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# The Domestic Mode of Production and Risk Management by Quintana Roo, Mexico

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## Introduction

Marshall Sahlins's theory of the domestic mode of production (hereafter, DMP) held great import for the analysis of peasant economic systems. In short, this theory states that "primitive" economies, generally based on domestic groups and kin relations, are inherently underproductive. The net result of the underuse of land and labor is that most households barely eke out a subsistence. Though the DMP describes an idealized situation that Sahlins admitted probably does not exist, many economic anthropologists take the DMP to heart (Brush 1977; Donham 1981; Reyna 1994). Unfortunately, most modern ethnographic research fails to incorporate the type of quantitative data necessary for testing Sahlins's theory. Furthermore, the increasing market integration of once peripheral areas means that many ethnographic field sites violate some of the DMP's basic assumptions. For these reasons, the data presented here are from an older ethnographic source, Alfonso Villa Rojas's study of the Maya of east central Quintana Roo, Mexico (Villa Rojas 1945). Villa Rojas provides data on the agricultural production and demography of 52 households, but gives no in-depth analysis of this data. Since his data on household agricultural practices are of superb quality and this case meets all of the underlying assumptions of the DMP theory, we have before us the ability to quantitatively test Sahlins's model. In doing so, we see that the DMP does not accurately describe the productive activities of the Maya of Quintana Roo. On average, households are overproducing, i.e., producing much more than is necessary to meet their basic subsistence requirements. One explanation for this overproduction is that households overproduce in an attempt to mediate environmental variation. This conclusion points to one of the underlying weaknesses of Sahlins's theory – his failure to adequately include the environment as a factor affecting household production and risk management.

As anthropologists, why should we bother with a critical examination of a theory whose heyday

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has passed and which has already been subject to enormous criticism? Two reasons immediately come to mind. First, the underlying argument of Sahlins's theory of the DMP has been unconsciously, if not sometimes uncritically, absorbed by many economic anthropologists. As a discipline, we should constantly check our premises rather than rely on accepted and oftentimes stale theoretical models. In this way, our theories for explaining cultural behavior become more sophisticated, as do the models that these theories generate. Fortunately, the centennial of American anthropology encourages many anthropologists to take such a critical historical perspective.

Second, while an in-depth discussion of an older theory in light of even older data may seem outdated, to say the very least, the situation described by the DMP model, as well as the circumstances encountered by the Mayan farmers in Quintana Roo in the 1940s, are quite contemporary. At the heart of the DMP model lies strategies for risk management. The peripheral areas which Sahlins hoped to describe with this model still exist and have become even riskier environments due to market integration and the impact of globalization. Now, more than ever, an understanding of risk management strategies is critical, particularly because of the implications this understanding may have for theories of development and our understanding of globalization as a local process.

*The Domestic Mode of Production*

According to Sahlins (1972), the domestic mode of production characterizes economies that are organized on the basis of domestic groups and kin relations. In such a system, production is geared towards the requirements of a household or family unit, and this production is for the benefit of the producers alone (1972:77). Three interrelated elements make up the DMP. First, the household consists of a small labor force with a division of labor by sex. In this regard, the household appears much like the peasant farm described by Chayanov (1986); the labor force available to the household is constrained by the number of people in the household. Members of the household neither engage in wage labor, nor do they hire wage laborers. Second, the household uses simple technology. The technology must be compatible with the household's organization and must be of a similar dimension or scale (1972:79). For example, a peasant household would not use a combine to harvest its maize nor would a multinational agribusiness use a dibble to till soil and sow crops. Third, these economic systems have finite production objectives and more specifically, are oriented towards subsistence rather than market production. In Sahlins's model of the DMP, as in Chayanov's theory of peasant economy, the household produces for its own consumption and exists outside any developed marketing system.

The implication of these three elements is that the DMP under-uses the available resources, particularly land and labor. Much of Sahlins's quantitative data come from slash and burn agriculturalists and demonstrate that actual production in much less than is possible (1972:42). In more ecological terminology, those groups characterized by the DMP live well under the carrying capacity of their environments. Rather than arguing that the environment is a factor influencing agricultural production, Sahlins claims that sociocultural organization, that is, the domestic organization of production, impedes the development and intensification of productive means.

*The Maya of East Central Quintana Roo*

Villa Rojas studied the Maya of east central Quintana Roo during 1935 and 1936 as part of Redfield's comparative project on the "folk culture" of the Yucatan (Redfield 1941). Four communities were compared, Merida, Dzitas, Chan Kom, and X-Cacal, each of which represented a different degree of cultural development in Redfield's folk-urban continuum (See Figure 1)[Note: Figures are found at end of article.]. Redfield intended X-Cacal to represent the most "primitive" of the communities. While Redfield's folk-urban continuum no longer survives as a viable model, the ethnographic data generated by his and Villa Rojas's work is impressive. As with much older research, these ethnographies contain a wealth of information, some of which has yet to be fully analyzed.

Villa Rojas describes Quintana Roo as divisible into three zones, the northern, central, and southern, with the central or "native" zone being the focus of his study. Concentrated here are Mayans who "are characterized by seclusiveness, by a hostility toward civilization, and especially by their dislike of the Mexican Government. These traits, together with scarcity of roads and other means of communication, have kept this a marginal region" (Villa Rojas 1945:40). Within this central zone, the X-Cacal sub-tribe is particularly known for its self-imposed isolation and hostility to outside influence. For example, only one community, Chanchen, tolerated the presence of a schoolteacher and this for only a short period of time (Villa Rojas 1945:42). The route to the village is very seldom ever traveled, and very few non-natives are ever seen in the pueblos. Travelers and strangers passing through the territory of X-Cacal are not allowed to sell anything in the pueblos, nor are they allowed to remain in a pueblo for more than one night (Villa Rojas 1945:42). Only two or three known itinerant merchants are tolerated. In many ways, the X-Cacal Maya of the 1930s exemplify a closed corporate peasant community (Wolf 1957).

The X-Cacal sub-tribe is composed of nine settlements, all of which are quite small (see Figures 2 and 3). While Villa Rojas concentrated on Tusik and X-Cacal, the most important villages of the sub-tribe, he collected data on all nine settlements. The residents of these pueblos share a common culture, including a fusion of Catholicism and traditional Mayan religious beliefs, maize agriculture, very little accumulation of wealth, exclusive use of the Mayan language[1], and an emphasis on extended family relations. Marriage is village exogamous, leading people to view the sub-tribe as one very extended family (Villa Rojas 1945:44). Given this marriage pattern, numerous ties exist between communities. But even though close relatives may live in other communities, people only leave their village three or four times a year and only for special occasions (such as births, illnesses, and fiestas) or ceremonies which require their presence in another pueblo (Villa Rojas 1945:44). The distribution of population is fairly stable, and negligible amounts of in-migration and out-migration occur. Only within the 1930s did people from X-Cacal migrate to the commercial centers of Valladolid and Peto, 168 km and 192 km respectively; Villa Rojas claims that this is because the X-Cacal Maya are "somewhat afraid to appear among the Whites." Trips are infrequently made to Valladolid and Peto to purchase knives, machetes, whiskey, salt, pepper, and clothing and to Belize (then British Honduras) to sell pigs (Villa Rojas 1945:45).

Given the basic assumptions of the DMP and their implications, the X-Cacal Maya of east central Quintana Roo are the perfect test case for Sahlins's theory. First, X-Cacal households correspond to family units with a division of labor by sex. This division of labor is symbolized in the ceremony called *hetzmek*, whereby infants are "baptized" and presented with the tools with which they will work for the remainder of their lives. Females, whose lives are to center around the household and the three stones of the hearth, are given weaving implements and cooking utensils. Males, whose lives are to center on the four stones marking the boundaries of their corn field (*milpa*), are presented digging sticks and machetes. As infants grow into productive members of the community, they learn to perform the activities associated with the items they are given during the hetzmek ceremony. Women are responsible for all housework, including the preparation and grinding of maize, cooking, washing, sewing, embroidering blouses (huipiles), and fetching water from the well.

Women also act as midwives, care for domestic animals, raise small gardens near the house, and make cigarettes. Though firewood is cut by men and boys alone, windfall and downed limbs may be gathered by women. Public and religious functions are the responsibility of men, but women may play a secondary role in religious ceremonies. Likewise, men are responsible for the milpa, though women may assist in weeding, sowing, and harvesting. Men do all work requiring the use of a machete or axe; hunt; care for beehives; make candles, hats, and baskets; and extract chicle (Villa Rojas 1945:70).

Second, the slash-and-burn technology used by the X-Cacal Maya is relatively simple. The livelihood of the X-Cacal Maya depends on the milpa: its selection, preparation, maintenance, and harvesting. Once a plot of land is selected, the existing brush is felled with axes and machetes purchased in Valladolid. After the brush is sufficiently dry, it is burned over, and the milpa is ready for planting. A pointed stick (xul) tipped with iron is used for digging holes about a pace apart. After making the hole, the farmer plants five or six maize kernels, plus squash and beans. The seed is carried in a shoulder bag (sabucan). The crop grows, is weeded once or twice, and eventually is harvested and stored (Villa Rojas 1945:56-57). Thus, the main technological requirements of this economic system are axes, machetes, fire, and a pointed stick, all relatively simple.

Third, the X-Cacal sub-tribe exists outside of the marketing areas of any nearby towns (see Figure 2). Villa Rojas describes the entire region as extremely isolated and hostile to outside influence (Villa Rojas 1945:42). Routes of communication here were in bad condition during Villa Rojas's fieldwork, and roads were only useable during the dry season. During this time, November to April, itinerant merchants came through the area, and people were able to make any necessary purchases of knives, axes, clothing, and so forth. Only two or three recognized merchants were allowed to trade in the pueblos. All other travelers "were objects of suspicion, whose every attempt to engage in friendly conversation was evaded" (Villa Rojas 1945:42). Villa Rojas, who remained in Tusik and X-Cacal for some time, was still regarded suspiciously in the other pueblos. Furthermore, as other villages in the central zone were increasingly receptive to outside influences, including the federal government, cooperative organizations, and schoolteachers, the X-Cacal Maya were becoming relatively more isolated.

Given this isolation, the X-Cacal Maya engage in a negligible amount of commercial activity. The primary item of consumption throughout the area is maize, and given the difficulties of transporting it any distance and the X-Cacal's dislike of outsiders, very little of it goes for commercial purposes (Villa Rojas 1945:59). Only rarely is maize sold to muleteers and itinerant merchants for their animals and then only in emergencies. Chicle production is of secondary importance, engaged in very occasionally and undertaken on individual initiative. When presented with the opportunity to develop chicle extraction as a commercial endeavor through the establishment of a government cooperative organization, the X-Cacal Maya flatly rejected the idea (Villa Rojas 1945:40-42). Only one pueblo, Chuncunche, has anything resembling a craft specialization. Straw boxes are made and sold in Chuncunche, but no other village specializes in any industry or product (Villa Rojas 1945:44). The very occasional journeys that people make to Valladolid and Peto generally have no commercial purpose whatsoever. During Villa Rojas's fieldwork, he noted only one such excursion, when a man who owned a horse carried a tin of lard[2] into the city to exchange it for whiskey (Villa Rojas 1945:45-46).

Based on these three characteristics, division of labor by sex, simple technology, and production for consumption, Sahlins predicts that such a group will not fully exploit their available labor and land resources. An examination of available data shows that the X-Cacal Maya fulfill each of these predictions, as much labor time and land are either unused or used for non-economic activities.

First, labor resources are under-used. Villa Rojas (1945:77) provides data on the distribution of time, by days, for an average man of the Tusik pueblo[3] (see Figure 4). Only half of the average man's time, or 186 days, is devoted to labor. Of labor time, only 75% or 141 days was devoted to agriculture, the basis on the X-Cacal economy (Villa Rojas 1945:77). Therefore, the average man has much room to reallocate the distribution of his time in favor of economic activities, yet fulfill his religious obligations and have the occasional diversion. Figures 5 and 6 show the distribution of time between labor, religious obligations, and diversions, as well as the distribution of time among four types of labor activities (agriculture, chicle extraction, hunting, and beekeeping).

Therefore, the labor resources of the average man are not fully exploited, as nearly half of available labor time is spent fulfilling religious obligations, attending fiestas, visiting kin, or sitting idle. Furthermore, Sahlins would argue that the division of labor by sex contributes to the under-use of labor resources (1972:54). Women seldom participate in agricultural activities, and when women do assist their male relatives and husbands, they are restricted to weeding and harvesting. Women are not physically incapable of agricultural work, nor do their household duties consume all of their available time. As a whole, then, the X-Cacal Maya under-use their available labor resources.

As predicted by Sahlins's theory, the X-Cacal Maya also seem to under-exploit the available land resources. According to Villa Rojas's calculations, there must be between 36 and 42 mecate (0.0828 to 0.0966 km$^2$) of land available per person over the course of a lifetime.[4] This estimate takes in to account the standard of living, the prevailing techniques of maintenance, variations in soil fertility, and necessary fallow time (Villa Rojas 1945:60). The population of the X-Cacal sub-tribe is 720 people distributed in 9 communities. Given this population, there must be between 59.61 and 69.55 km$^2$ of land available for the sub-tribe as a whole. The total territory of the sub-tribe is 1625 km$^2$, well over the necessary upper limit of 69.55 km$^2$. Thus the X-Cacal sub-tribe under-exploits their available land resources.

The DMP's prediction, based on the above information, would be that the X-Cacal Maya have a domestic mode of production. Therefore, their failure to fully exploit the available labor and land resources translates into widespread under-production. Rather than investing more time and energy into agricultural production, people would develop other aspects of their culture, e.g., religious activities, diversions, and social relationships, as seen in Figures 4 and 5. An examination of Villa Rojas' data show that this prediction does not hold true. In fact, the X-Cacal Maya, on average, over-produce.

*Household production in Quintana Roo*

Villa Rojas provides data on 52 households for the agricultural season of 1935-1936. These data come from five of the nine villages of the X-Cacal sub-tribe and are slightly weighted to the pueblos of X-Cacal and Tusik. Given that these are two of the larger and more accessible settlements, this distribution is not surprising. And given the relative homogeneity of the X-Cacal sub-tribe, this distribution should not significantly impact the data. Villa Rojas' goal was to provide an estimate of the area's total maize production. To this end, he presents data on area planted and amount of maize harvested and breaks this down by type of milpa planted. Farmers in this area recognize three types of milpa.

*Chacben*: first year plots, when the high brush must be felled,

*Zakab*: second year plots, when the re-growth must be cleared and burned, and

*Hubche*: land that is fallow after being planted for several years and will eventually by re-planted.

The land in this area is moderately fertile, but fertility declines yearly as the soil of a particular plot becomes depleted. Morris Steggerda's informants in the northern part of the Yucatan at roughly the same ethnographic period estimated that a plot of land produced half the yield in the second year that it produced in the first. Steggerda's own field experiments demonstrate that this estimate is exaggerated. He found that yield declined by an average of 17% in the second year (Steggerda 1941:119-120). In terms of the types of milpas listed above, "the harvest is satisfactory if the produce amounts in terms of the average mecate to: 1 carga in milpa chacben; 0.6 carga in milpa zakab; and 0.8 carga in milpa hubche" (Villa Rojas 1945:60). Given the variability of the different types of milpas and the extra time and labor needed to prepare the more fertile types, farmers usually prepare two tracts of land a year, one in chacben and the other in either zakab or hubche. A tract is chosen and measured off, and the brush is felled from December until beginning of April. The first rains are believed to fall on St. Mark's Day, the 25th of April, so the burning and preparation of the milpa must be completed in the first two weeks of April but no later than the end of May (Villa Rojas 1945:56-57).

Figure 7 shows the data that Villa Rojas presents for the 52 households he studied. The only modification made is to convert cargas into kilograms (1 carga = 46 kg). More specifically, this table presents data on the type of milpa planted and the amount of maize harvested from each plot.

To arrive at an estimate of household overproduction, we must first determine the amount of maize necessary for each household to subsist. Thus, we must look at the number of people in each household and the amount of maize needed per person. Villa Rojas included data on household demography, and Steggerda's work gives a fairly precise estimate of the amount of maize consumed per day per person. He calculated that the average person consumed 1.43 lb or 0.64 kg of maize per day.[5] Also, he found that households fed an average of 3.5 lb or 1.58 kg of maize per day to their domestic animals, namely swine and poultry, regardless of the number of animals they had (Steggerda 1941). Thus, we can arrive at the amount of maize needed for each household in a year by multiplying the number of people in the household by the amount of maize needed per person per day, adding in the amount of maize fed to domestic animals per day, and multiplying all of this by 365. This calculation represents the minimum needed for that household for one year and is shown for each of the 52 households in Figure 8. Any maize produced over the amount needed to feed the members of that household and their domestic animals is classified as overproduction, while failure to meet this minimum standard is under-production (italicized in Figure 8).

Because subsistence farmers should plan to produce at least this minimum amount of maize, we next calculate their expected harvest. Again, this is a rather straightforward calculation, given that we know the areas for each type of milpa planted for each household and the expected yield[6] for each type of milpa. We can then compare the minimum amount necessary to subsist with the amount expected at harvest time. This figure indicates the planning and management that each household does in order to allocate their land and labor resources. In terms of testing the DMP, the comparison of necessary harvest and expected harvest is crucial. Assuming that each household unit knows how much maize is necessary for their survival (and there is no reason to believe otherwise), the DMP predicts that the household would take this as its goal, i.e., each household will plan to produce just enough to subsist and nothing more.

Figure 8 shows the total amount of maize necessary, expected, and harvested for each of the 52 households. Some households, like #33, come very close to planting exactly what is necessary to subsist. Others, like #30 and #35, do not plant enough to meet their subsistence needs based on expected yields. As it turned out, this agricultural season was slightly better than expected, and these households do manage to plant enough to survive. What is most startling about these calculations is that the majority of the X-Cacal farmers are planning to over-produce. They are planting well above what they need to survive, as shown by the difference between the amount of maize necessary and the expected harvest based on area and type of milpa planted. These figures are graphically represented in Figure 9. Positive figures indicate that a household planned to produce more than was necessary, while negative figures show that the household planned to produce less than was necessary for the survival of that household. On the whole, households are over-producing; the average difference between expected yield and the amount necessary is 1,292 kg per household. If the X-Cacal Maya were part of a developed marketing system and had access to reliable transportation, such over-production is to be expected. Everything that the household did not consume could be sold in the market. However, in the absence of a marketing system, as is the case here, such over-production makes very little sense, and the obvious question arises: Why over-produce?

*Overproduction among the X-Cacal Maya*

One explanation for agricultural overproduction is that some households will over-produce, while others will under-produce. Under-producers can then call upon over-producers when they are in need, and everything within the social system averages out in the end. As Sahlins hypothesizes, the difference between over- and under-production is evidence of social organization and reciprocity. While this may explain his test case, this interpretation does not explain overproduction among the X-Cacal Maya. Sahlins' explanation can be disregarded for two reasons.

First, Villa Rojas states that cooperation between households and villages is uncommon among the X-Cacal Maya. Undoubtedly some reciprocity occurs within families or households, but the overall impression that Villa Rojas gives is that households produce for themselves alone. The only time that large-scale cooperation occurs is in response to an external threat from the federal government. Even communal work parties, so common just to the north in Chan Kom (Redfield and Villa Rojas 1934), are extremely rare among the X-Cacal Maya. Therefore, the individualistic nature of each household unit seems to preclude reciprocity as an explanation for overproduction.

Second, and more convincingly, the average per household production is much higher than is to be expected. For the entire X-Cacal area, households are overproducing. Even if the under-producing households drew on the resources of the over-producers, as Sahlins claims that they will, a net surplus still exists. And, this net surplus is large. The average household is producing over 1,200 kg of maize more than is necessary. At the end of the agricultural cycle, a huge surplus remains, yet there is no apparent mechanism for the disposal of this surplus.

The conclusion to be drawn from the data presented here is that the DMP does not explain the situation of the X-Cacal Maya, even though this case meets all of the basic assumptions of the model. One explanation for the failure of the DMP to explain this case is that Sahlins failed to include risk management in his model. In subsistence agriculture, the main source of risk is environmental variation. In variable environments, farmers will plan differently than if they did not have to deal with such variation. One strategy that farmers around the world have developed for dealing with this variation is agricultural overproduction. But first, what is the evidence for environmental variation in the X-Cacal area?

*Climate and Risk Management*

The climate of Quintana Roo is very similar to that of the rest of the Yucatan peninsula. Nights are cool and days warm. The average temperature is 78° F and rarely ever drops below 50° F. Villa Rojas

(1945:39) states that the temperature may drop to 38_ F, but an examination of weather records from Chichen Itza shows that this must be a very rare occurrence indeed (Steggerda 1941). While temperatures are quite important to agriculture in areas where they are more variable, for example the Mexican highlands, they do not appear to be a factor significantly impacting the agriculture of the Yucatan.

What does greatly impact agriculture in the Yucatan is rainfall. The year can be divided into two seasons based on amount of rainfall rather than on temperature. Figure 10 shows monthly rainfall for the years 1928 through 1935 as recorded by the Chichen Itza weather station (Steggerda 1941:132-133). The rainy season apparently begins in May and lasts through October; therefore the traditional belief that the rains begin on St. Mark's Day, the 25th of April, is fairly accurate. In the interior areas of the Yucatan, including the X-Cacal area, precipitation varies from 60 to 80 inches. Records show that precipitation can be three or four times the average in some years (Villa Rojas 1945:39). The dry season begins in November and lasts through April. Very little rain falls during these months, and a cold north wind blows over the land (Steggerda 1941:130).

Variation in rainfall can significantly impact the agricultural cycle, as all phases of slash-and-burn agriculture as practiced by the X-Cacal Maya must coincide with the most favorable weather conditions. Just before the maize crop ripens, men select their fields for the following year. The brush is cut and allowed to dry through December, January, and February, ordinarily months of little rainfall. In March and April, also months of little precipitation, farmers burn the brush in preparation for sowing the crop in May. Should heavy rains fall during these months, as it did in 1928, the brush will not dry, and the fields cannot be properly burned. Thus, less area can be planted. According to Steggerda (1941:131), May is the most critical month, for little rainfall may portend a famine.[7] Again, this was the case in 1928. Very little rain fell in May and June when the maize should be making its most rapid growth, and this drought caused famine conditions in 1929. Throughout the typical summer, though, the maize grows and matures, until September when the ears are bent down. Bending the ears prevents rain from running into the ear and causing various molds that ruin the crop. Harvest takes place from November through the beginning of the next agricultural cycle (Steggerda 1941:131-135).

Given that precipitation is so variable in its timing and amounts, farmers must plan, and this planning is the key element missing from the DMP model. For example, early rains may prohibit the proper burning of one's fields, thus restricting the amount of land available for cultivation. Therefore, the sensible thing to do is to clear a bit more than is needed so that in a year with early rains, enough land can be burned to plant a full crop. Drought may dramatically decrease one's harvest, so planting more than is needed is a way to mediate that risk. Plagues of rats and grasshoppers, in addition to the normal predation of animals on crops, also pose a risk for which farmers must plan. Again, the best bet is to over-produce. This strategy is used by farmers elsewhere to adjust to unpredictable environmental variation. In Melanesia, for example, "planting what will be more than enough should the weather be good is a means of ensuring that there will be enough or possibly just barely enough should the weather be bad" (Vayda, Leeds, and Smith 1961:70). According to Vayda, Leeds, and Smith, this adaptation exemplifies Liebig's law of the minimum, as farmers are planning for the extreme case rather than the average outcome. Thus, when subsistence farmers like the X-Cacal Maya are over-producing, and doing so in such a large amount and in the absence of a marketing system, they are experiencing cooperative weather conditions and a good agricultural season. They have planted more than is necessary – just in case the rains come early, or a drought hits in May, or some other environmental upheaval occurs.

*Granaries and Piggy Banks*

When harvests are more than adequate, what is to be done with the surplus? Several options immediately come to mind. Sell the extra maize: but given the lack of a developed marketing system, poor road conditions, and unreliable transportation, marketing is not feasible for the X-Cacal Maya. Eat more food: but a person can only eat so much until they are satisfied. Have more children who can eat more food: but this is an impractical solution with long-term consequences. Store the maize until it is needed during the next food shortage. Of the possible options, storage makes the most sense and is the easiest to accomplish. More importantly, storage of food allows environmental vicissitudes to be overcome more easily. Should a risk-conscious farmer plant more than enough maize, but a severe drought or flood destroys most of the crop, the harvest may still fall short of the amount needed to feed the household. But, maize that has been stored can be used to survive this slim season in the hopes that next year's harvest will be more bountiful. In fact, the X-Cacal Maya try to store enough maize to make it through two or three lean years (Villa Rojas 1945:60).

The X-Cacal Maya can store their surplus maize in one of two ways. The more widely acknowledged method of storage is a granary. Usually a small structure is built near the milpa, and maize is stored there for a year or more (Villa Rojas 1945:52). The problem with granaries is that the stored maize is vulnerable to rodents, theft, and spoilage, losses which are irrecoverable.

A less widely acknowledged way of preserving the use-value of maize is to feed it to livestock, primarily poultry and swine (Wilk 1981; Kyle 1995). Households can feed their surplus maize to swine, and then sell the pig when they are in need of cash or supplies. In this sense, swine are quite literally piggy banks, i.e., they store the use-value of maize just as a savings account preserves the use-value of money. Based on a survey of the ethnographic literature, this method of "banking" is common throughout Mesoamerica.[8] For example, the Kekchi Maya, who live in Belize, just south of the X-Cacal Maya, preserve their corn in this way (Wilk 1981, 1991). Pigs are thought of as secure sources of emergency cash: "If crops fail completely, a pig can be sold and food purchased from others or from shops in town" (Wilk 1981:22). For the Kekchi, pigs are the most important way to store surplus and reduce risk. Plus, they take resources not available to humans and make them available (Wilk 1981:23). These resources can be spoiled maize and maize-based household slop, wild resources that are foraged, or human excrement.[9] Thus, when maize harvests are bountiful, swine can be fed from the household's maize supply and fattened, but when times are lean, swine can be turned out to forage for their own subsistence.[10] According to Villa Rojas, at least two or three of a household's pigs are raised for sale, while the others are eaten on the Day of the Dead or at a patron saint's fiesta (Villa Rojas 1945:57). When a household chooses to sell a pig, they can either wait until an itinerant merchant comes through the area or take the pig to Belize and sell it there. Once or twice a year large parties of X-Cacal Mayans would travel to Belize to sell their swine in exchange for clothing and other merchandise (Villa Rojas 1945:59). These parties are taking advantage of another benefit of pigs (other than being edible and requiring little care), that is, pigs are mobile. Even though the X-Cacal area is not part of a developed marketing system, swine represent a commodity that is amenable to distance-marketing, since they can be herded (Ewald 1977). This quality led to the development of a thriving trade in swine throughout the Yucatan (Redfield 1941).

Regardless of the method chosen, the basic function of such storage for the X-Cacal Maya is to mediate environmental variation. Extra maize in the granary or a pig that can be eaten or sold provides a bit of security when households are faced with an uncertain environment and thus, an uncertain future.

*Conclusions*

Given an absolutely perfect test case, one that fulfilled all the basic assumptions of the model, Sahlins' DMP failed to predict or explain the behavior of the X-Cacal Maya. Rather than under-producing, or at the very least aiming to break-even, the X-Cacal Maya are over-producing. Overproduction, as practiced here, is a form of risk management. This is why Sahlins' model fails: the DMP does not incorporate or acknowledge risk management. In general, when conditions are variable, households will plan for that variation as much as is feasible. For subsistence agriculturalists, risk comes in the form of environmental variation, and this is particularly the case for the X-Cacal Maya, where every phase of the agricultural process is dependant on cooperative weather. Thus, in any given year, the typical X-Cacal household will seek to produce more than is necessary to subsist, just in case the yield is less than is expected. The result is that in an average year, with moderately cooperative conditions, the average farmer will not only produce enough to subsist, but will over-produce. In order to carry over this surplus to the next year, the household will store its maize—either in a granary or through feeding surplus maize to domestic animals, especially swine. Therefore, in order for the DMP (or any other theory explaining economic systems and their development) to be a viable model that explains actual human behavior in actual environments, it must take into account risk management through overproduction

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***Footnotes***

[1] At the time of Villa Rojas's fieldwork, no one spoke or understood Spanish, nor did many people express interest in learning Spanish. Villa Rojas noted that many people desired to learn English and saw it as a more prestigious language. Given the fervent dislike of the federal government by the people of this area, that point of view is unsurprising (Villa Rojas 1945:48).

[2] During the 18th century, pork products, especially lard, were part of an illicit export trade between the Yucatan and Cuba. Jars of lard and pork were secretly shipped to Havana (Pohl and Feldman 1982:304).
[3] Interestingly enough, Villa Rojas claims that this village is known as one of the more industrious of the X-Cacal sub-tribe.
[4] In the X-Cacal area, the mecate equals 23 $m^2$. This measure varies by area; e.g., in Chan Kom a mecate equals 20 $m^2$ (Villa Rojas 1945:60).
[5] For a more complete discussion of maize consumption in Mesoamerica, see Stuart (1990). This article also includes an interesting comparison of different field methods used to estimate consumption. For a more regional approach, see Kyle (1995).
[6] Expected yields are 1 carga per mecate in milpa *chacben*; 0.6 carga in milpa *zakab*; and 0.8 carga in milpa *hubche* (Villa Rojas 1945:60).
[7] Steggerda (1941:135) states that 15 great famines occurred in the Yucatan from 1535 to 1835, at an average interval of 20 years. Most of these famines could be directly linked to anomalous weather condition: drought, floods, and hurricanes.
[8] See Vayda, Leeds, and Smith (1961) for a description of swine "banking" in Melanesia (cf. Rappaport 1984).
[9] Though lots of anecdotal literature describes pigs' unbridled affinity for human waste (see Mary and Fred del Villar's *Where Strange Roads Go Down*, for example), swine do derive some essential nutrients from excrement, particularly amino acids. This assertion is based on Poovaiah, Napton, and Calloway's experimental work on the composition of coprolites (1977).
[10] Though neither Villa Rojas nor Wilk allude to feral swine populations in this area, pigs can and do subsist without the help of humans throughout South America and Mesoamerica, including the Yucatan (Lever 1985:114).

**Figure 1: Location of the Maya of East Central Quintana Roo** (adapted from Villa Rojas 1945)

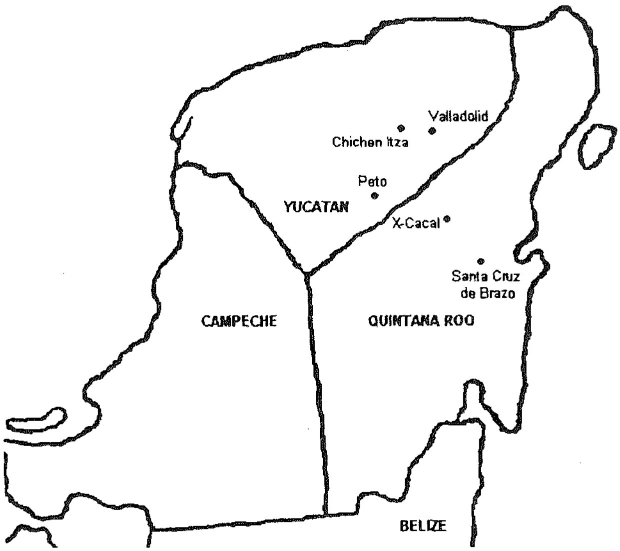


**Figure 2: The Pueblos of the X-Cacal Maya** (adapted from Villa Rojas 1945)

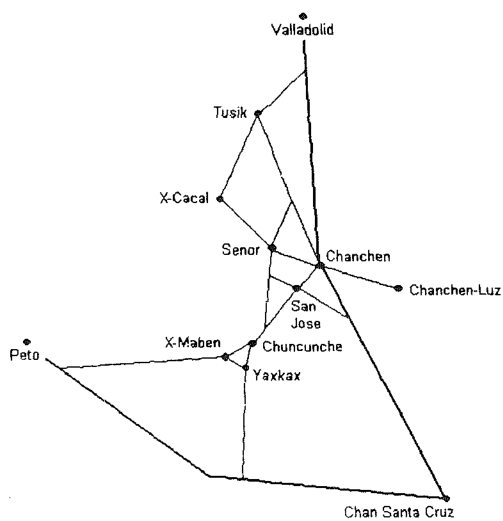

**Figure 3: Population Distribution of the X-Cacal Maya** (Villa Rojas 1945: 43-44)

| Pueblo | Number of Households | Population |
|---|---|---|
| X-Cacal | no data | 206 |
| X-Maben | 18 | 140 |
| Tusik | 23 | 116 |
| Señor | 13 | 71 |
| Chuncunche | 8 | 54 |
| San José | 7 | 45 |
| Chanchen | 7 | 42 |
| Yaxkax | 4 | 26 |
| Chanchen-Laz | 6 | 20 |
| **Total** | | 720 |

**Figure 4: Distribution of Time for an Average Tusik Man,1935 – 1936** (Villa Rojas 1945:77)

| Activity | Number of Days |
|---|---|
| Labor | 186 |
| Fiestas and religious obligations | 132 |
| Diversions and trips | 48 |
| Total | 366 |

**Figure 5: Time Allocation for an Average Tusik Man, 1935 – 1936** (based on Villa Rojas 1945:77)

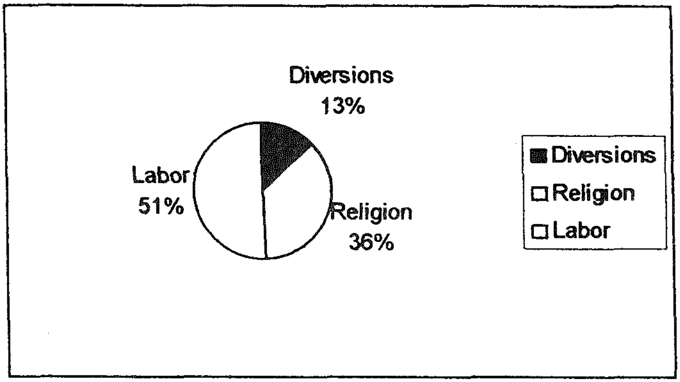


**Figure 6: Labor Allocation for an Average Tusik Man, 1935 – 1936** (based on Villa Rojas 1945:77)

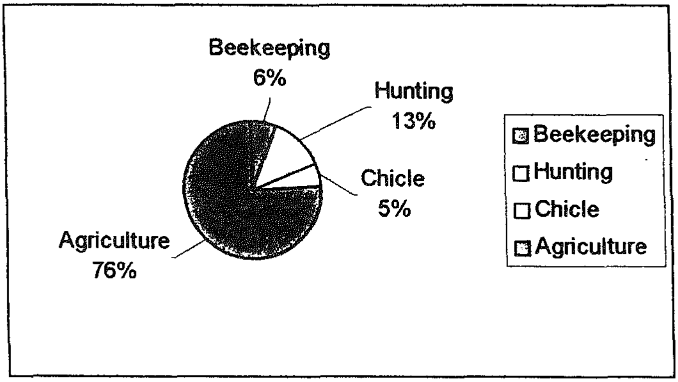

**Figure 7: Amount Planted for Each Type of Milpa for 52 X-Cacal Households** (Villa Rojas 1945)

| Household # | Chacben Mecates Planted | Chacben Kilos Harvested | Zakab Mecates Planted | Zacab Kilos Harvested | Hubche Mecates Planted | Hubche Kilos Harvested | Total Mecates Planted | Total Kilos Harvested |
|---|---|---|---|---|---|---|---|---|
| 1 | 26 | 1,196 | | | 24 | 1,104 | 50 | 2,300 |
| 2 | | | 12 | 552 | 40 | 1,840 | 52 | 2,392 |
| 3 | 18 | 828 | | | 25 | 1,150 | 43 | 1,978 |
| 4 | | | | | 118 | 5,428 | 118 | 5,428 |
| 5 | 100 | 4,600 | 10 | 460 | 60 | 2,760 | 170 | 7,820 |
| 6 | 18 | 828 | | | 42 | 1,932 | 60 | 2,760 |
| 7 | 25 | 1,150 | | | 35 | 1,610 | 60 | 2,760 |
| 8 | 18 | 828 | | | 84 | 3,864 | 102 | 4,692 |
| 9 | 12 | 552 | | | 20 | 920 | 32 | 1,472 |
| 10 | 5 | 230 | 11 | 506 | 28 | 1,288 | 44 | 2,024 |
| 11 | | | | | 48 | 2,208 | 48 | 2,208 |
| 12 | 90 | 4,140 | | | 180 | 8,280 | 270 | 12,420 |
| 13 | | | | | 70 | 3,220 | 70 | 3,220 |
| 14 | | | | | 45 | 2,070 | 45 | 2,070 |
| 15 | 90 | 4,140 | 15 | 690 | 95 | 4,370 | 200 | 9,200 |
| 16 | 40 | 1,840 | | | 18 | 828 | 58 | 2,668 |
| 17 | 20 | 920 | | | 30 | 1,380 | 50 | 2,300 |
| 18 | | | | | 52 | 2,392 | 52 | 2,392 |
| 19 | | | 22 | 1,012 | 67 | 3,082 | 89 | 4,094 |
| 20 | 23 | 1,058 | | | 20 | 920 | 43 | 1,978 |
| 21 | | | | | 43 | 1,978 | 43 | 1,978 |
| 22 | 20 | 920 | 12 | 552 | 15 | 690 | 47 | 2,162 |
| 23 | 30 | 1,380 | | | 40 | 1,840 | 70 | 3,220 |
| 24 | 100 | 4,600 | | | 50 | 2,300 | 150 | 6,900 |
| 25 | 30 | 1,380 | 20 | 920 | 14 | 644 | 64 | 2,944 |
| 26 | 25 | 1,150 | | | 15 | 690 | 40 | 1,840 |
| 27 | 200 | 9,200 | 250 | 11,500 | 20 | 920 | 470 | 21,620 |
| 28 | 80 | 3,680 | 60 | 2,760 | 15 | 690 | 155 | 7,130 |
| 29 | 60 | 2,760 | 50 | 2,300 | 20 | 920 | 130 | 5,980 |
| 30 | | | 10 | 460 | 25 | 1,150 | 35 | 1,610 |
| 31 | 20 | 920 | 15 | 690 | 20 | 920 | 55 | 2,530 |
| 32 | | | 25 | 1,150 | 15 | 690 | 40 | 1,840 |
| 33 | 15 | 690 | 12 | 552 | 20 | 920 | 47 | 2,162 |
| 34 | 15 | 690 | 15 | 690 | 20 | 920 | 50 | 2,300 |
| 35 | 15 | 690 | 15 | 690 | 20 | 920 | 50 | 2,300 |
| 36 | 30 | 1,380 | 20 | 920 | 20 | 920 | 70 | 3,220 |
| 37 | 20 | 920 | 15 | 690 | 15 | 690 | 50 | 2,300 |
| 38 | 15 | 690 | 15 | 690 | 20 | 920 | 50 | 2,300 |
| 39 | 30 | 1,380 | 20 | 920 | 15 | 690 | 65 | 2,990 |
| 40 | 40 | 1,840 | 15 | 690 | 50 | 2,300 | 105 | 4,830 |
| 41 | 50 | 2,300 | 50 | 2,300 | 30 | 1,380 | 130 | 5,980 |
| 42 | 60 | 2,760 | | | 15 | 690 | 75 | 3,450 |
| 43 | 40 | 1,840 | 6 | 276 | 5 | 230 | 51 | 2,346 |
| 44 | | | | | 50 | 2,300 | 50 | 2,300 |
| 45 | 12 | 552 | 15 | 690 | 18 | 828 | 45 | 2,070 |
| 46 | 15 | 690 | 14 | 644 | 25 | 1,150 | 54 | 2,484 |
| 47 | | | | | 58 | 2,668 | 58 | 2,668 |
| 48 | 40 | 1,840 | 20 | 920 | 30 | 1,380 | 90 | 4,140 |
| 49 | 70 | 3,220 | | | 90 | 4,140 | 160 | 7,360 |
| 50 | 15 | 690 | 15 | 690 | 50 | 2,300 | 80 | 3,680 |
| 51 | 100 | 4,600 | | | 35 | 1,610 | 135 | 6,210 |
| 52 | 100 | 4,600 | | | 70 | 3,220 | 170 | 7,820 |
| Total | 1,732 | 79,672 | 759 | 34,914 | 2,049 | 94,254 | 4,540 | 208,840 |

**Figure 8: Total Maize Necessary, Expected, and Harvested for 52 Households**

| House-hold # | Family Size | Family Kilos Necessary | Animals Kilos Necessary | Total Kilos Necessary | Total Kilos Expected | Total Kilos Harvested | Difference of Expected & Necessary |
|---|---|---|---|---|---|---|---|
| 1 | 6 | 1,409.27 | 574.88 | 1,984.14 | 2,079.20 | 2,898 | 95.06 |
| 2 | 6 | 1,409.27 | 574.88 | 1,984.14 | 1,803.20 | 2,392 | (180.94) |
| 3 | 3 | 704.63 | 574.88 | 1,279.51 | 1,748.00 | 2,392 | 468.49 |
| 4 | 7 | 1,644.14 | 574.88 | 2,219.02 | 4,342.40 | 5,428 | 2,123.38 |
| 5 | 6 | 1,409.27 | 574.88 | 1,984.14 | 7,084.00 | 10,580 | 5,099.86 |
| 6 | 5 | 1,174.39 | 574.88 | 1,749.26 | 2,373.60 | 3,542 | 624.34 |
| 7 | 4 | 939.51 | 574.88 | 1,514.39 | 2,438.00 | 3,450 | 923.62 |
| 8 | 9 | 2,113.90 | 574.88 | 2,688.77 | 3,919.20 | 5,382 | 1,230.43 |
| 9 | 2 | 469.76 | 574.88 | 1,044.63 | 1,288.00 | 1,978 | 243.37 |
| 10 | 2 | 469.76 | 574.88 | 1,044.63 | 1,564.00 | 2,208 | 519.37 |
| 11 | 4 | 939.51 | 574.88 | 1,514.39 | 1,766.40 | 2,530 | 252.02 |
| 12 | 12 | 2,818.53 | 574.88 | 3,393.41 | 10,764.00 | 15,410 | 7,370.60 |
| 13 | 7 | 1,644.14 | 574.88 | 2,219.02 | 2,576.00 | 3,680 | 356.98 |
| 14 | 5 | 1,174.39 | 574.88 | 1,749.26 | 1,656.00 | 2,300 | (93.26) |
| 15 | 4 | 939.51 | 574.88 | 1,514.39 | 8,050.00 | 11,500 | 6,535.62 |
| 16 | 5 | 1,174.39 | 574.88 | 1,749.26 | 2,502.40 | 3,680 | 753.14 |
| 17 | 4 | 939.51 | 574.88 | 1,514.39 | 2,024.00 | 2,990 | 509.62 |
| 18 | 3 | 704.63 | 574.88 | 1,279.51 | 1,913.60 | 2,760 | 634.09 |
| 19 | 6 | 1,409.27 | 574.88 | 1,984.14 | 3,072.80 | 4,232 | 1,088.66 |
| 20 | 4 | 939.51 | 574.88 | 1,514.39 | 1,794.00 | 2,714 | 279.62 |
| 21 | 4 | 939.51 | 574.88 | 1,514.39 | 1,582.40 | 1,380 | 68.01 |
| 22 | 6 | 1,409.27 | 574.88 | 1,984.14 | 1,803.20 | 2,714 | (180.94) |
| 23 | 8 | 1,879.02 | 574.88 | 2,453.90 | 2,852.00 | 3,910 | 398.11 |
| 24 | 23 | 5,402.18 | 574.88 | 5,977.06 | 6,440.00 | 12,650 | 462.94 |
| 25 | 6 | 1,409.27 | 574.88 | 1,984.14 | 2,447.20 | 4,416 | 463.06 |
| 26 | 3 | 704.63 | 574.88 | 1,279.51 | 1,702.00 | 2,484 | 422.49 |
| 27 | 12 | 2,818.53 | 574.88 | 3,393.41 | 16,836.00 | 15,870 | 13,442.60 |
| 28 | 9 | 2,113.90 | 574.88 | 2,688.77 | 5,888.00 | 7,590 | 3,199.23 |
| 29 | 3 | 704.63 | 574.88 | 1,279.51 | 4,876.00 | 4,830 | 3,596.49 |
| 30 | 4 | 939.51 | 574.88 | 1,514.39 | 1,196.00 | 1,610 | (318.39) |
| 31 | 6 | 1,409.27 | 574.88 | 1,984.14 | 2,070.00 | 2,208 | 85.86 |
| 32 | 4 | 939.51 | 574.88 | 1,514.39 | 1,242.00 | 1,840 | (272.39) |
| 33 | 5 | 1,174.39 | 574.88 | 1,749.26 | 1,757.20 | 2,484 | 7.94 |
| 34 | 6 | 1,409.27 | 574.88 | 1,984.14 | 1,840.00 | 2,622 | (144.14) |
| 35 | 8 | 1,879.02 | 574.88 | 2,453.90 | 1,840.00 | 2,622 | (613.90) |
| 36 | 7 | 1,644.14 | 574.88 | 2,219.02 | 2,668.00 | 5,290 | 448.98 |
| 37 | 4 | 939.51 | 574.88 | 1,514.39 | 1,886.00 | 1,978 | 371.62 |
| 38 | 5 | 1,174.39 | 574.88 | 1,749.26 | 1,840.00 | 3,542 | 90.74 |
| 39 | 9 | 2,113.90 | 574.88 | 2,688.77 | 2,484.00 | 5,060 | (204.77) |
| 40 | 10 | 2,348.78 | 574.88 | 2,923.65 | 4,094.00 | 5,750 | 1,170.35 |
| 41 | 11 | 2,583.65 | 574.88 | 3,158.53 | 4,784.00 | 7,130 | 1,625.47 |
| 42 | 12 | 2,818.53 | 574.88 | 3,393.41 | 3,312.00 | 4,830 | (81.40) |
| 43 | 3 | 704.63 | 574.88 | 1,279.51 | 2,189.60 | 4,416 | 910.09 |
| 44 | 5 | 1,174.39 | 574.88 | 1,749.26 | 1,840.00 | 2,760 | 90.74 |
| 45 | 4 | 939.51 | 574.88 | 1,514.39 | 1,628.40 | 3,036 | 114.01 |
| 46 | 5 | 1,174.39 | 574.88 | 1,749.26 | 1,996.40 | 3,404 | 247.14 |
| 47 | 4 | 939.51 | 574.88 | 1,514.39 | 2,134.40 | 2,760 | 620.02 |
| 48 | 7 | 1,644.14 | 574.88 | 2,219.02 | 3,496.00 | 5,290 | 1,276.98 |
| 49 | 8 | 1,879.02 | 574.88 | 2,453.90 | 6,532.00 | 9,430 | 4,078.11 |
| 50 | 8 | 1,879.02 | 574.88 | 2,453.90 | 2,944.00 | 4,830 | 490.11 |
| 51 | 9 | 2,113.90 | 574.88 | 2,688.77 | 5,888.00 | 8,510 | 3,199.23 |
| 52 | 14 | 3,288.29 | 574.88 | 3,863.16 | 7,176.00 | 7,820 | 3,312.84 |
| Total | 336.00 | 78,918.84 | 29,893.50 | 108,812.34 | 176,023.60 | 247,112 | AVE = 1292 |

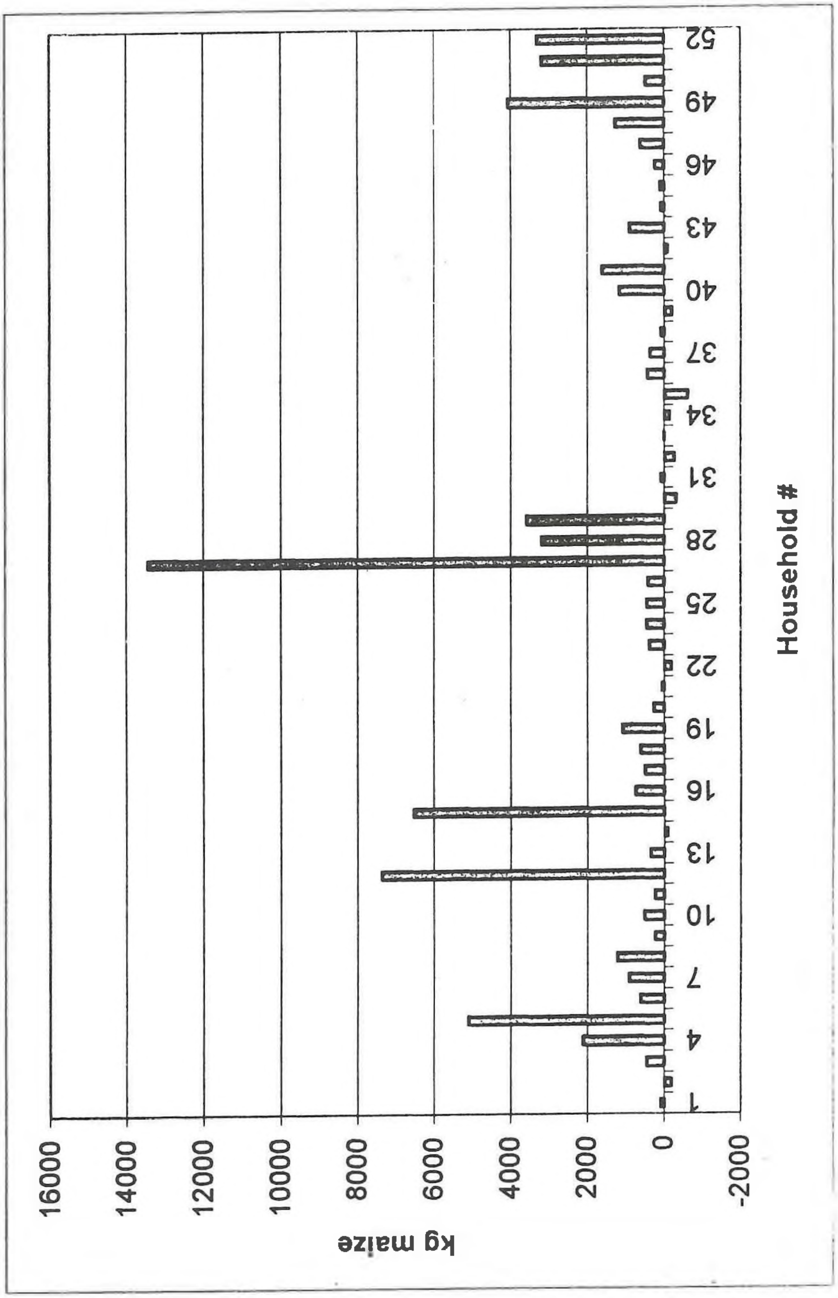


Figure 9: Expected Maize Production as Compared to Household Need

Figure 10: Rainfall for Chichen Itza, 1928-1935 (Steggerda 1941:131-132)