can be made at the strategic level. The farmer may follow the traditional strategy of producing partly subsistence and partly cash crops, he may produce only subsistence crops, he may produce only cash crops, or he may not engage in agriculture at all.

Strategy Alternatives

If a subsistence strategy is followed, approximately 1 ha of land is sufficient to supply a family of five if cash expenditures are kept at a minimum. Very few families are or have been in such desperate circumstances that they must rely on subsistence agriculture alone; however, it has happened in the past and is likely to occur again. Such a situation might occur with the incapacitation or death of the head of the family.

Few families practice no agriculture. Since the termination of the *bracero* program, most family heads have not chosen to restrict themselves to wage labor alone, although an exclusive wage labor strategy may be followed by those without access to land. The majority of wage laborers are young adults who migrate to the city. A mixed strategy of farming plus wage work is also possible for those with special skills, such as farmers who raise subsistence crops during the agricultural season and work for wages as masons, etc., during the dry season.

The most common form of agricultural strategy is the traditional pattern of mixed subsistence and cash farming. Due to the scheduling system and the distribution of land within the village, some farmers attempt to grow a crop of irrigated tomatoes in addition to the usual crops of corn and peanuts. The tomato crop matures in late December during the corn harvest. While the mix of corn and peanuts is typical of Chalcatzingo, only 6 percent of the farmers attempt to grow irrigated tomatoes each year.

Since the tomato crop is viable in terms of scheduling, it would seem that the increased investment in terms of cash and labor is the major constraint on its acceptance. Tomatoes are a risky crop, and many farmers complain that they are difficult to grow. In 1975 all but one field of irrigated tomatoes in La Esperanza had been affected by disease and failed to produce salable crops. The only productive field at that time was owned by a farmer who cash crops on a full-time basis and who had stopped the blight by daily applications of fungicide. In his case, the reduction of risk was dependent upon his experience with the crop and his ability to vastly increase his labor and cost inputs. Not all risk with tomatoes will respond to increased labor, however. Too much or too little rain may significantly decrease the production, as will high temperatures, improper fertil-

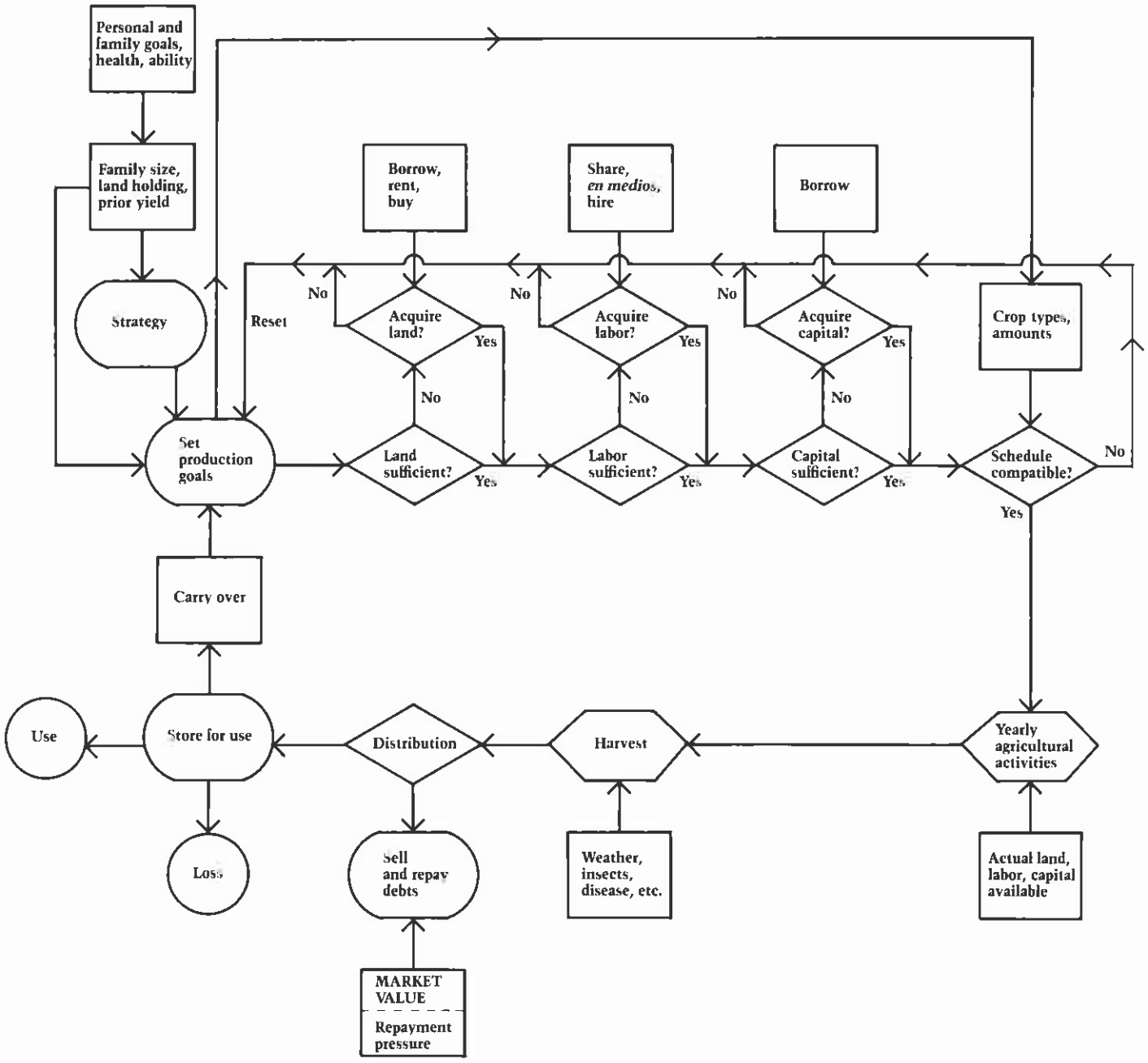

Figure 26.5. Agricultural decision-making flow chart.

ization, or other complications.

The fourth alternative is the planting of cash crops alone. This is a very limited possibility today, due largely to the small amount of irrigated land available. At other villages in the valley upstream from Chalcatzingo, farmers who have access to irrigated land often grow cash crops of onions, tomatoes, chiles, beans, or sugarcane. At Chalcatzingo, there are only two farmers who regularly plant only cash crops. Another four farmers grow only cash crops during some, but not all, years. Since failures with cash crops are often total when they occur, this strategy is not viable without some sort of backing. Those villagers planting only cash crops were able to fall back on kinsmen who provided them with food and cash in case of a total crop failure.

Alternative Tactics

Measures which Kirkby (1973:54–59) found to vary in Oaxaca, such as date of planting, plant spacing, distribution of crops on different soil types, and the area planted, are almost without variation at Chalcatzingo. The system here is marked by stability, a lack of tactical decision-making, and very little game-playing.

Planting dates are set by custom; the reasons for the dates are unknown and planting at different times is not done. The planting dates are not changed, although farmers try to predict the beginning or intensity of the rains. Since only one type of maize is commonly used, there is no attempt to plant early and late crops or insurance crops, as is the case with Oaxaca and Veracruz (Kirkby 1973; Coe 1974).

Peanuts are planted from May 1 to May 30, depending on when the plowing is done. Maize is planted from June 13 to June 23. Beans and squash are planted at the same time as corn. Irrigated crops such as tomatoes, chiles, and onions are planted from August 2 to August 5.

The inflexibility of the planting dates represents a subtle working out of the seasonality (environmental timing) of climatic factors and the requirements of individual crops. The planting dates minimize the effects of climatic variation and reduce conflicts of scheduled activities. The June planting dates for corn are late enough to insure that the rainy season has begun, but early enough to avoid damage to the plants in the dry period in August. Although corn could be planted earlier in some years, false starts of the rainy season are common. In 1972, the rains seemingly began in May, but there followed a month-long dry period until the middle of June. Had corn been planted with the rains in May, it would not have survived. On the other hand, if corn is not planted early enough, it does not have sufficient storage capacity to enable it to survive the August dry period.

Similarly, if corn were planted earlier, then the timing of the harvest would conflict with the harvest of peanuts. If it is planted later, green corn would not be available during the summer months (when there is the greatest food shortage), and the harvest would reduce the time available for wage labor and would probably result in lower prices for the corn that is sold. Therefore, variability in planting dates, because of the systemic nature of agricultural activities, would have resultant effects throughout the agricultural cycle. Dislocations at the beginning of the year bring scheduling conflicts later.

In the case of other potential sources of variability such as plant spacing, other explanations must be sought. Plant spacing is determined by the techniques of plow agriculture (Fig. 26.6). The planters follow the plow and every two steps drop the seed and cover it. Row spacing is determined by the spacing of the yoke of oxen. Plant spacing measured in three fields averaged 85.6 cm with a range of 56–114 cm and a variance of 8.4 cm. Row spacing averages 86 cm with a range of 80–100 cm and a variance of 7 cm. Plants average 4.1/m^2. These figures were found to remain constant despite differences in soil type and location. The data suggest that plant and row spacing are not varied as the result of tactical decisions.

The distribution of crops within the Chalcatzingo area is also not the result of a tactical, event-matching decision but is determined by strategic decisions made before the agricultural season begins. The decisions are made on the basis of how well the production of the preceding year met the actual needs of the farmer. The distribution of crops, the particular mix of subsistence and cash crops, depends upon such factors as family size, expected cash needs, production in the preceding year, and important personal factors such as health, ability, and the desires of each farmer. This analysis of Chalcatzingo concurs with that of Oaxaca by Kirkby (1973) that a basic constraint on the productivity of the agricultural system is the desire on the part of the farmer to meet his expected needs with a minimum of labor expenditure.

Therefore, the goal of the agricultural system at Chalcatzingo—to provide a consistent and adequate supply of food and crops for sale—is met despite environmental variability. Farmers attempt to estimate their needs and set their production goals at the beginning of the season. Once the season has begun, there is very little game-playing or variation in techniques since farmers are constrained by their labor supply and the schedule of agricultural activities.

Figure 26.6. Traditional and modern agricultural methods.

Due to this rigidity of the farmer's schedule and the limited amount of land and labor available, there are few viable alternatives to the traditional agricultural system. Although farmers experiment with new crops and techniques, change seems to occur only when a new *strategy* is attempted. The success of these alternatives is largely dependent on the nature of the larger socioeconomic system of which Chalcatzingo is only a part.

IMPLICATIONS FOR AGRICULTURAL DEVELOPMENT

Studies of the modernization of peasant agriculture fall into two broad categories: those which take an evolutionary approach and those which emphasize the dependence of peasant farmers on the world capitalist economy (Long 1977:9). The former stress the role of sociocultural factors such as traditional values and ritual obligations which are seen as barriers to modernization (Foster 1962; 1965; 1967; Rogers 1969). Dependency theorists, on the other hand, see peasants as rational decision-makers who are barred from development by the economic domination of the world economy (Baran 1957; Frank 1969a; 1969b; Matos Mar et al. 1969; Stavenhagen 1969).

At Chalcatzingo neither ritual obligations nor traditional values seem to present barriers to modernization; yet the barriers which do exist are not as simple as the dependency theorists suppose. While it is the case that farmers are for the most part rational, efficient, and profit-oriented, constraints on development exist at many levels. These have been enumerated with the consideration of decision-making and alternatives which exist at the tactical and strategic levels. The basic parameters of the system are the amount of land available for agriculture and the demographic factors which determine labor availability and production goals. Ecological constraints are revealed in the character of the climate and the soils and in the requirements of different crops. The scheduling system integrates the lower-level parameters and variables into a coherent functional whole. The socioeconomic context determines the viability of the system in terms of the national economy.

Experimentation with new techniques and crops is constant at Chalcatzingo, but most attempts to change do not prove viable, given the constraints of the system. Under the conditions of farming at Chalcatzingo, there is little margin for error, as most farmers do not have the resources to survive either a single crop failure or a year of low prices. Mechanisms to decrease risk are simply not available to the majority of families. Therefore, most farmers follow the conservative strategy of traditional agriculture which will meet their needs with a minimum of risk.

IMPLICATIONS FOR ARCHAEOLOGY

Applying these conclusions to prehistoric agriculture, it is evident that the most likely cause of change in adaptive strategies is the character of the selective pressures in the socioeconomic environment, given the stability of other factors. Agricultural intensifications such as the construction of terraces and water-control systems during the Formative were, I believe, in some way related to contact with the Gulf Coast. But, following Flannery (1968:79–80), the problem is to explain changes in subsistence strategies without invoking Olmec migrations, missionaries, or conquests. Similarly, the system of long distance trade in exotic raw materials (Flannery 1968; Grove 1968c) is not likely to have affected the subsistence base.

Both Flannery (1968:105–107) and William L. Rathje (1972) have proposed explanations for the growth of Formative cultures which emphasize the process of economic symbiosis. Both have proposed the import of raw materials into the Olmec heartland. In turn, the Olmec may have exported religious knowledge, symbols, and "status trappings" (Flannery 1968:105) or "systems of social integration" (Rathje 1972:386–387). It is difficult to specify how either symbols of status or ideas of organization could have been responsible for the massive building projects at Chalcatzingo. What is lacking in both models is a means of social control.

The hypothesis I propose here is that calendric knowledge and associated rituals may have provided the missing mechanism. Scheduling, especially of the initiation of agricultural activities, is the single most important factor determining the viability of agricultural innovations. Scheduling organizes and determines variables such as the amount of land planted, the distribution of crops, and the type of crops. In order to be accepted, new techniques and crops must be compatible with the scheduling system.

Given the fact that farmers are poor predictors of the onset of the rains, individual scheduling decisions would tend to reduce overall production and lead to a diffuse pattern of activities. If, on the other hand, scheduling decisions were vested in a few individuals with esoteric knowledge of calendrics, predictability would be increased, crop losses reduced, and activities synchronized. Calendric regulation of the agricultural cycle would therefore provide the local elite with a powerful means of social control, a means whose accuracy was demonstrable and reinforced by ritual. With such controls, the elite could gain the leverage necessary to begin the processes of agricultural intensification and control the subsistence system.

Calendric organization of the agricultural cycle also leads to the definition of non-agricultural periods. Without scheduling, farmers may tend to scatter their non-agricultural activities throughout the year, as at Tepoztlan (Lewis 1951: 150–153), leaving no time available for community activity. Calendrically defining a non-agricultural period would have made labor available for the massive construction projects which were carried out at Chalcatzingo during the Formative period. Introduction of a calendar may have been a first step for a group of specialists establishing social control. The emphasis of some carvings at Chalcatzingo on weather "control" and fertility (Chapter 10, Area I-A monuments) suggests that such an event may have occurred with Olmec contact.

RESUMEN DEL CAPÍTULO 26

El sistema agrícola en Chalcatzingo en el presente es el resultado de una larga historia de decisiones individuales tomadas por los campesinos con la intención de proveer de alimento a sus familias y poder cubrir otras necesidades. Las variables que entran en juego al hacer las decisiones en materia agrícola son muchas—tierra, labor, capital, requerimientos de los cultivos, disponibilidad de almacenamiento y facilidades de transporte, etc. La tierra agrícola es ejido, o es de propiedad privada. Una pequeña cantidad es de riego y la mayoría de temporal. Los campesinos distinguen dos tipos básicos de suelo, tierra negra, el suelo orgánico más productivo que se subdivide en los tipos arena y barro, y la tierra amarilla. Ciertos cultivos serán más productivos en uno o en otro tipo de suelo, y en tierra irrigada o en la de temporal, pero dado que todos los campesinos no tienen acceso a todos los tipos de suelo y tierra, deben escoger qué cultivos emprender y en dónde, cada estación del año, en función de las necesidades que tengan.

Los cultivos en Chalcatzingo incluyen tanto los de subsistencia como los de venta. Los cultivos de subsistencia básica son el maíz, los frijoles, y la calabaza. El maíz es de la variedad indígena, maíz criollo, el cual está relacionado con el pepitilla. El maíz híbrido podría ser más productivo, pero no ha tenido éxito porque requiere grandes inversiones de capital (en la forma de fertilizante), labor, e irrigación para lograr productividad máxima. Los cultivos de venta importantes son los cacahuates y los jitomates, los cuales requieren una inversión de trabajo bastante pesada, y los jitomates además necesitan mayor inversión de capital en forma de cajas, antiplagas, e insecticidas.

El trabajo puede ser un factor crítico en la agricultura dado que la cantidad que de él se requiere varía a lo largo de la temporada agrícola. Los periodos críticos de trabajo son la siembra y cosecha, los cuales son diferentes para los distintos cultivos. El campesino debe escoger sus cultivos basándose no sólo en los cálculos de sus necesidades, sino también con respecto a esperar los menores conflictos posibles al pretender utilizar el trabajo familiar o asalariado. Las actividades agrícolas tradicionales han sufrido una evolución a lo largo de un período grande de tiempo y han llegado al punto en que los problemas de programar el trabajo debieran no presentarse. Sin embargo, el cultivo para venta tiene como consecuencia el que tenga que sobreponerse a los períodos agrícolas tradicionales, con los cuales entra en conflicto precisamente en el momento crítico de la cosecha.

Dadas todas estas restricciones, el campesino tiene que hacer frente cada año al problema de escoger entre cuatro estrategias básicas: emprender sólo cultivos de subsistencia, emprender sólo cultivos de venta, emprender ambos cultivos de venta y subsistencia, y no emprender ningún cultivo. La estrategia seguida más comunmente es la tercera, o sea emprender ambos cultivos de subsistencia y venta con objeto de poder alimentar tanto a la propia familia, como también tener un ingreso adicional, aun cuando los campesinos con ello tienen que hacer frente a problemas de programación de la tierra y de empleo del trabajo en una situación de conflicto entre dos estrategias relativamente inflexibles.

Una vez hecha la decisión de qué estrategia seguir al principio de la temporada agrícola, cada campesino tiende a seguir las prácticas agrícolas de costumbre desarrolladas para minimizar los riesgos de pérdida. Por ejemplo, la programación, el factor más crítico, se encuentra fuera del alcance de cada campesino una vez que decide qué cultivos emprender, dado que las fechas para la siembra están dadas por la costumbre.

Si éste hubiese sido el caso dado en el pasado, i.e., si las decisiones de programación hubiesen sido hechas no por cada campesino sino por unos cuantos individuos dotados de conocimiento esotérico sobre el calendario, ello podría ayudar a explicar el surgimiento de una élite local con un medio de control social bastante poderoso. Esta élite pudo haber determinado la programación no sólo de las actividades agrícolas sino también de las no agrícolas, i.e., públicas o ceremoniales. La introducción de un calendario, controlado por una élite en ascenso, pudo haber sido un acontecimiento principal en la evolución de la complejidad sociopolítica en Chalcatzingo.