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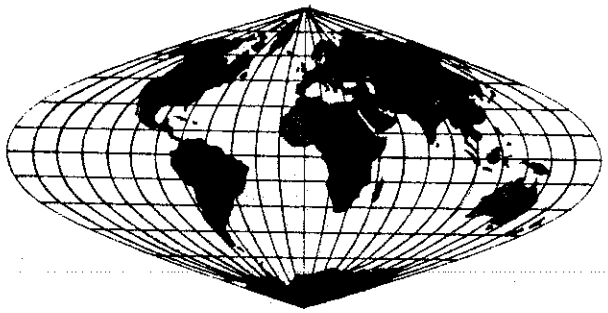
AGRICULTURAL DEVELOPMENT IN THE MEXICAN TROPICS: ALTERNATIVES FOR THE SELVA LACANDONA REGION OF CHIAPAS

Turner Price and Lana Hall



DEPARTMENT OF AGRICULTURAL ECONOMICS
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York 14853

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NEW YORK STATE COLLEGE OF AGRICULTURE AND LIFE SCIENCES
A STATUTORY COLLEGE OF THE STATE UNIVERSITY
CORNELL UNIVERSITY
ITHACA, NEW YORK 14853-0398
U.S.A.

DEPARTMENT OF
AGRICULTURAL ECONOMICS
WARREN HALL

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This is a study of agricultural development in the Selva Lacandona region of the state of Chiapas, one of the last frontier areas in Mexico's tropical southeastern zone. Cornell has a distinguished history of research work in the Mexican tropics which the present study of the Selva complements nicely. The development of the Selva is important not only because it is a frontier area, but also because the pattern of agricultural development followed there is rich in conflicts and contradictions, the resolution of which present major challenges for policy-makers.

Settlement in the Selva Lacandona began in earnest in the 1960s when tens of thousands of landless peasants migrated from the over-crowded Highlands of Chiapas. The dominant farming systems established among these colonists converted the rain forest first to cropland, and eventually to cattle pasture. While extensive cattle production offers the region's farmers a means of increasing incomes rapidly in the short run, in the long run it leads to depletion of soil fertility and erosion. The expansion of extensive cattle production among settlers in the Selva Lacandona is gradually reducing the productive potential of the region's agricultural resources.

The agricultural development policies applied to the tropical Southeast in general, and specifically to the Selva Lacandona, have failed to induce the establishment of sound agricultural economies. These policies have sought to impose modern technology and financial assistance in fixed crop or livestock improvement packages, without an understanding of the physical, social and economic environment of agriculture on the tropical frontier.

In this study, an alternative development strategy for the Selva Lacandona is devised, one which improves rather than replaces existing farming systems. The focus is on promoting mixed enterprise farms producing field crops, plantation crops, and small livestock as alternatives to destructive extensive grazing systems. The strategy attempts to harmonize the short run income goals of settlers with the long-run ecological health of the region.

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Lana L. Hall

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AGRICULTURAL DEVELOPMENT AND TROPICAL MEXICO: THE SAM ON THE FRONTIER

Mexico has continually intensified efforts to develop the agriculture of its tropical Southeast since the 1950s. As increases in food production have become more difficult to achieve in traditional producing areas, the development of the tropical zone has grown in importance in the national development strategy. The development of agriculture in the Southeast has, however, proved an elusive goal. Tropical agricultural systems are complex, and the environmental conditions for agriculture generally adverse, making agricultural development extremely difficult.

Development in the Southeast has primarily been in the form of road construction and other infrastructural investments that have opened land to colonization. The opening of the tropical wilderness has been undertaken without an adequate understanding of environmental conditions. Appropriate technologies for increasing food production beyond the subsistence level in tropical areas have been particularly lacking. Government agricultural development projects have generally attempted to transfer technology and to impose modern practices on traditional farmers. This development strategy has not been successful in establishing sound agricultural economies in the region.

The opening of the Southeast has resulted in the establishment of two dominant agricultural systems; shifting cultivation for subsistence, and extensive cattle production. Shifting cultivation systems generally provide a relatively reliable level of production for subsistence, but are incapable of generating substantial surpluses for market. Because the cattle systems have very low levels of productivity (in terms of per hectare value produced and of basic food production), and because they rapidly degrade the land, their expansion has led to the irrational use of valuable agricultural resources.

This is a study of the development of the the Selva Lacandona region of northeastern Chiapas, one of the last frontier areas in the tropical Southeast. Drawing upon the previous experience of development programs in other areas of the Southeast, and upon field research in the Selva Lacandona, a strategy for agricultural development, based on the establishment of permanent and profitable mixed enterprise farming systems, will be presented. This strategy flows from a thorough understanding of the ecological, social and economic basis for agriculture in the region. Existing farming systems that are well adapted to local conditions are taken as the basis for agricultural development efforts. This strategy makes use of the knowledge embodied in these systems in devising ways of aiding small farmers to overcome obstacles to the improvement of productivity on their farms.

AGRICULTURAL DEVELOPMENT IN SOUTHEASTERN MEXICO

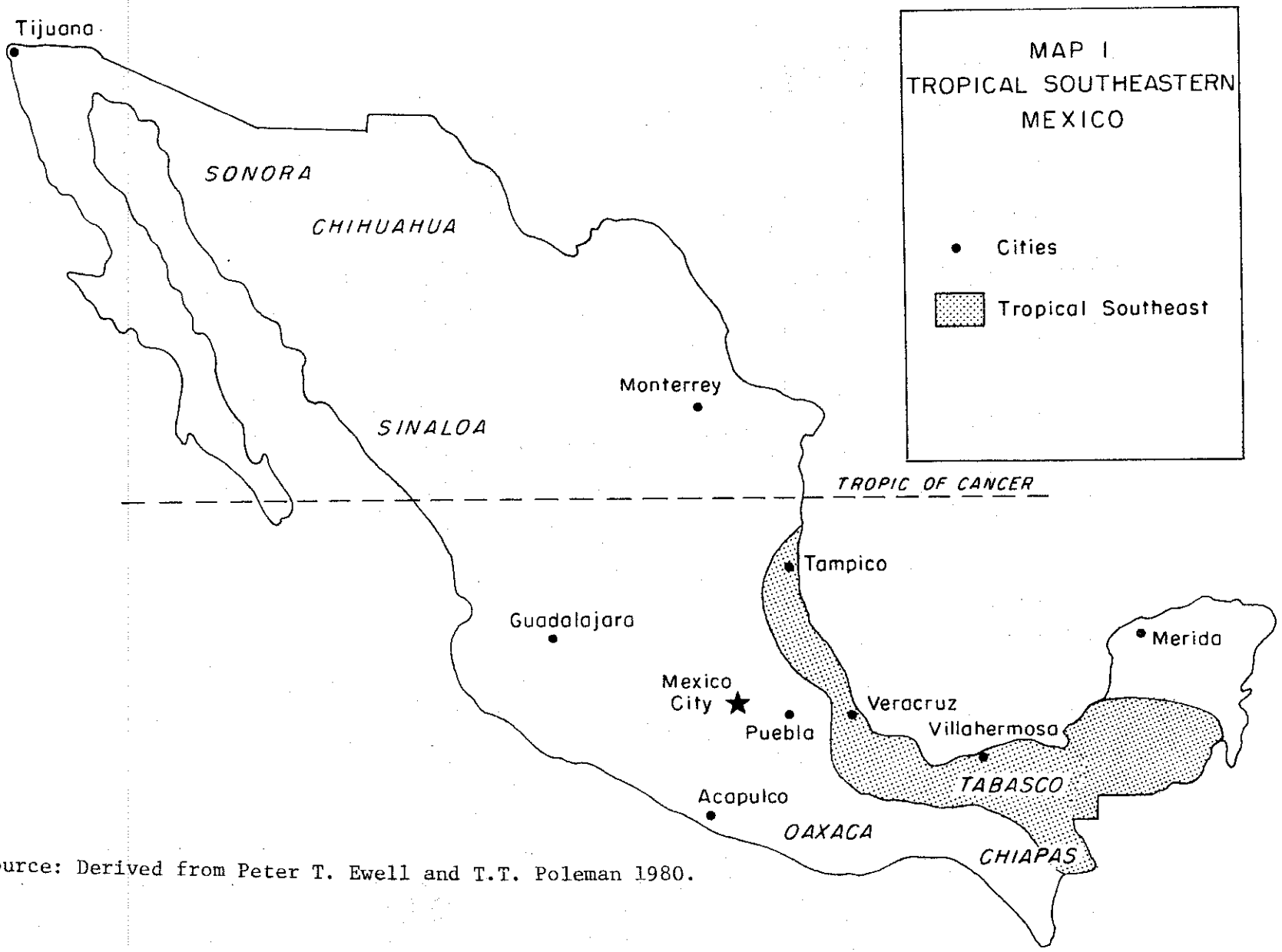
The Southeast of Mexico includes the States of Veracruz, Tabasco and Chiapas, Campeche, as well as the eastern portion of Oaxaca, and the southern section of Yucatan. The tropical regions of these states lie on the Gulf Coastal Plain or on the eastern slopes of the Southern Highlands (see Map 1).

The tropical southeastern region of Mexico has been recognized since the 1940s as having significant potential for agricultural development. The Mexican government has devoted considerable attention to the exploitation of this region since the 1950s. The Southeast has served the Mexican development strategy primarily as a source of land for redistribution, as part of a continuing agrarian reform, and for the expansion of the area available for agricultural production. As increases in food production became more difficult to achieve in traditional agricultural zones in the 1960s and 1970s (see Welhausen and Hewitt de Alcantara), the Southeast became increasingly important in the national development strategy.

The potential of the tropical Southeast lies in its relatively abundant rainfall, and in the availability of large tracts of under-utilized land. The region as a whole receives approximately 62 percent of all of Mexico's rainfall. The major rivers of the Southeast carry almost half of all of the country's water (Scherr 1975, p. 10). As much as eight to ten million hectares are believed to have under-utilized agricultural potential (Ewell and Poleman, p. 13).

Although the tropical Southeast was the site of flourishing pre-Columbian civilizations, from the Conquest to the 1950s the region was sparsely populated. In the Colonial and post-Colonial periods, the Mexican population was concentrated in the highlands. Tropical areas were plagued by diseases and therefore considered a dangerous environment for habitation. Much of the region was also subject to periodic flooding, making communications and agriculture difficult. As a result, the Southeast did not receive investment in infrastructural development until the 1950s.

Human activity in the Southeast was confined to extensive cattle production, and plantations in the major river valleys. Isolated communities of indigenous farmers also practiced shifting cultivation (slash-and-burn agriculture) for subsistence as they had for centuries. Most of the population of the tropical Southeast has traditionally subsisted through the cultivation of maize, beans and other food crops with shifting cultivation. This system is adapted to the poor soils and pest problems that are characteristic of many tropical areas. Although the system provides a stable subsistence, it is not well adapted to the production of consistent marketable surpluses. Shifting cultivators have generally remained subsistence farmers as a consequence.



Source: Derived from Peter T. Ewell and T.T. Poleman 1980.

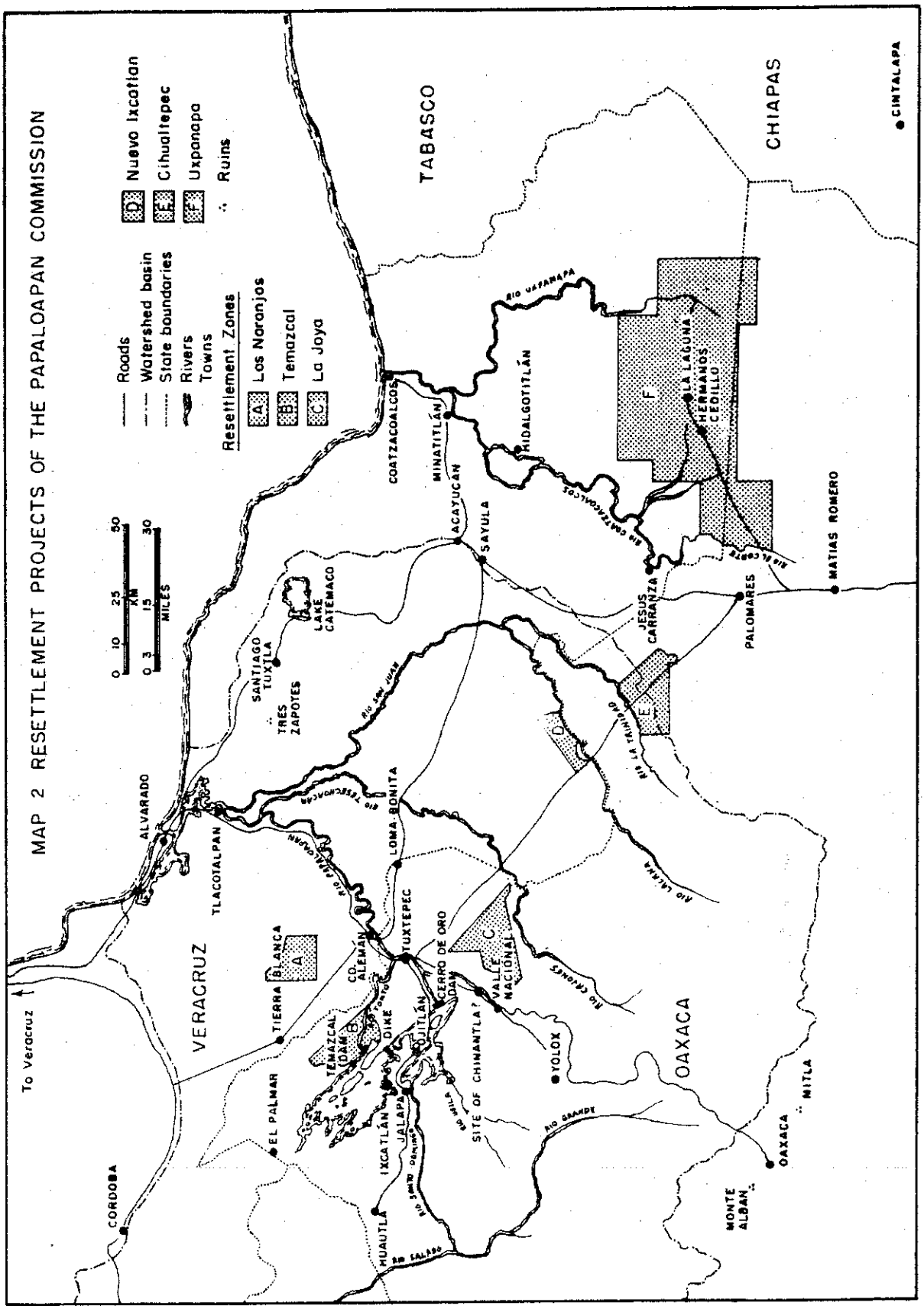
The Papaloapan Project

The first major federal development initiative in the tropical Southeast began with the establishment of the Papaloapan Commission in 1947. This river basin development authority was responsible for flood control, road construction, electrification and public health projects in a 17,800 square kilometer area of Veracruz, Oaxaca and Puebla. Several resettlement schemes were also undertaken by the Commission. The experience of the Papaloapan Commission demonstrates many of the problems that have plagued development efforts in the Mexican Tropics. Map 2 shows the location of the Papaloapan Basin development projects.

Flood control, road construction and public health projects (especially malaria erradication) changed the face of the Papaloapan Basin. Thousands of colonists moved into the area, and many older settlements were freed from their previous isolation. However, in general, economic development was slow, and incomes in the region remained low. Assistance to colonists was insufficient and inconsistent, contributing to stagnation in the development process. The slow development of marketing systems was also a major problem. Technical assistance was particululary inadequate because tested technologies for the Tropics were unavailable. The result was an expanded, though not developed, agricultural economy. More small subsistence farms were established, and more land was cleared for an extensive cattle industry that was dominated by larger land holders (Poleman 1964, Scherr 1978, Allen, Ballesteros et al).

Where economic growth among independent migrants was slow, directed settlement projects were development disasters. The Papaloapan Commission was responsible for the resettlement of thousands of families that were displaced by dam projects. Several resettlement projects were established in previously uninhabited areas of the basin. Each of these projects encountered difficulties, and none could have been labled a success. Descriptions of two of these projects illustrate several of the important issues in agricultural development in the Mexican Tropics.

In 1953, the Papaloapan Commission began a fully integrated settlement project at Los Naranjos. The design of the scheme was paternalistic, with all phases of the program being directed by the project staff. The object was to establish a modern farming community in a forested frontier zone through heavy investment in mechanization. The cost of capital investments and inputs, other than basic infrastructure, was to be borne by the colonists through a credit program. Both the cropping and credit systems were experimental in nature. A 'training credit' system was used in which the colonists were given credit for set purposes that were entirely dictated by the staff. This paternalistic approach to credit reduced the colonists to employees of the bank. The cropping system was based on mechanized production of dry field rice. The lack of experienced staff and poor coordination of input deliveries, as well as poor selection of secondary crops, resulted in the failure of the agricultural program (Poleman 1964, pp.129-141).



Source: Peter T. Ewell and T.T. Poleman 1980.

Budget cuts in 1957 forced a settling of debts upon the colonists. Because of the extremely low levels of productivity of the project, most were unable to repay the debt and were forced off of the land. This project was a costly failure for the Commission, and especially for the colonists (Ewell and Poleman, p.80).

Other major resettlement projects were undertaken between 1954 and 1967 in the southern section of the Papaloapan Basin. 1,180 families were relocated in projects at Nuevo Ixcatlan and at Cihualtepec. The colonists were given about ten hectares of forested, infertile land per family. Heavy rainfall caused leaching of the soil, resulting in a rapid decline in soil fertlity. Yields fell off by 50 percent in the first three years. The farmers were forced to leave most of their land fallow in an effort to maintain fertility. As a result, they were barely able to feed their families (Ewell and Poleman, p.29).

A progression of subsistence farming with shifting cultivation, succeeded by the sowing of pasture and the establishment an extensive ranching system is commonly followed in Mexico's tropical Southeast. As a tropical forested area becomes more densely populated, the forest fallow system often degenerates. The land will eventually become unproductive without adequate fallows. Because of the nature of the environment and of the agricultural systems of the tropical Southeast, the development of infrastructure, with the influx of population that it brings, has often resulted in the degradation of land and cropping systems. Extensive grazing operations tend to replace cropping systems in part because they are better adapted to the poor soil conditions of degraded agricultural land.

At Nuevo Ixcatlan and Cihualtepec, mestizo[1] ranchers bought up the exhausted cropland from the colonists for pasture, and sold or rented forested land to them. The colonists continued the cycle by clearing more land for crops and conversion to pasture. Some colonists became laborers for the ranchers. By 1977, about 70 percent of the colonists had no land at all (Ewell and Poleman, p.83).

In the Papaloapan Basin, the development of large tracts of land was made possible through road construction, flood control, and malaria erradication. Because adequate technologies were not available to colonists for maintaining productive cropping systems, and because marketing systems were poorly developed, large portions of the region were transformed into extensive cattle ranches. Development in the Papaloapan Basin was therefore biased in favor of larger land holders who owned cattle enterprises. Small holders were unable to establish profitable enterprises.

Despite the lack of success realized by the Commission in combining land settlement and agricultural development in the 1950s and 1960s, a larger resettlement project was undertaken in the 1970s. The Uxpanapa Project

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[1] People of mixed Indian and White ancestry. The colonists were Indians. Mestizos tend to dominate Indians economically in Mexico.

attempted to overcome the problems encountered in earlier projects by making use of more advanced technology and a larger scale of operations. Many mistakes were repeated at Uxpanapa.

Uxpanapa: Modern Agriculture in the Rain Forest

With the planned construction of the Cerro de Oro dam in 1973, the Papaloapan Commission assumed responsibility for some 3,000 families of traditional Indians who would be displaced by the reservoir. A complex resettlement plan was designed involving rapid economic, social and technological change in one of Mexico's largest remaining rain forests. The planners dealt with two dynamic processes; the transformation of a wilderness into productive cropland, and making modern collectivized farmers of traditional campesinos[2] (Ewell and Poleman, p.169).

The Uxpanapa development zone encompassed 260,000 hectares, by far the largest of the Commission's projects (see Map 2). Of this total, 60,000 hectares were to be cleared for the resettlement project. Clearing, planting and harvesting were all to be highly mechanized. High yielding varieties of rice and maize, along with high yielding clone rubber trees were the basis of the cropping systems. The object was to increase national grain production through mechanization of farming systems in the tropical zone, while increasing incomes and creating regional growth centers.

Because traditional small holdings were inefficient for mechanization, a system of collectivized farming was introduced at Uxpanapa (Ewell and Poleman, pp.112-129). A 'training credit' system similar to that devised for earlier projects was set up. Costs were charged to the accounts of the colonists. Collective costs were aportioned to each family. The paternalistic nature of this system made heavy demands on the staff who were responsible for almost all decisions. Colonists had almost no say in the affairs of the project (Ewell and Poleman, p.136).

The Uxpanapa Project became a juggling act for the management staff. The number of variables involved in the plan proved to be excessive and led to repeated failures. At every stage of the program there was experimentation. In the face of the complexities of the rain forest environment, and the high technology of modern agriculture, these experiments met with disaster.

The coordination of inputs, especially heavy equipment and chemicals, was extremely difficult under the isolated conditions of Uxpanapa. The mechanization program was hampered by breakdowns and a lack of skilled labor and spare parts. Tilling and harvesting schedules were fraught with costly delays. The slow movement of colonists into the zone caused severe labor shortages (Ewell and Poleman, p.130).

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[2] Small farmers.

The cropping systems proved to be very poorly planned. Variety choices were inappropriate. The worst problem was an attack of rice blast, a disease that damaged much of the crop. Lodging of rice also contributed to the failure of the cropping program by making the planned mechanized harvesting impossible. Maize production was reduced by the poor performance of dwarf varieties, and later by agronomic difficulties associated with large scale cultivation of native varieties. Rice and maize yields did not meet production costs in any of the first three years. The staff was over-taxed, and unable to deal with the multitude of problems that arose on a daily basis. Research and development for the cropping systems suffered as a result (Ewell and Poleman, pp.140-152).

Collectivization did not work well. The colonists saw no real benefit from it. Many would have preferred to farm their own small plots by hand, and some did leave the collective. There was a lack of feeling of ownership, and the colonists came to see themselves as working for the Commission and the bank (Ewell and Poleman, p.168).

The credit system, based as it was on the expectation of high yields and returns from an expensive package of inputs, was a failure. The government had insured the crops, and the settlers were not held responsible for the loses. There were, however, no profits (Ewell and Poleman, p.130).

By 1981, it was reported that much of the cleared area at Uxpanapa was being sown in pasture for cattle production. This was being done in an attempt to recover some of the cost of clearing for the failed crop programs.

Uxpanapa was a costly fiasco for the Papaloapan Commission. Excessive experimentation in all phases of the project was the primary cause for failure. Paternalism and top-down management and planning were also to blame. The divergent goals of modernizing agriculture in the Tropics, increasing food production, conducting resettlement operations and of organizing traditional farmers into collective structures conflicted disastrously in the project.

One of the final acts of the colonization process on Mexico's tropical frontier is now taking place in the Selva Lacandona. Increased emphasis on agricultural production (as a result of severe problems in the Mexican food economy in the 1970s and early 1980s) has pushed the frontiers of national development programs to one of the most marginal agricultural areas in the Southeast. Already, in the early stages of these development efforts, there is evidence that some of the mistakes of the Papaloapan and Uxpanapa Projects are being repeated.

DEVELOPMENT IN THE SELVA LACANDONA

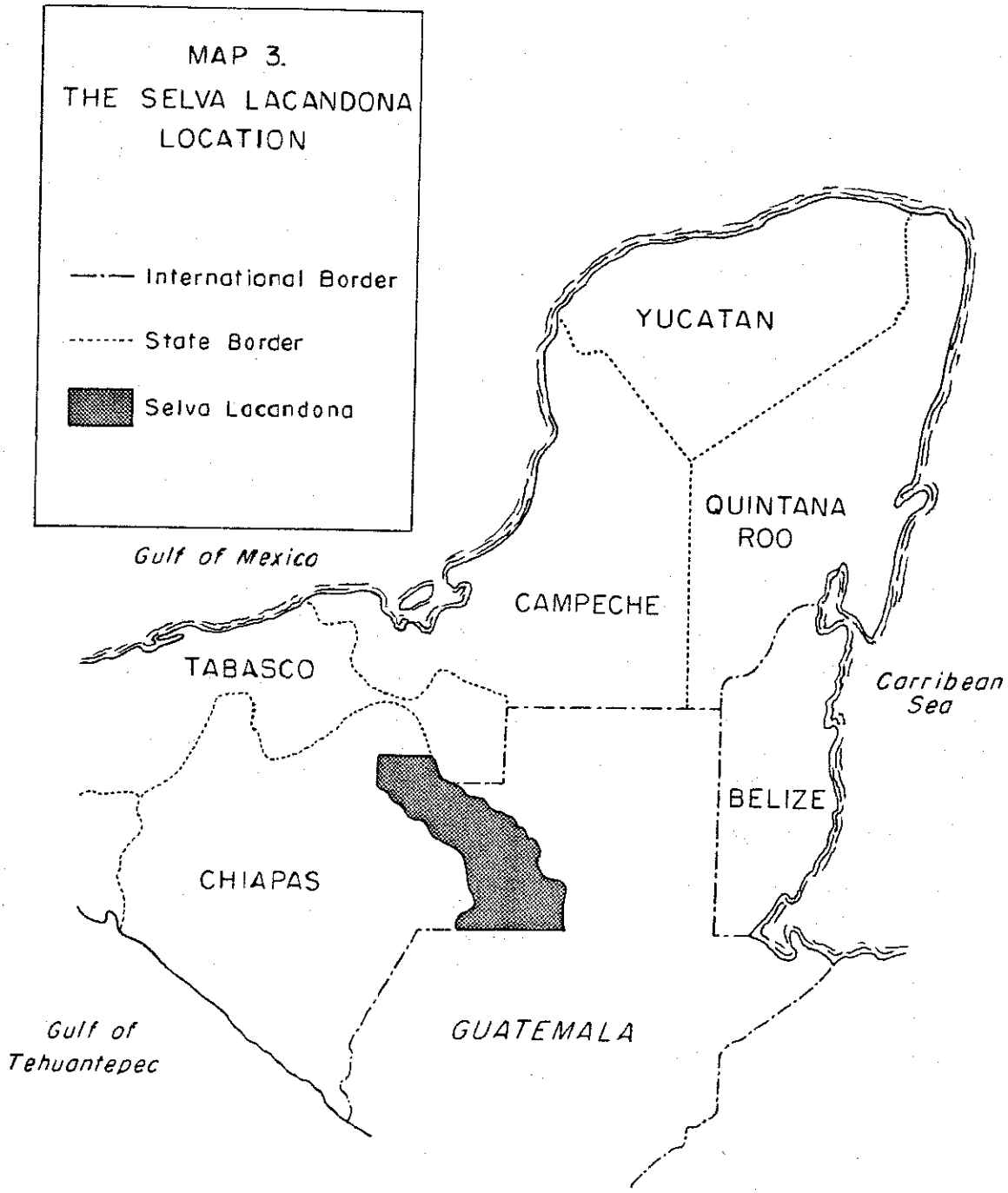
The Selva Lacandona is a region of tropical moist forest located in the northeastern corner of the state of Chiapas, along the Guatemalan border. Map 3 shows the location of the Selva Lacandona. The region is one of the last frontier areas in Mexico. Rugged terrain and extremely heavy rainfall had kept the Selva Lacandona almost completely isolated until logging roads opened it to colonization in the 1960s. Development in the region has taken a similar course to that of other areas in the Southeast, but at a slower pace due to its isolation. Independent migrants have gradually settled the region and established subsistence farms. The government has also been involved in some directed resettlement projects. Commercial cattle ranches were established in the 1940s and 1950s. As in the Papaloapan Basin, the extensive cattle industry has been exanding rapidly in recent years.

Agriculture in the region is dominated by subsistence cultivation with slash-and-burn farming techniques, and by extensive cattle production. Shifting culivation however, provides only a subsistence. Many of the small farmers in the Selva Lacandona are currently using farming systems that gradually convert forest to cropland, and eventually to pasture. This process threatens the long-run viability of the Selva's agricultural economy.

If properly practiced, under low population densities, shifting cultivation is an ecologically sound system for subsistence in the Selva Lacandona. Many of the migrants from highland areas, however, appear to have an inadequate understanding of the agro-ecology of tropical lowlands. Their farming systems are relatively unproductive, and their practices have led to some land degradation. Other more adept farmers have also failed to establish profitable systems because of poorly developed infrastructure, low prices, and production difficulties. The inability of farmers to develop permanent and productive farming systems has led many to turn to extensive cattle production for cash income.

Extensive cattle production among small holders in the Selva Lacandona has been part of a wider expansion of the beef cattle industry in the tropical lowlands. A well developed commercial cattle industry provides a strong market for feeder cattle from small operations, and for pasture for fattening cattle. Small-holders in the Selva have found cattle production to be an economically attractive enterprise. The selection of cattle as the primary farm enterprise is economically sound in the short run. In the long run, however, the conversion of cropland to pasture may result in the inability of farmers to provide even a subsistence for their families.

Extensive cattle systems among small-holders in the Selva Lacandona are generally not sustainable because they are ecologically unsound. Agricultural production in the region is based on the use of a forest fallow cycle that replenishes fertility and reduces animal and plant pest problems. Small-holders in the Selva have twenty hectares or less of cultivable land. Extensive cattle systems require relatively large land areas per unit of production. In order to produce sufficient cattle for sale to meet their needs, the farm-family must use all or most of their


MAP 3.
THE SELVA LACANDONA
LOCATION
International Border
State Border
Selva Lacandona
YUCATAN
QUINTANA
ROO
Gulf of Mexico
CAMPECHE
TABASCO
Carribean
Sea
BELIZE
CHIAPAS
Gulf of
Tehuantepec
GUATEMALA

holding as pasture. This deprives the land of a fallow. Pastures are, in addition, poorly managed, adding to the instability of the grazing system. The disruption of the fallow cycle, the depletion of soil nutrients under grass, and erosion that accompany the conversion of forest and cropland to pasture lead to land degradation. The holding will eventually degrade to a point where it is no longer suited to any type of agricultural production.

The government first intervened in the development process in the Selva Lacandona in the mid-1970s. An 'integrated development plan' devised by Governor Velasco Suarez involved little more than a rationalization of timber exploitation. This was done at great cost to thousands of colonists who where forcibly resettled, under very poor conditions. Before 1980, the only development programs in the Selva, save basic infrastructure, were cattle credit schemes.

The SAM in the Selva

Several factors contributed to increased attention being focused on the Selva Lacandona in the 1980s. The development of the region is part of the more general development process in the Gulf Coastal Lowlands. The phenomenal growth of the petroleum industry in Tabasco, Campeche and northern Chiapas in the late 1970s and early 1980s has brought with it infrastructural development and rapid population growth. This development has increased the demand for agricultural products from adjacent regions such as the Selva Lacandona and helped to integrate the Southeast into the national economy. Another factor has been the growth in the number of landless peasants in Chiapas and in other states that has increased the interest of government officials in resettlement projects in uninhabited sections of the region. The discovery of petroleum reserves in the southern portion of the Selva, very close to the Guatemalan border, has also made its integration economically, and perhaps strategically important. This border region is increasingly troubled by the mounting violence in adjacent districts of Guatemala.

The commencement of agricultural development activities in the Selva Lacandona was, however, primarily the result of a major national initiative begun by President Lopez Portillo in 1980. The program for the Mexican food system, the SAM, was a far reaching national plan that grew out of the food crisis of the late 1970s. The inability of Mexican agriculture to keep pace with the growth in demand for basic foods (a growing problem since the late 1960s) became an acute problem in 1979. Severe drought in that year resulted in exteremely poor grain harvests. Imports of grain reached 25 percent of consumption in 1980. Maize imports alone were more than four million tons. The declaration of the SAM signalled that the Mexican food economy was in a state of emergency (Tiempo, Comercio Exterior).

The SAM was a broad program designed to deal with all phases of the food economy. The major objectives of the program were to increase food

production and to subsidize food consumption to low income families.[3] The most important focus of the SAM was on increasing production among traditional small farmers in non-irrigated areas. Effectively, the Mexican government sought to achieve a second "green revolution" among those farmers who were by-passed by the development process in the past.[4] This was to be accomplished through the transferral of a large fraction of the income from foreign petroleum sales to the traditonal agricultural sector (Meissner, Redclift).

The Ministry of Agriculture and Water Resources (SARH) is the paramount authority in agricultural development in Mexico. Most aspects of production programs under the SAM were the responsibility of the SARH. The mission of the SARH in the Selva Lacandona was the same as in all of the rainfed districts in the country; to increase grain production as rapidly as possible. This was to be accomplished through the introduction of 'improved' technology, and through the use of producer subsidies. The SARH staff was also to work in coordination with other government agencies such as the Rural Credit Bank (Banrural), for producer financing, with the national seed company (PRONASE), and with the National Subsistence Commodity Corporation (CONASUPO) in marketing and storage operations.

At the core of the SAM s national production effort was the Shared Risk Crop Improvement Program (Programa de Riesgo Compartido). The program called for the introduction of crop improvement packages, primarily for maize and beans, in marginal agricultural areas (SARH 1981). Generally, the program involved the use of improved seed, fertilizer, insecticides and herbicides in a prescribed package. Under the SAM, the prices of chemical inputs and seed were heavily subsidized, and credit was provided at reduced rates to small-holders. Crop insurance was also issued to cover the cost of inputs, and an imputed value of the farmers labor.

Two programs were available to farmers in the Selva Lacandona in the 1982 spring/summer cropping cycle. The complete package, labeled the Normal Package, provided credit and insurance for the cost of inputs, and an imputed value of the farmer's labor. Another package, called the Input Package, provided credit and insurance for the cost of inputs alone. 145 farmers participated in the Input program, and 387 in the Normal package in the Selva Lacandona. A total of 1473 hectares of maize were planted with the two programs. The average planted area of maize per holding under the project was 2.7 hectares. The total number of farmers participating in the two programs represented approximately 20 percent of all farmers in the region.

The objective of the programs was to increase maize production by 50 to 90 percent per hectare. The SARH estimates that current maize yields in the region average approximately 1.3 tons per hectare. It was hoped that

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[3] President Lopez Portillo acknowledged that as much as one quarter of the Mexican population was inadequately nourished in 1980 (Tiempo).

[4] For a discussion of the poorly distributed benefits of the 'green revolution' see Welhausen, Hewitt de Alcantara, and Hall and Price.

the improved package would increase yields to an average of 2 to 2.5 tons per hectare.

The SARH/SAM program was terminated after its first year of operation because of a shortage of funds that resulted from Mexico's severe financial crisis. Inconsistency in the funding of development projects has been a common problem in Mexico. Although the program in the Selva Lacandona lasted only one year, an examination of some of the issues and problems that emerged offer insights into the approach to agricultural development that has been followed by the government.

The program had many administrative problems. Because there was an emphasis on purchased inputs, and on credit, worth tens of thousands of dollars, there was a considerable bureaucratic aspect to the crop improvement scheme. A large fraction of the SARH staff s working time was devoted to filling out forms in quadruplicate. This clearly detracted from time spent in the field. In the field, the primary occupation of the technical staff was again bureaucratic. Signatures and thumb prints had to be be collected from farmers in scattered settlements for a multitude of forms. The crop insurance program required that the technicians verify crop damage. Because fields are often several kilometers from the homestead, this was a time consuming task. Technicians were also handicapped by language difficulties. As much as half of the population of the Selva does not speak Spanish. None of the SARH staff members speak the Indian languages.

Some technical problems had appeared by July 1982. The most serious of these centered around on-farm logistics. Although the SARH administrators reported that 532 farmers were participating in the program within the Selva Lacandona, it was evident that not all were folowing the prescription for inputs. Some farmers were not using the full recommended doses of fertilizer. This was due in part to the difficulty of transporting an average of 675 kilograms of urea and 18-46-0 fertilizers to their plots. Many of the fields are located in hilly areas that are reached by narrow paths through the forest. Most of these paths are too small for horses and mules. Fertilizer must be carried on the men's backs. An undetermined, and perhaps large quantity of the fertilizers may not have been used (Aguilar p.c.).

The SAM efforts in the Selva had elements of a crash program. Little was done to make the program a sustained and long term operation. The emphasis was on immediate results. Further, the SARH staff members generally had little or no experience with tropical agriculture. Most of their training has been in rainfed and irrigated crop production such as that found in highland areas.

The type of crop credit/insurance program employed may have been counter-productive. In addition to being highly bureaucratic and time consuming for the staff, the insurance scheme may actually have discouraged involvement of the local population in the SAM program. Firstly, the size of the debt requirement may have been too intimidating for some farmers. Secondly, for farmers who did participate, but who failed to repay, the failure would bar further involvement with crop improvement efforts.

Because the program was designed as a fixed package, credit was mandatory for all participants. Without credit there was no assistance from the SARH.

A major problem with the SARH/SAM program in the Selva Lacandona was the high costs per unit of anticipated increase in production. The total cost per hectare of the program could not be established from available data. It was evident, however, that it was indeed expensive. The program involved subsidies on inputs, relatively cheap credit and crop insurance, and the subsidized transportation of inputs to the region. If the SARH's anticipated production increases were realized in 1982, total maize production in the Selva would have been increased by from 1031 to 1768 tons, through the crop improvement programs. This would have represented an increase of approximately 20 to 35 percent, over traditional yields. The total recoverable capital outlay required for the credit/insurance scheme (excluding administrative costs and subsidies, and assuming 100 percent repayment) was estimated at 4,648,500 pesos ($96,844 U.S., July 1982), or some 2600 to 4500 pesos per ton of increased production (depending on the size of the increase).

In addition to production costs there were administrative costs associated with the credit and insurance programs, as well as the costs of maintaining the staff and their equipment. Because the SAM is a national program, the future of the project in the Selva was dependent on decisions beyond the control of the farmers or the local project staff. The program was based almost exclusively on capital and inputs from outside of the region, and came to a halt with the end of federal funding.

The SARH/SAM program had numerous similarities to previous development efforts in the tropical Southeast. Many of the perennial problems that have plagued agricultural development in the Southeast re-emerged in the Selva Lacandona. The program sought to impose a radically different and technologically complex cropping system on the traditional farming systems. It was paternalistic and came entirely from the top-down, with little or no decision making by farmers. The program was heavily dependent on a substantial credit component to finance the purchase of chemical inputs and crop insurance. The program was focused on maize and to a lesser extent on bean production. No attention was given to other components of the mixed enterprise systems that are found on most farms. The SARH/SAM crop improvement scheme was designed primarily to acheive the national goal of food self-sufficiency, and not to improve local welfare. Most crucially, the current development strategy for the Selva Lacandona, as exhibited in the SARH/SAM program, fails to meet the issue of the expansion of extensive cattle grazing in the region.

The successful development of the agriculture of the Selva Lacandona will require a strategy that promotes ecologically sound and economically profitable systems. This can be accomplished through the improvement rather than replacement of existing farming systems. Improvement in productivity can be achieved through the the identification and promotion of sound existing practices, and the identification and elimination of obstacles to enhanced productivity.

FIELD RESEARCH PROGRAM AND OBJECTIVES

This study focuses on current conditions and existing farming systems in the Selva Lacandona. It attempts to identify practices that are well suited to local conditons, and that offer potential for improving agricultural productivity. The basic premise of this study is that the farming systems of the Selva Lacandona are complex and integrated. Improving the welfare of local farm-families through enhancement of the productivity of their systems requires an holistic and integrated systems approach to research and development.

The study is the product of a program of field research conducted in Chiapas in 1981 and 1982 that included four field trips to the region. A total of five months was spent in field research in the Selva Lacandona and in research at Mexican institutes.

Valuable background information was available from several previous studies conducted in the Selva Lacandona. These included a Masters thesis in Agronomy from the Graduate College at Chapingo (Muench), a Masters thesis in Economics from the College of Economics and History of the National Autonomous University (Labato 1979), an interdisciplinary post-graduate study by German and Mexican students (Grosser ed.), two studies prepared by the Mexican government (SFF 1975, SARH 1980), and a doctoral dissertation in Human Ecology from Southern Methodist University (Nations 1979). Additional information and perspectives on issues in the development of the Selva Lacandona were provided in discussions with researchers at the Center for Ecological Investigations in the Southeast (CIES), the Franz Blom Library, and the Center for Applied Human Ecology, all in San Cristobal de las Casas, Chiapas, and at the National Institute for Studies of Biotic Resources (INIRB), in Xalapa, Veracruz.

Field research in the study area was conducted in three phases; an initial reconaissance, farm surveys, and a study of the SARH development program. The initial reconaissance was carried out in two parts. The Selva Lacandona was first visited in January 1981 for a brief interval before commencement of library research and discussions with researchers in San Cristobal de las Casas. During this visit, basic infrastructure and settlement patterns were studied. A thorough reconaissance was undertaken in July and August 1981. At that time, all of the major settlement areas that were accessible by road were visited. The region's principal agricultural systems were identified, and the social and political organization of the settlements examined.

Farm surveys were conducted in selected settlements in January 1982. Informal interviews were held with farmers to gather information on production, consumption and marketing practices, in both recent and older settlements, ranging in age from seven to thirty years. Observations of farming practices in a wide variety of crop and livestock operations were also made at that time. Using information obtained from settlements at various stages of development, the evolution of cropping and livestock systems in the region, over time, was evaluated. Marketing practices for agricultural products were also examined. The final phase of the field research involved a detailed study of the recently initiated SARH/SAM

program, in June 1982. This research centered on ejidos in the Santo Domingo Valley in the central area of the Selva Lacandona.

Through this program of library and field research, an understanding of the physical, cultural and institutional setting for agricultural development in the Selva Lacandona was developed. The patterns of development and the processes that are at work in the region's agricultural economy were identified and analyzed.

Because this is a frontier region, and because the government has only recently become actively involved in the development process, the data available were scanty and of poor quality. In the brief period of the field investigation it was impossible to gather precise data from a large sample of farmers. Language problems also inhibited data collection. Many of the region's men don't speak Spanish, or speak it poorly. Almost none of the women speak Spanish. The general mistrust by the local population of outsiders also caused difficulties. The field study therefore relied heavily on information from key informants and field observations.

In the following chapters, the agriculture of the Selva Lacandona is described and evaluated. Conditions for agriculture, and ancient systems that evolved in the region are first examined. Some ancient agricultural practices that may have potential for solving current problems are reviewed. In Chapter III, the process of development in the Selva, and the effects of this process are discussed. The two dominant agricultural systems, shifting cultivation and extensive cattle grazing, are introduced. Emphasis is placed on the long-run implications of the expansion of the extensive cattle industry for the Selva's economic development. Chapter IV outlines current economic and social conditions in the region and ongoing development projects. Chapter V examines cropping and small livestock systems. Special attention is given to the more highly adapted practices of experienced farmers. Technical, commercial and institutional barriers to improved productivity are also identified. In Chapter VI, various types of extensive cattle operations are described. The long and shortrun economics of these systems are analyzed. The final chapter offers an alternative development strategy for the Selva Lacandona, and makes specific recommendations for agricultural development projects.

Chapter II

THE SELVA LACANDONA

A persistent cause of the failure to develop productive and permanent agricultural systems in colonized areas of southeastern Mexico has been a lack of understanding of the nature of agriculture in the tropical environment. In the Selva Lacandona, the physical environment for agriculture is a difficult one. A development strategy for the Selva's agriculture must therefore begin with a thorough understanding of the region s physical environment.

This chapter examines the geography and natural history of the Selva Lacandona. The region is first defined, and regional sub-divisions established. The landforms, soils, hydrology, climates and flora and fauna are then briefly described. In the final section, agricultural systems that evolved in the Selva Lacandona during the Mayan period, and among the Lacandone Indians will be reviewed. Some aspects of these systems that offer promise for solving current agricultural problems are emphasized.

GEOGRAPHICAL SETTING

Location and Definition

The Selva Lacandona or Zona Lacandona is located in the northeastern section of the state of Chiapas. Chiapas is the southeastern most Mexican state. The total area of the Selva is approximately 13,000 square kilometers, an area roughly equivalent to the state of Connecticut. Map 3 shows the location of the Selva Lacandona. The eastern and southern borders of the region also form the international border between Mexico and Guatemala. On the north, the Selva is bounded by a range of hills that separates the region from the Gulf Coastal Plain. The western border of the region has been defined in several ways.[5] Map 4 shows the Selva Lacandona as defined in this study.

Thus defined, the Selva Lacandona is smaller in extent than in previous studies. Heavily settled sections in the valleys of the Perlas, Jatate and Tulija rivers, and areas to the west of lake Miramar in the southwest have been deleted. The elimination of these areas from the study was due to the fact that they are no longer part of the frontier. In addition, these deleted western zones have developed with an economic focus on Ocosingo and

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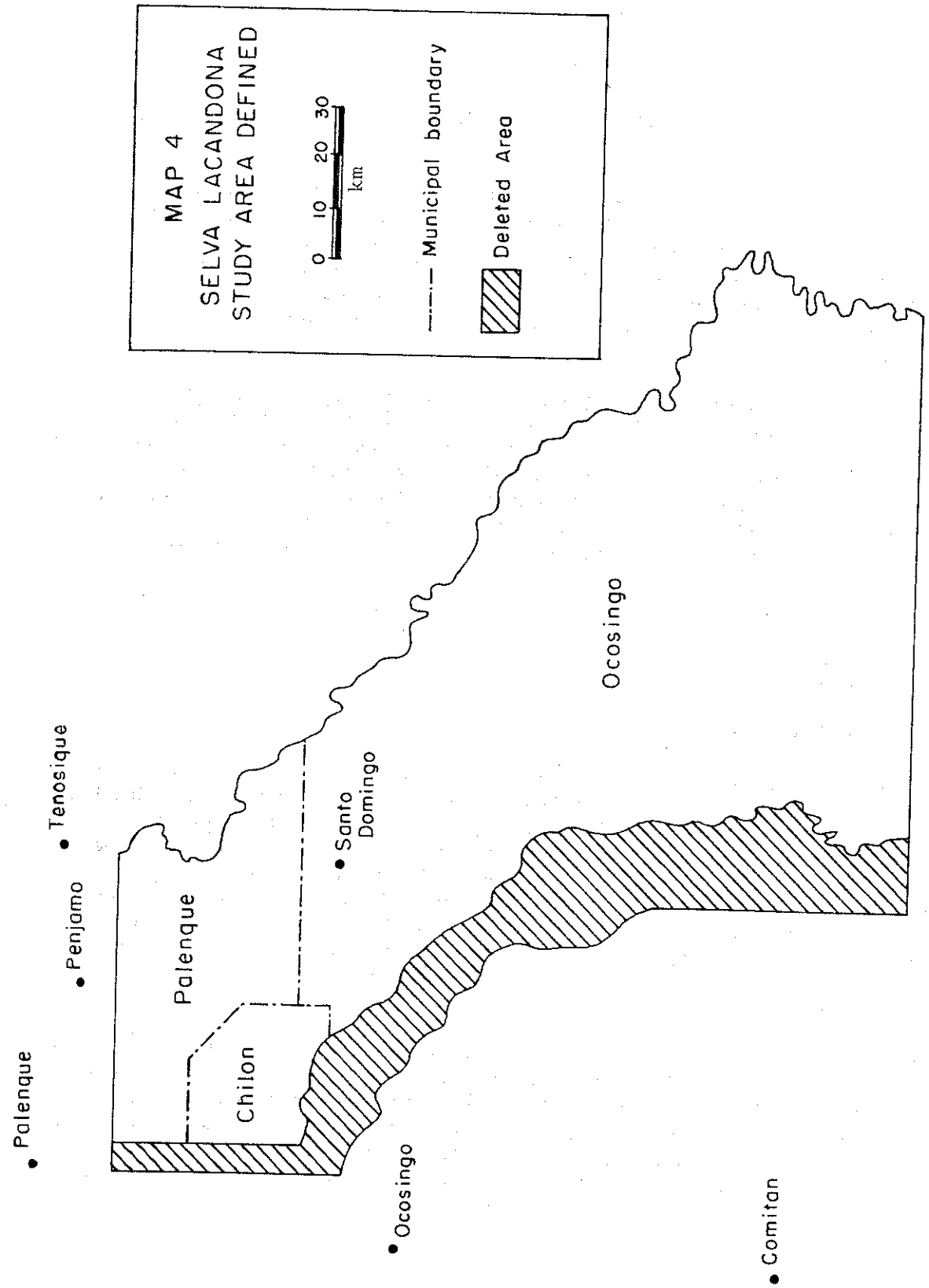
[5] See Labato 1979, Muench, SFF, and Grosser ed..


MAP 4
SELVA LACANDONA
STUDY AREA DEFINED
0 10 20 30
km
Municipal boundary
Deleted Area
Palenque
Tenosique
Penjamo
Palenque
Chilon
Santo Domingo
Ocosingo
Ocosingo
Comitan

Comitan (see Map 4). The rest of the Selva is economically tied to Palenque and Tenosique, in the north. In this study, the Selva Lacandona is, effectively, defined as the frontier areas of northeastern Chiapas that lie to the east of the Chiapas Highlands, and south of the range of hills that form the northern edge of the Chocolja valley.

Political and Geographical Divisions

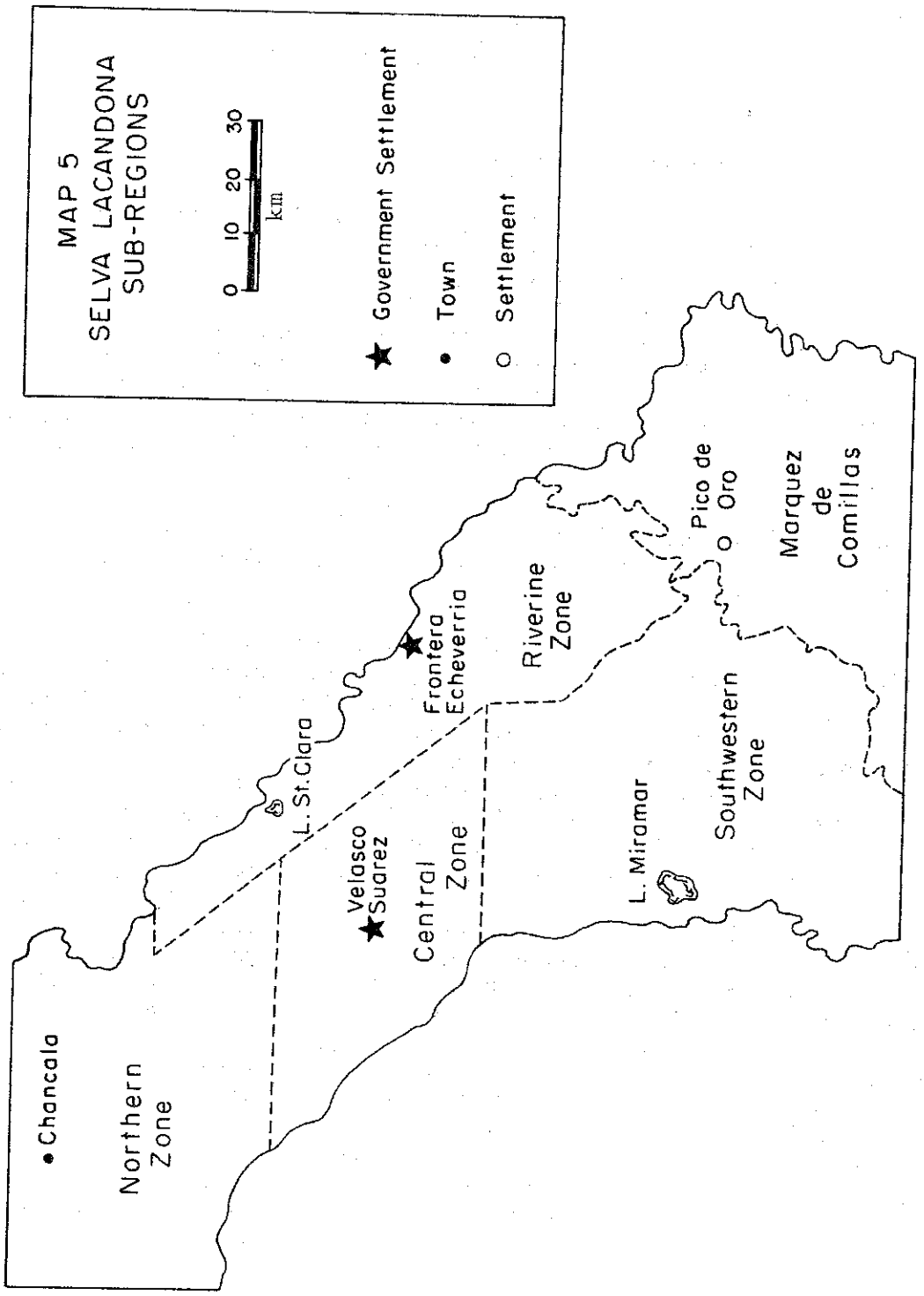
The territory of the Selva Lacandona is divided up among three municipos. Most of the northern section is part of Palenque municipo. Chilon municipo accounts for a small portion. Ocosingo municipo controls the southern part. Much of the actual administration of the Selva Lacandona is conducted directly by state and federal agencies. The municipal centers are removed from their land in the Selva and have little actual control or authority. As the region develops, the political divisions will probably change to reflect the realities of the region. One of the settlements will eventually become the seat of a new municipo.

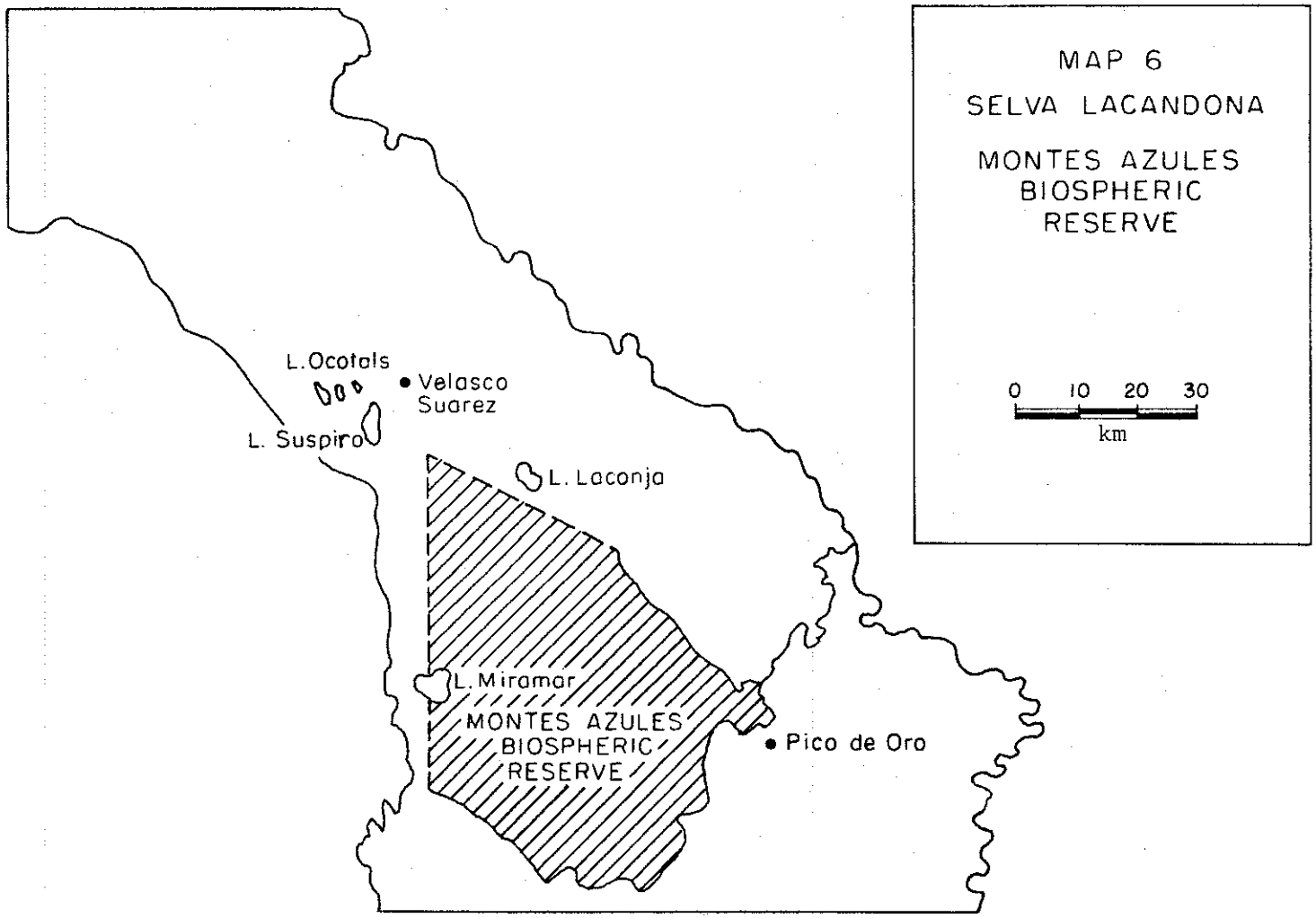
To facilitate discription, the Selva Lacandona has been divided into five sub-divisions that will be referred to throughout the text. The sub-divisions are based on economic and geographical criteria. Map 5 shows the sub-divisions.

The Northern Zone is the most highly developed and longest settled sub-region. The Zone roughly corresponds to the extent of Palenque and Chilon municipos in the Selva. The Northern Zone is the most densely populated and has the region's only town, Chancala (population estimate 1500). The Central Zone is the second most developed and populated sub-region. It includes the upper Santo Domingo and Laconja river valleys and the area around the Ocotal lakes. There is one large government settlement in this zone and many smaller settlements. Unlike the Northern Zone, the Central Zone contains some undeveloped forest.

The Southwestern Zone is almost wholly uninhabited. The greatest part of this zone is a forest reserve encompassing 300,000 hectares (see Map 6). Called the Integrated Biospheric Reserve Montes Azules (RIBMA), this reserve was decreed by President Lopez Portillo in cooperation with the UNESCO Man and the Biosphere project (MAB). The Selva Lacandona has been identified as an important botanical and zoological resource by UNESCO (Rich). Colonization is, however, pressing into the zone on several fronts. LANDSAT images, and reports from visitors to the area evidence the clearing of forest near lake Miramar, in the valleys of the Perlas and Jatate rivers, and south of lake Suspiro. Colonists in this zone come from the regions around Comitan and Altimirano (see Map 4). The Southwestern Zone is bounded on the East by the Laconja river, and on the South by the Lacantun.

The Riverine Zone occupies a narrow strip of land along the margin of the Ucumacinta river. The western boundary of this zone parallels the river to the west, following the Sierra del Guiral. Except for some logging and an occasional settlement, this region remained almost


MAP 5
SELVA LACANDONA
SUB-REGIONS
0 10 20 30
km
Government Settlement
Town
Settlement
Chancala
Northern Zone
L. St. Clara
Velasco Suarez
Central Zone
Frontera Echeverria
Riverine Zone
Pico de Oro
Marquez de Comillas
L. Miramar
Southwestern Zone



Source: Pablo E. Muench 1978.

completely undeveloped until quite recently. Around lake Santa Clara, the Santa Clara Ranch (of several thousand hectares) was established over thirty years ago. The ranch appears as the only major area of cleared forest in LANDSAT images from the mid-1970s.

In 1976 the government established a large settlement on the Ucumacinta in the Riverine zone. Named Frontera Echeverria, but known as Corozal, this settlement was linked to the north by a road in 1977. This was the first road ever to enter the Riverine zone. In 1981, construction began on a new road that will cross the length of the zone from north to south, opening it for colonization. Most of the Riverine zone is federal land that will probably be used for resettlement of landless peasants in the future.

The fifth zone is the Marquez de Comillas. Located in the southeastern corner of the region, this sub-region was almost uninhabited until oil was discovered near Pico de Oro in 1980 (see Map 6). By 1983, the Marquez de Comillas will be linked to the north and to Comitan by a border road that is now under construction. The government plans to settle almost 30,000 colonists in this zone in the next few years. In 1982, the population of the Marquez de Comillas was approximately three to five thousand people. The settlements are located along the Ucumacinta and Lacantun rivers.

PHYSICAL ENVIRONMENT

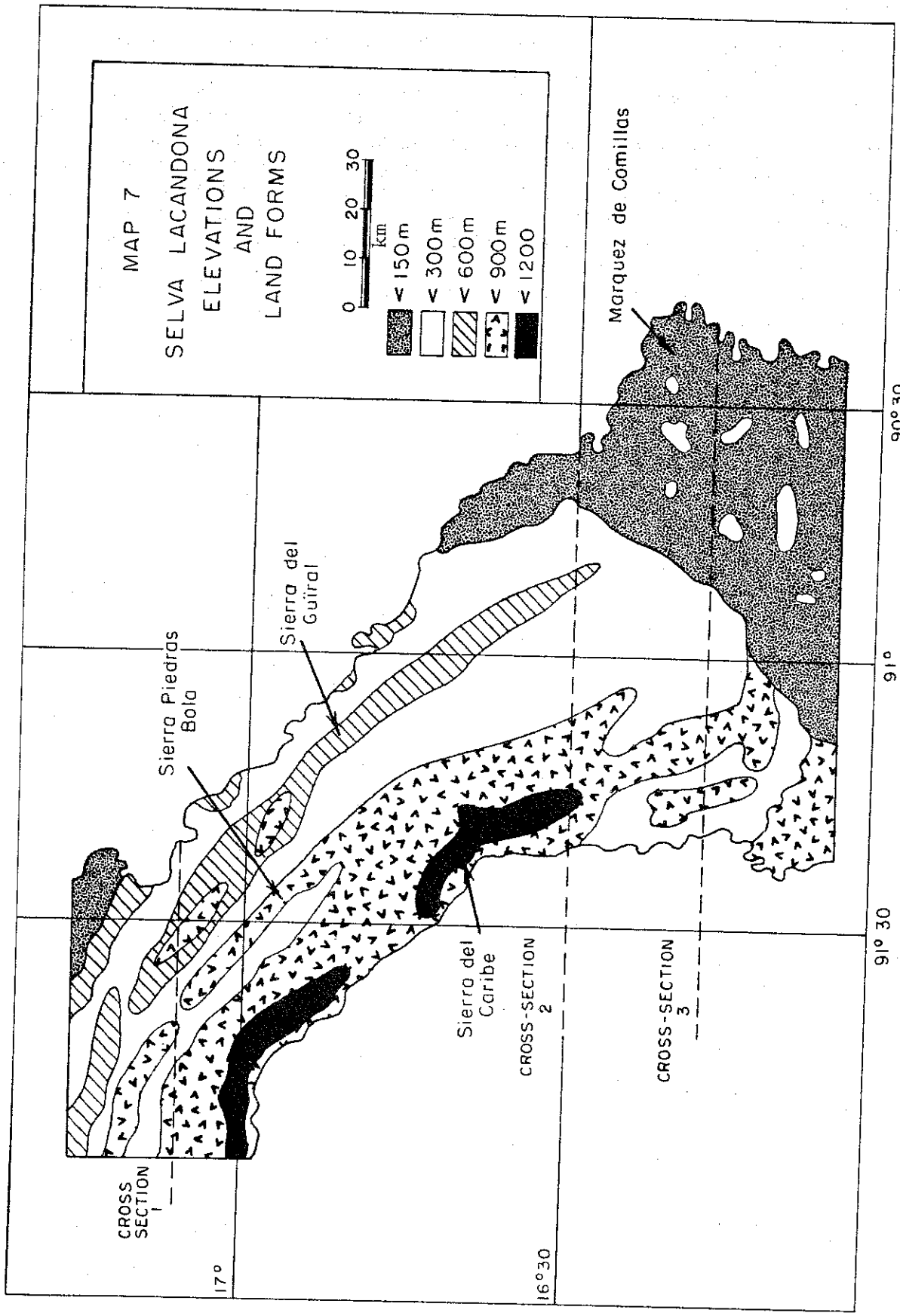
Land Forms

The Selva Lacandona is Mexico°s last frontier. This is primarily because the terrain made it very difficult to exploit the resources of the region. The dominant landform is a series of northwest-southeast ridges that divide the region into isolated valleys. The ridges create a rugged landscape that slowed the development process by inhibiting the penetration of roads. Map 7 shows the Selva°s landforms and elevations.

The elevation of the ridges and valley floors generally declines from the highlands in the West to the Ucumacinta in the East. Figure 1 shows cross-sections at three latitudes in the region. Elevations range from about 1300 meters on ridge tops in the west to 150 meters on the flood plains of the Ucumacinta. Map 7 and the southern cross-section reveal large expanses of low lying land in the Marquez de Comillas Zone. Much of this land is either permanently or seasonally inundated.

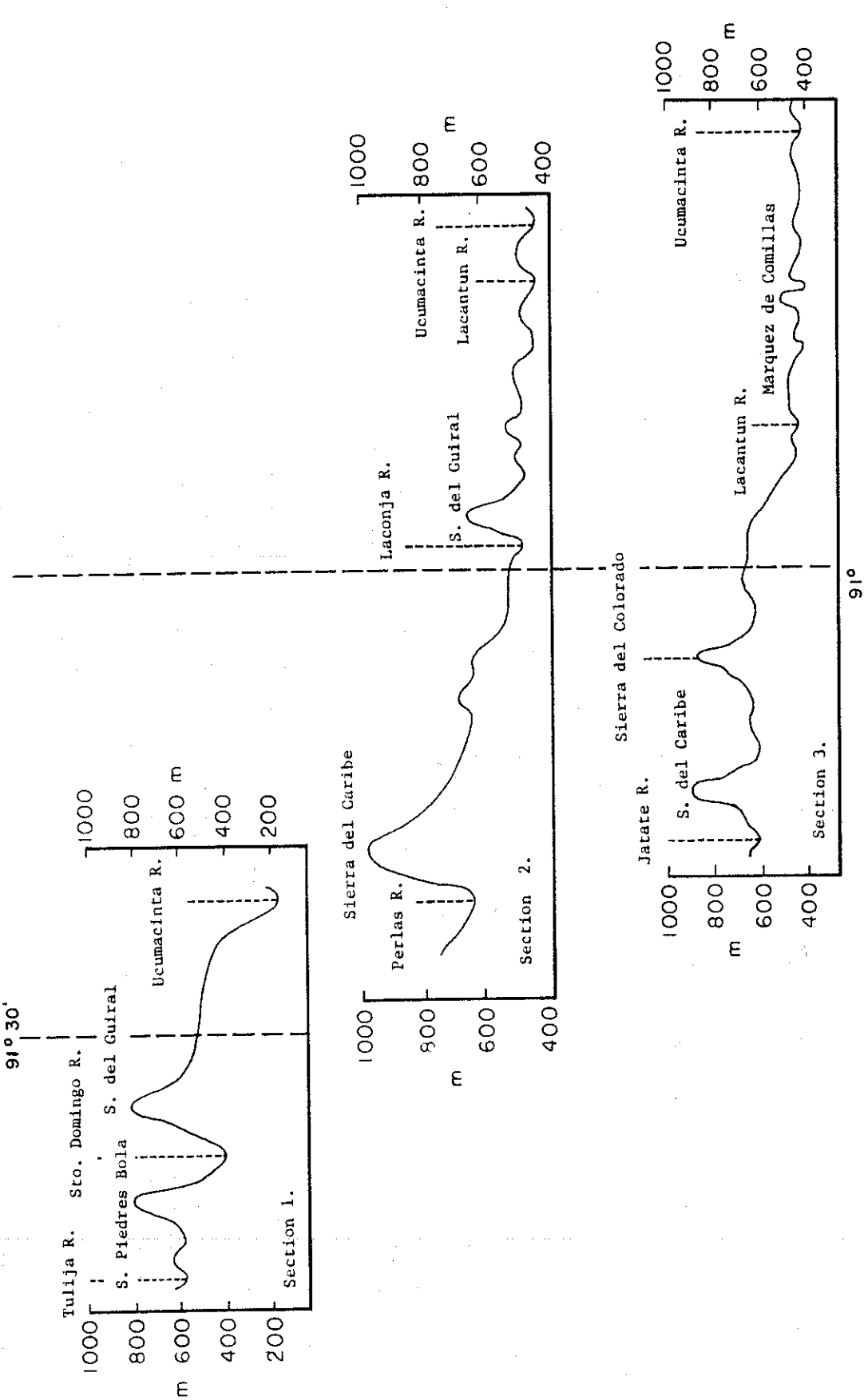
Hydrology

The Mexican portion of the upper watershed of the Ucumacinta river roughly coincides with the Selva Lacandona's borders. The principal tributaries of the Ucumacinta are the Chixoy, Lacantun, Laconja, Jatate and Chocolja rivers. Map 8 shows the hydrology of the Selva Lacandona. A few streams in the region are tributaries of the Grijalva river. The Grijalva joins the Ucumacinta in Tabasco before flowing to the Gulf of Mexico near Villahermosa. The largest of these tributaries is the Tulija which rises in the Northern Zone. With the exception of the Lacantun and Ucumacinta, none of the Selva's rivers are navigable except by canoe. As can be discerned from Map 8, the southern part of the region is a maze of rivers and streams. There are also numerous lakes in the Selva. The largest lakes are Laconja, Metzabok, Santa Clara, Miramar, Ocotal Grande, and Suspiro.

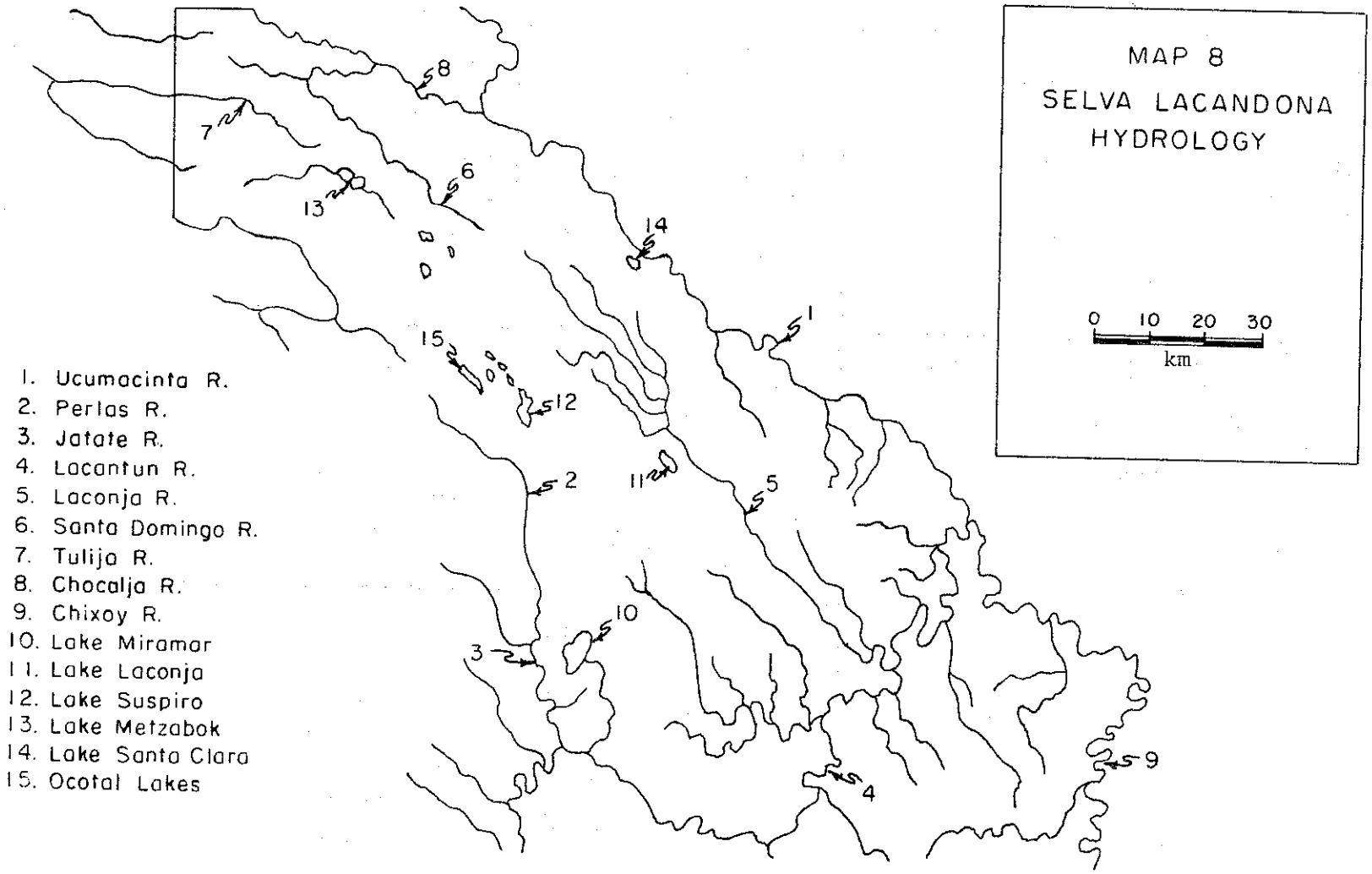


Source: Pablo E. Muench 1978, Rudolfo Labato 1979, and SFF 1975.

FIGURE 1. SELVA LACANDON EAST-WEST SCHEMATIC CROSS-SECTIONS



Source: Pablo E. Muench 1978.



Source: James D. Nations 1979.

Soils

As is typical of many humid tropical regions, the Selva Lacandona has a complex pattern of soils. A few generalizations are possible. The most important generalization is that there is considerable variation in soil types even over a relatively small area. Variation is due to the slope of the land, parent material, vegetative cover, rainfall, and elevation. Only very general studies of the soil types and their distribution have been completed.

The soils on steep slopes or on the tops of ridges tend to have a shallow layer of topsoil, are relatively infertile, and highly susceptible to erosion when vegetation is cleared. The soils on more gently sloping land or near the bottem of hills usually have a deeper topsoil layer, relatively good fertility, and moderate susceptibility to erosion. These soils are generally fairly well drained. On very gently sloping land or on valley floors there are frequently found deeper organic soils. If well drained these are fertile soils and have good potential for crop production. But with poor drainage they tend toward acidity and waterlogging. Soils on the floodplains of the region's rivers and streams usually have deep profiles with high organic matter and silt contents. If sufficiently well drained these soils can support crop production, but they are usually waterlogged.

The SARH has classified the general soil groups of the Selva according to the FAO System. The major soil groups found in the Selva Lacandona are: Ortic Acrisols, Eutric Cambisols, and Rendisols. Other associated soil groups include Ferric Luvisols, Chromic Cambisols, and Lithosols. These soils are generally medium to fine textured in the Selva (SARH 1980, p.59-60).

Climates

The Selva Lacandona has a humid tropical climate. There is, however, considerable variation within the region, between seasons, between years, and between sub-regions. The climate throughout the region is bi-modal (rainy and dry seasons), but in the northern half of the Selva the dry season is better defined. Table 1 shows weather data for five stations in the region. Chart 1 illustrates the monthly rainfall pattern for one station. These weather data are of short time series because of the relatively recent establishment of weather stations in the region. The rainy season is in the summer months, with a peak in June. The dry season comes in the winter. The lowest rainfall is generally in March or April. Total average annual rainfall for the Selva ranges from 1700 to 4295 mm per year. The average for the Santo Domingo Valley (the principal study area) is 2129 mm per year (Grosser ed., p.61).

TABLE 1

Climatic Data for Five Weather Stations in the Selva Lacandona

Station	Median Annual Temp.	Median Max. Temp.	Median Min. Temp.	Median Annual Precip.	Days of Rain	Rainy Period
El Cedro	25.8	39.5	9.3	2087mm	151	4/15-12/15
Nueva Esparanza	25.4	39.5	11.2	2050mm	218	5/15-12/15
Laconja	24.3	41.0	9.5	2330mm	138	5/15-11/30
Bonampak	24.7	41.0	9.0	3302mm	138	5/15-12/15
Ixcan	24.8	40.2	9.0	4295mm	184	6/10-12/31

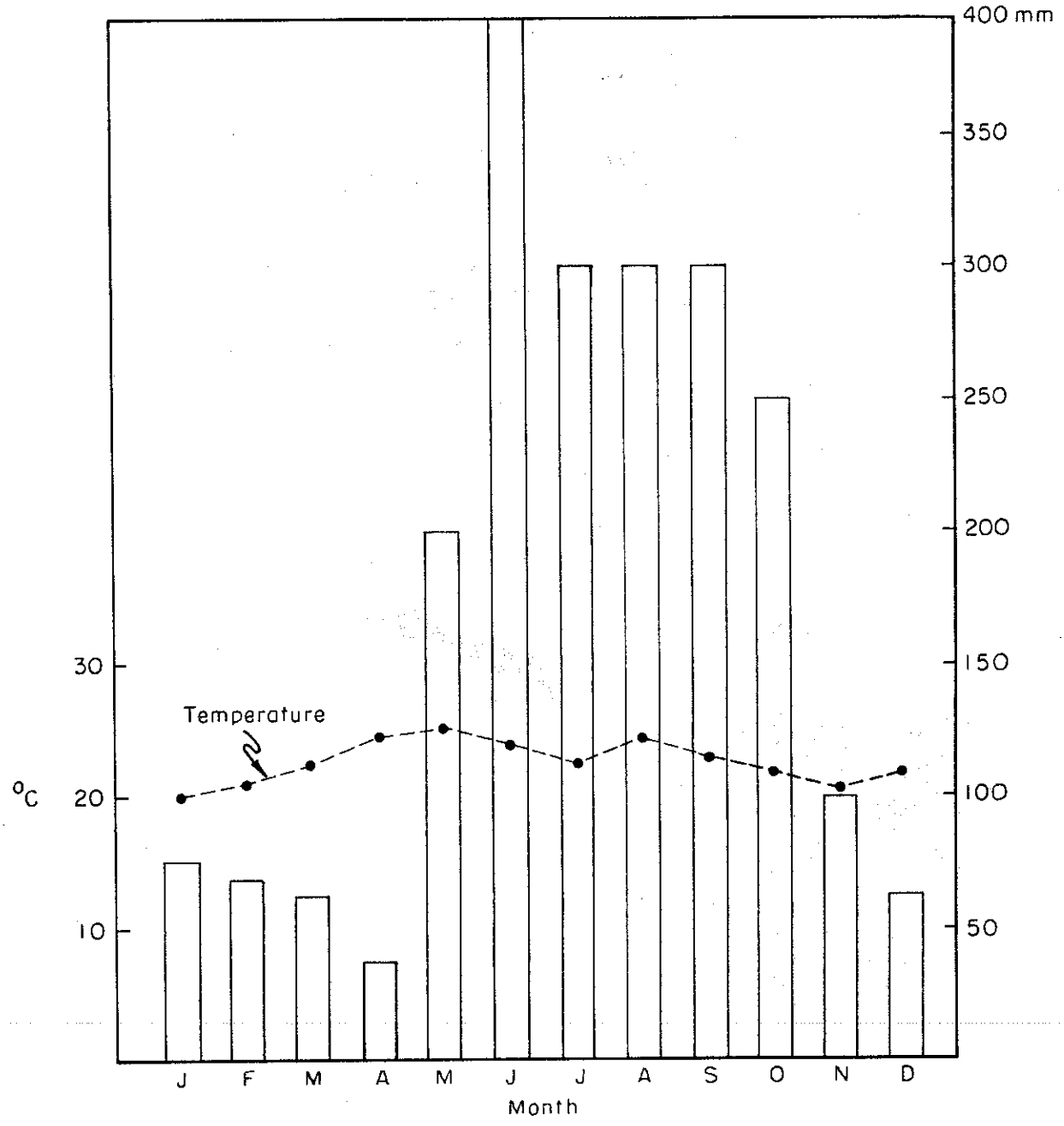
Source: SFF 1975

These weather data are unfortunately unrepresentative of the region as a whole. Map 9 shows the location of the weather stations. They are all located in the southern section of the region. Map 9 also demarcates a rough division of the region into two sub-climatic divisions. The northern division experiences considerably greater variation in rainfall between rainy and dry seasons. It also has lower total annual rainfall. Precise data were unavailable, but field observations in both seasons would tend to confirm the difference between conditions in the North and South. Map 9 also defines a climatic sub-division for zones of higher elevation.

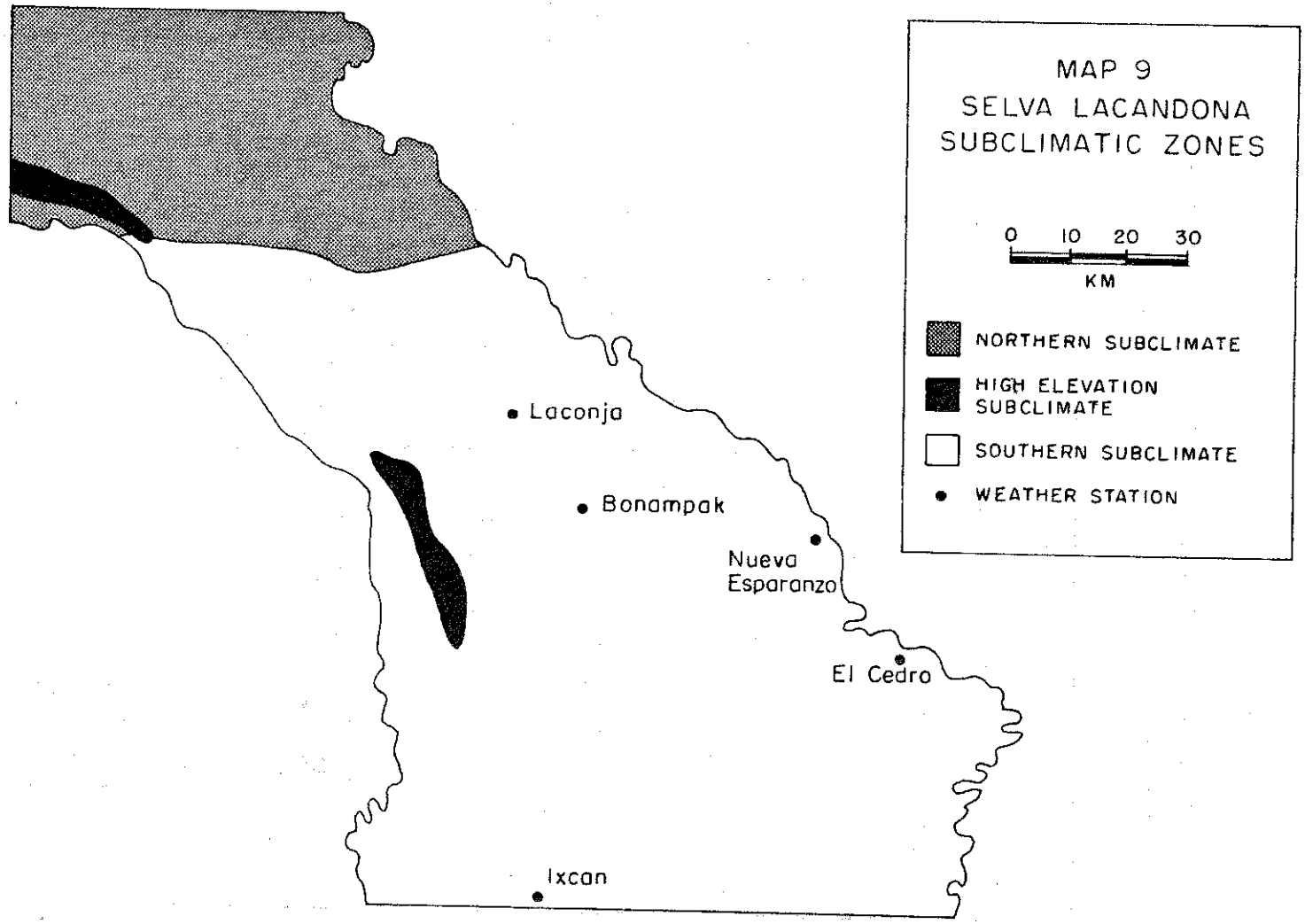
There is some evidence of wide variation in rainfall between years, but conclusive data are unavailable. Grosser et al reported crop losses due to drought in the Selva during the 1975 growing season. Conditions were reportedly most severe in the Northwest (Grosser ed., p.61). In 1981 widespread crop damage was observed as a result of exceptionally high rainfall. Flooding of fields appeared to be particularly bad in the Northwest. Lakes in the region can change level by as much as two to three meters between rainy seasons. The level can change an equal amount between rainy and dry seasons in a given year.

Temperature readings from the Selva Lacandona's weather stations are reported in Table 1. Again, these readings are exclusively from the southern area. The average annual temperature is 25.3 degrees C. The

CHART I. MONTHLY AVERAGE TEMPERATURE AND RAINFALL
LACONJA WEATHER STATION



Source: N. Grosser (ed.) 1975.



Source: Pablo E. Muench 1978.

maximum temperature generally comes in April. The average maximum temperature is 29.3 degrees C. The minimum temperature usually comes in January, and averages 26.8 degrees C. The maximum high and low temperatures are 42.7 degrees C., and 9.0 degrees C., respectively (SFF, p.27). Chart 1 depicts monthly temperature readings for one station.

There is also considerable diurnal (day-night) variation in temperature. Even during the hottest months, evenings are usually fairly comfortable. Nights can be quite cool during the winter. Elevation also effects temperature. At the higher elevations in the West, temperatures are cooler than in the South or East, but the region is frost free.

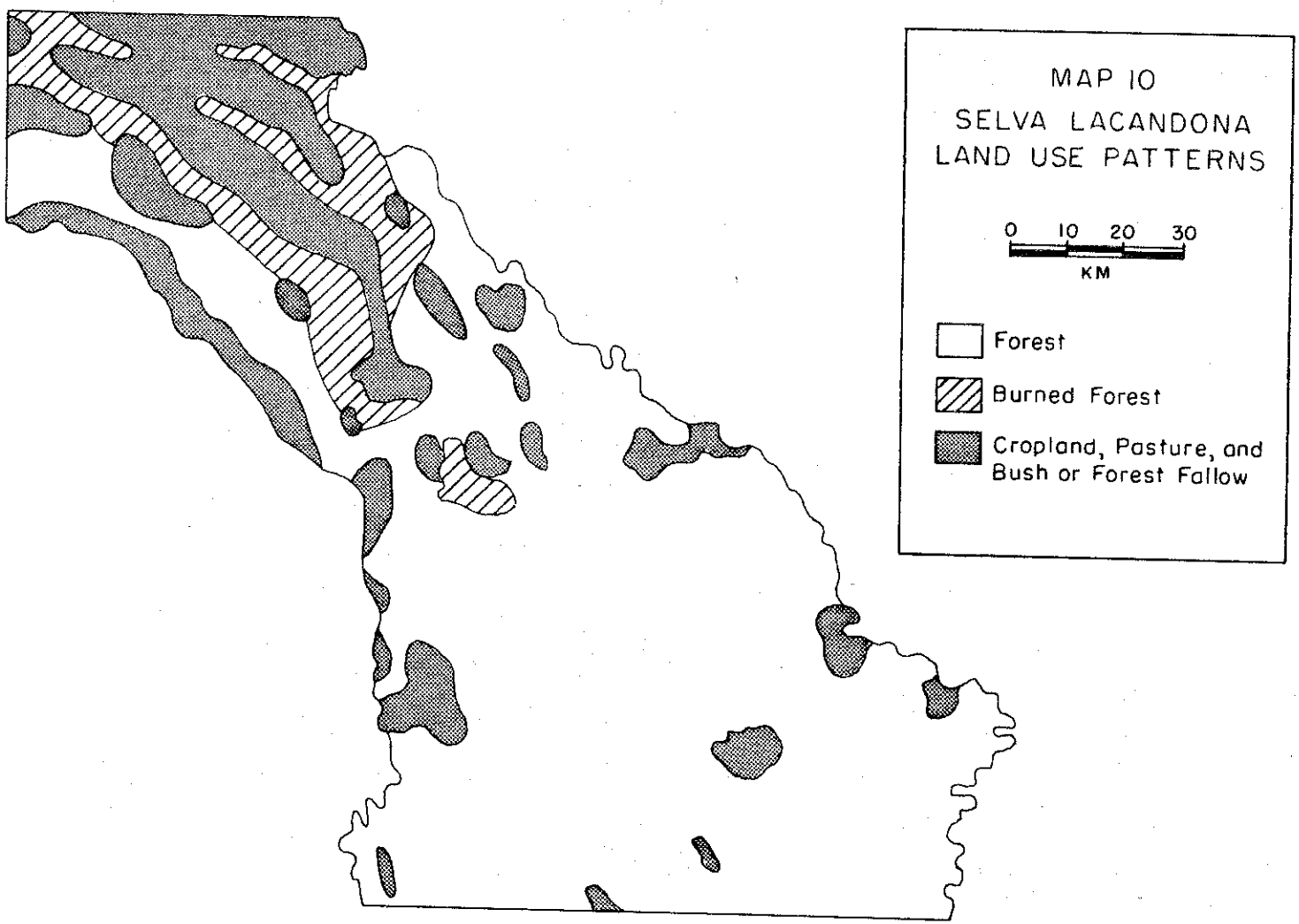
Stormy weather is uncommon in the Selva Lacandona, but not unknown. Severe weather will occasionally come in the form of nortes (northern storms) generally in the winter months. These are thunder storms with high winds, and very rarely, hail. An interesting feature of the Selva's climate is the canicula. This is a brief dry spell, lasting for about two weeks in July or August.

Flora and Fauna

The natural vegetation of most of the Selva Lacandona is tropical moist forest. Selva means tropical forest in Spanish. There are two principal types of forest; lowland, and lower montane rain forest. The lowland rain forest canopy rises to between 30 and 60 meters in height. This forest type is primarily located in the river valleys of the region. The lower montane rain forest reaches a maximum canopy height of about 30 meters. This forest type is found on hills and ridges. Up to 30 percent of the leaves of the lower montane rainforest are lost during the dry season. Lowland rainforests are evergreen. At higher elevations there are some stands of conifers in the region.

In 1980, the total extent of forest cover in the Selva was approximately 930,000 hectares, or about 70 percent of the total surface area. The forests of the Selva Lacandona comprise about ten percent of all Mexican forest reserves (SFF, p.18). Map 10 shows the patterns of land use in the region. The effects of logging and agriculture are evident. Agricultural land, forest fallows, and burned forest account for at least two thirds of the total area of the Northern Zone. Only the Southwestern and Marquez de Comillas Zones have large tracks of undisturbed forest.

The Selva Lacandona is one of the few remaining habitats of several endangered species including jaguars, pumas, ocelots, spider and howler monkeys, crocodiles, giant tapirs, anteaters, and many species of birds (Rich). In the settled areas wildlife has become quite rare. In more recently colonized areas game is still hunted. An occasional jaguar or wild boar is killed in the South of the region. The greatest concentration of wildlife is now found in the Biospheric Reserve.



Source: Rudolfo Labato 1979, LANDSAT, and Field Observations.

ANCIENT AGRICULTURE

The Maya, and the Lacandone Indians developed agricultural systems that are more intensive than those practiced by migrants in the Selva Lacandona today. The existence (and former existence) of agricultural systems that are highly adapted to conditons in the region could have important implications for agricultural development. Some ancient practices may hold promise for improving productivity if introduced into existing farming systems. The Maya had several strategies for coping with the humid tropical environment. Recent archeological and agronomic evidence shows that the Maya employed sophisticated systems of water management for cultivation in low lying areas. On hilly terrain, the Maya used terraces. The Maya may also have engaged in agro-silviculture. The Lacandones adopted a complex forest-farming-gathering system that uses diversity of cultivars and intensive resource management to provide a subsistence.

The Maya

The Selva Lacandona, along with Peten (northern Guatemala) was part of a core area of the Mayan civilization between the Third and Tenth Centuries A.D.. A number of archeological sites have been identified in the region, and many more probably remain covered by the forest. The principal ceremonial centers in the Selva Lacandona, Yaxitlan and Bonampak, have been excavated. The ruins at Palenque, just outside of the Selva, are a popular tourist attraction.

The Mayan population in this core area may have numbered in the millions at its peak between the Third and Ninth Centuries (Nations 1979, p.25). This was the time of the building of the great ceremonial centers. In about the Nineth Century the Mayan civilization collapsed. For decades it was believed that the collapse was caused by an ecological catastrophy resulting from a population density too great for the carrying capacity of the rain forest environment. It was held that the Maya were dependent on slash-and-burn agriculture, and that the collapse was the result of soil exhaustion. In recent years, however, evidence has been brought forward to dispute this assertion.

Research on Mayan agricultural practices increasingly points to the widespread use of intensive agriculture throughout the Lowland Maya civilization. Investigation of sites in the Candelaria region of Campeche, Mexico, and in northern Belize, provided evidence of the employment of systems of canals and raised fields by the Maya (Siemens and Puleston). These discoveries were followed by large scale reconnaissance of the Maya Lowlands with remote sensing technology (Adams et al). Large areas were detected, and some later ground-proofed, that had signs of water management systems and raised fields. It is now believed that most of the major population centers in the Maya Lowlands were located on or near swampy areas (Harrison and Turner). This has given more credence to the

assumption that Mayan agriculture was dominated by intensive practices, especially highly organized drainage systems and raised fields.

Raised field farming systems create new cropland in inundated areas. Canals are dug in a grid pattern on swampy land. The soil from the canals is heaped upon a platform of land between the canals. The excavated soil forms a raised field on the platform that is elevated above the flood level. This system permits the production of crops in the rainy season because the field is protected from flooding. The drainage canals also provide a constant source of water for dry season cropping. Aquatic vegetation from the canals can provide green manure for the field to enhance soil fertility.

In hilly areas, the Maya evidently employed terracing as a means of intensifying agriculture through the maintenance of fertility and soil moisture. Extensive excavations have been made of terraces in Quintana Roo, Mexico (Harrison). In the Selva Lacandona, investigations of agricultural sites has been limited. One terrace has been described in ejido Santo Domingo (Labato), and Nations and Nigh have tentatively identified canals and tanks near lake Metzabok (Nations and Nigh).

Other subsistence cropping systems as alternatives to slash-and-burn for the Maya have also been put forward by scholars. Puleston (1968) hypothesized that the ramon (Brosimum alirostrum) which can provide up to 2.7 metric tons of nuts per hectare per year, could have been an important food crop near Tikal in Guatemala. Wilken (1971) proposed that the Maya may have practiced an agro-forestry system for subsistence. He suggests that the Maya replaced the natural forest with an artificial forest of useful trees.

The findings in archeology have led to interest in ancient agricultural systems among agricultural researchers in Mexico. At the College of Tropical Agriculture at Cardenas, Tabasco, extensive research has been conducted on the productivity of a Tabascan raised field system known as the chinampa (Gliessman et al. 1981). Investigators from the National Institute for Research on Biotic Resources at Xalapa Veracruz (INIRB) have also experimented with chinampas. Their findings show that one hectare of chinampa can support at least ten people the year round (Gomez-Pompa 1978). The potential for using ancient intensive practices in the Selva Lacandona will be discussed in Chapter VII.

The collapse of the Mayan civilization resulted in a decline in population and a breakdown of intensive agricultural systems (Thompson). In the Selva Lacandona, a remnant population of forest farmers was found by the Spanish Conquistadors when they turned their attention to the region in the 17th Century. After several punitive expeditions against what were described as tribes of fierce warriors, the Selva was pacified and the population enslaved. Eschewing the lowlands as unhealthy, the Spaniards transported their captive labor force to work on haciendas in the highlands (Nations 1979).

The Lacandones

Some time before the 16th Century, Yucatec Maya speakers began to enter the Selva Lacandona from Peten in Guatemala. This ethnic group, that became known as the Lacandones, continued to migrate into the region through the late 1800s (Thompson, Nations 1979). Little was known of the Lacandones until the early 20th Century. Tozzer made a study of them early in this century (Tozzer). Franz Blom and Gertrude Duby made more detailed studies of the Lacandones in the 1930s-1950s (Blom and Duby).

The Lacandones lived in scattered settlements throughout the region. They practiced shifting cultivation with maize, beans, and some tubers and fruits as the principal crops. Hunting with bows and arrows and the gathering of forest products were also important.

The Lacandone traditional farming system is one of the most diverse and productive forest farming systems in the world (Nations and Nigh). It is based on a set of complex resource management techniques that draws on the resources of shifting cultivation, and the natural environment. Farmers are able to produce relatively high and dependable yields of a wide range of food, and non-food products. This is accomplished with little destruction of the forest. Although the Lacandones today are few in number (perhaps 350 remain), their farming practices could be very important to agricultural development in the Selva because of the depth and precision of the knowledge of regional conditions that their system embodies.

The Lacandone system is based on shifting cultivation. Almost all of the cropping systems of the Selva are based on the cutting of vegetation, the burning of debris, and the planting of crops. The Lacandones are masters of this type of system. They have developed a farming system that consistently provides for the needs of their population. This system is the product of centuries of experience with subsistence farming in the tropical forests of the Selva Lacandona and adjacent Peten. They have adapted their practices over time to make the most of the forest's resources.

A key element of the Lacandone system is that it imitates the natural environment. The tropical forest is nature s most diverse biome (Richards 1973). The Lacandone system responds to this with great diversity in cultivars. The Lacandone milpa[6] system may employ over 100 varieties of plants in a single hectare (Nations and Nigh, pp.10-11). This diversity allows the farmer to take advantage of several biological nitches, to reduce the risk of hunger from the failure of a few crops, and to provide a varied diet for his family.

The Lacandone farming system is primarily based on maize. Root crops, vines, tree crops, and vegetables are also grown. The cultivars are scattered throughout the milpa. Like, or similar plants are rarely placed in close proximity. This fools species specific predators, and thus

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[6] Milpa is an Indian word used in southeastern Mexico to refer to a farm plot, generally a slash-and-burn plot.

reduces crop loses. The cultivars are also arranged in time and space to make maximum use of available resources. Plants occupy positions below, on, and above the ground. Various crops are planted at different times to give a constant supply of fresh food, and to keep the soil covered and protected from the elements (Nations and Nigh).

Lacandone farming is relatively intensive for a shifting cultivation system. Milpas are small (one to two hectares), and are cropped for two to six years, then fallowed for five to twenty years. Weeding, site selection, land preparation practices, and cropping patterns all contribute to a more 'durable' milpa system. The Lacandones require less land for subsistence than most of the region's farmers.

Milpa cropping is not the sole source of subsistence for the Lacandones. Resources are also drawn from the primary forest, from forest fallows, and from lakes and streams. A wide range of plant and animal products are taken from the primary forest. Hunting and gathering have traditionally played an important role in the Lacandone subsistence economy.

The Lacandone conception of the forest fallow or acahual as it is generally called in Chiapas, is illustrative of their complex strategy of resource use. The acahual is called pak che kol in Yucatec, which means planted tree garden (Nations and Nigh). Unlike many shifting agriculturalists, the Lacandones view the forest fallow as a productive part of the system. Tree and root crops are planted in the milpa before it is abandonned. These crops are harvested from the acahual over a period of years. The acahual is also attractive to many species of wild game that graze on acahual plants. These animals are hunted, providing an important protein source. The Lacandones consciously plant some crops as forage for wild animals. To attract game, they also leave some maize undoubled to make it easier for wild animals to feed. This is believed by the Lacandones to reduce crop loses to animals; some of the crop is 'given' to the game animals (Nations and Nigh).

The development process has had a severe impact on the Lacandone Indian population. Early contact with loggers and chicleros spread disease among the population and greatly reduced their numbers (Tozzer, Nations 1979). The massive migration from the highlands gradually forced the Lacandones to move deeper and deeper into the forest. Eventually there was nowhere for them to go.

Government intervention in the late 1970s resulted in their concentration in a few settlements. The traditional farming system suffered from this concentration because farmers no longer 'lived in their fields'. Their concentration also facilitated the conversion of many of their number to the Seventh Day Adventists faith by missionaries. The general deterioration of Lacanndone traditions has resulted in a movement away from traditonal farming. The effect has been an erosion of the level of intensity and care with which the Lacandones farm.

Nations believes that only about a dozen Lacadones continue to practice the traditional farming system (Nations p.c.). This number is being reduced as the older generation passes on. It seems likely that the highly

adapted forest farming technology of this culture will soon be lost. In the Lacandone system there are many important lessons that may apply to agricultural development problems in the Selva Lacandona and other tropical areas. The Lacandones possess an intimate understanding of the tropical forest environment. In the final chapter, some ways in which their knowledge might be applied to the region's agricultural development will be suggested.

Chapter III

THE DEVELOPMENT PROCESS IN THE SELVA LACANDONA

In many respects, the development process in the Selva Lacandona has been typical of that of most of the Mexican Tropics. After centuries of relative isolation, the construction of roads for timber operations opened the region to independent migrants. These settlers colonized the region and established a precarious existence based on shifting cultivation. The migrants were only able to produce small surpluses of staple crops because of a variety of technical problems. Poor markets for cash crops such as fruits and coffee limited the options open to farmers. A lack of alternatives for improving living standards has resulted in the spread of a highly destructive extensive cattle industry. Cattle production has proven to be one of the only systems available to the colonists for the rapid generation of cash income. Most cattle systems in the region, however, degrade the land.

Current patterns of land use are leading to a process where the human carrying capacity of the Selva Lacandona is being reduced. As more land is planted in pasture, the area available for the cultivation of food crops shrinks. This is the result of the dominance of short term economic incentives, and a lack of attention to longrun consequences.

This chapter examines the development process in the Selva Lacandona. The presentation is divided into four sections. The early phase of the development process was dominated by extractive industries. In the first section, logging, and chicle collection, before roads were constructed in the region, are reviewed. Initial independent colonization in the Selva is also included in this section. In section two, the development process after 1964 is described. In 1964, the first logging roads were constructed, opening the Selva Lacandona to massive migration. The third section examines the two principal agricultural systems that have evolved in the region since the begining of colonization. The progression of land use patterns characterized by the clearing of forest for farming, followed by the sowing of pasture for cattle is detailed, and the problems associated with extensive grazing examined.

THE DEVELOPMENT PROCESS BEFORE 1964

Early Extractive Industries

Until the late 19th century, only isolated groups of Lacandones inhabited the Selva Lacandona. In 1878, much of the region was divided into individual land holdings of between 50,000 and 200,000 hectares (Labato 1979, p.79). These divisions were rather meaningless because of the inability of the owners to exploit their isolated parcels. Private logging enterprises were able to harvest timber that was accessible along the margins of the Ucumacinta and Lacantun rivers and their larger tributaries. These companies extracted valuable timber along the rivers until the early 20th century (Blom and Duby 1957, p.277).

Loggers felled timber at a short distance from the rivers and dragged the logs to the banks with mule teams. The wood was then floated out on the waterways. Some fraction of this timber reached Tenosique, Tabasco, on the Ucumacinta, and was either milled or shipped to the sea for export. The effect of this logging on the region was limited by the difficulty of hauling timber over long distances. Operations were confined to a narrow band along the principal rivers. The extension of logging operations was also limited by the number of rivers that had sufficient depth and width to carry the logs.

Another early industry in the Selva Lacandona was chicle collection. Chicle is a natural rubber source that is the product of the sap of the chico zapote tree (Manilkara zapota (L)). It is primarily used as a base for chewing gum. Chicle collectors (chicleros) gravitated to the virgin forests of the Selva from Campeche (once yields were reduced there by over-exploitation) after 1926. The Selva Lacandona was exploited later than the forests of Campeche because the higher humidity of the Chiapas jungle results in a lower quality rubber from chicle (Labato 1979, p.72).

The increased demand for natural rubber in the United States during the Second World War, and the Japanese occupation of rubber producing areas in Asia resulted in intensification of chicle exploitation in the Selva Lacandona. American companies built airstrips to facilitate chicle extraction. The development of substitutes for natural rubber in the 1940s, and the end of the War contributed to a sharp decline in chicle gathering in the Selva thereafter (Labato 1979, p.73).

Early Settlement

The first settlers entered the Selva Lacandona after 1940 from the Highlands of Chiapas. The Indians of Chiapas were released from peonage in the early 1930s. Because the highlands were already fairly densely populated by that time, many of the second generation following this release were left landless (Nations 1979, p.106). Tseltal and Chol Indians from Ocosingo, Yajalon, Palenque, Chilon, and other municipos migrated into the forested valleys to the east. The first valleys to be settled in the Selva were the Jatate, Perlas and Tulija (see Map 8).

More meaningful subdivisions were made in this period with the establishment of large private ranches (Labato 1979, p.80). These ranches, owned in abstentia by wealthy families from the state capital, Tuxtla Guttierez, controlled between one and ten thousand hectares. The ranches were purchased from the federal government in the 1940s.

Ranchers had several methods of establishing pastures. Peons were sometimes used to clear forest and to plant the land in grass. In some cases, ranchers allowed landless peasants to clear the forest and plant crops for a season. These farmers would plant grass in their plots after taking off one crop. The peasants would then move on and clear another area. This method provided the rancher with free labor and the farmer with land for a year. This method was also practiced by unscrupulous landowners who would force peasants off of land that they expected to own after clearing (Nations and Komer).

Small ranches of less than 100 hectares were also established. These ranches primarily served as producers of feeder calves for the larger ranches. Because the region still lacked roads in this period, cattle were walked out on trails to Tabasco and Ocosingo.

LOGGING AND MIGRATION

Mechanized Logging

In 1964, The Asseraderos Bonampak logging company entered the Selva Lacandona and began mechanized logging operations. The company had previously logged the Candelaria region of Campeche and moved into the Selva after that region's timber resources had been depleted (Labato 1979, p.75).

The mechanization of logging made the construction of roads into the Selva Lacandona profitable for the first time. A road was constructed from the Southeastern railway siding at Penjamo (see Map 4) into the Chocolja Valley. This river valley had not been logged previously because the river was of insufficient size for floating logs. Bulldozers and other heavy equipment were used to construct a trunk road through the Chocolja and Santo Domingo river valleys, and a grid of tracks throughout the northern half of the Selva. The Bonampak Company's mill was established at Chancala.

The type of logging practiced by this company utilized very few tree species, primarily Caoba (Swietenia macrophylla K.), and Tropical Cedar (Cedrela odorata C.). Only about one tree per hectare was harvested. Bonampak harvested an average of 17,000 cubic meters of timber each year from 1964 and 1974 (SFF, p.172). Most of the logging was done between March and May when rainfall is light enough to make work with heavy equipment possible and the transportation of logs to Chancala easier.

Although only a small number of tree species are used by the logging industry in the Selva Lacandona, the attendent destruction is great.

Because the useful trees are widely scattered, tracks must be constructed across large expanses of forest to get at the economically useful trees. In the course of the construction of tracks, much of the surrounding forest is disturbed. The trees in the canopy of the tropical forest are connected by lianas and other vegetation. Because tropical rain forest trees are shallow rooting, many trees are toppled along with the economic trees in the course of harvesting. Additional destruction occurs when the logs are dragged out through the muddy forest floor. An estimated ten to thirty percent of the forest is damaged by this type of logging operation (Nations and Komer).

As it is exploited today, commercial timber in the Selva Lacandona is a non-renwable resource. There is no replanting. The trees that are currently of economic value are long maturing species. They typically require fifty to one hundred years to reach maturity.

The logging industry in the Selva is highly mechanized, therefore it has little employment effect on the region. Total employment in logging was only 213 people in 1975 (SFF, p.191). What employment there is is highly seasonal. Most of the workers are brought in from Palenque and Chancala, and the milling is done in or near those towns.

The most profound impact of logging has been the construction of roads. Logging roads through the river valleys of the region facilitated the migration of landless people from the highlands. In a manner similar to the Homestead Act in the United States (Nations 1979), migrants settled this frontier area, establishing settlements along the roads.

Massive Migration

From 1964 to 1978, massive migration from the Highlands of Chiapas occured. Migrants entered the Selva Lacandona along logging tracks and colonized the Chocolja and Santo Domingo valleys. Other migrants entered the Southwestern zone from the area known as Las Marguaritas (see Map 4).

In the 1960s, there was a conflict within the government over the use of the land of the Selva Lacandona. In 1961, the Department of Agrarian Affairs and Colonization (DAAC) expropriated 188,205 hectares for resettlement (approximately 10 to 15 percent of the total area).[7] This agency wanted to settle landless people from northern and central Mexico in directed settlement projects. The State of Chiapas wanted to relieve population pressures in the highlands of the state, and thus defuse conflicts between ranchers and landless peasants, through independent migration to the Selva (Labato 1979, p.85).

With the opening of logging roads, the migrants had indeed come into the region independently. Eventually, the federal government abandoned plans for directed settlement and accepted the defacto establishment of colonies

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[7] The boundaries of the Selva Lacandona in the report were unclear.

on the federal lands. The migrants were invited to petition for status as ejidatarios under the land reform laws. In 1967 the Departamento Agrarias (formerly DAAC) expropriated 401,959 hectares for redistribution into ejidos and as part of the national land reserve (Labato 1979, p.81). This represented about 30 percent of the total area of the region. The process of legitimization of land claims was long and drawn out, and frequently proved very expensive for the colonists.

The ejidos tended to be made up of families from the same area in the Highlands. Typically, one or two families pioneered a settlement and encouraged others from their village to follow. The ejidos grew into villages in the late 1960s and early 1970s. Between 1962 and 1975, about 50,000 people entered the region, and formed at least 120 colonies. The population of the Selva Lacandona in 1981 was probably over 80,000.

In the 1970s, the government became concerned with the course of the development process in the Selva Lacandona. Large areas of forest containing valuable timber were destroyed by independent colonists. In an effort to halt this waste, thousands of migrants were expelled from their farmsteads and resettled in concentrated settlements. An examination of the record of government involvement in the Selva's development reveals a great deal about the nature of the government's strategy for development in the region before the SAM. The resettlement projects undertaken in the 1970s offer another example of ill-conceived and poorly executed colonization schemes such as those of the Papaloapan Project and Uxpanapa. The actions taken by the government and their effects are detailed in Appendix A.

AGRICULTURAL SYSTEMS

Subsistence farming with shifting cultivation and extensive cattle grazing are the principal agricultural systems that have been established by migrants in the Selva Lacandona. Shifting cultivation in the region, under the proper conditions, is a viable system for small-holders, but is not sufficiently productive for the apparent needs of the colonists. Extensive cattle grazing in the Selva is very unproductive and often destructive to the land. This section examines the evolution of these two systems and analyzes the inherent problems that they hold for agricultural development.

Subsistence Farming

In the early years, the colonists were primarily concerned with eking out a living through subsistence cropping. They adopted farming systems based on shifting cultivation of maize and other staples in response to environmental conditons and the limited availability of markets and resources.

The Mexican ecologist Arturo Gomez-Pompa wrote that "the regenerative systems of the rain forest seems to be very well adapted to the activities of primitive Man" (Gomez-Pompa 1972, p.763). The shifting cultivation systems practiced by traditional forest farmers such as the Lacandones, under low population densities, are similar to the occasional destruction of the forest resulting from natural causes.

The nutrient cycle between the mature tropical forest and the soil is a nearly closed system. Storage occurs in the biomass and in the topsoil, which are connected by several nutrient pathways (Sanchez 1973, p.350). Tropical forest farmers take advantage of the nutrients locked up in the biomass and the soil through their slash-and-burn technique. Nutrients are released through burning and provide the basis for crop production. According to Ruthenberg (p.354):

> Shifting cultivation...allows soils poor in nutrients to regularly produce relatively high yields...If the fallow periods are long enough, this type of land use system represents a balanced exploitation of the resources available to farming.

However, shifting cultivation may be highly destructive under some circumstances such as high population densities, and the practice of shifting cultivation by inexperienced farmers. One common source of ecological instability in shifting cultivation systems is a breakdown in the fallow cycle. This may result from a scarcity of farmland or the establishment of pastures. A breakdown in the fallow cycle can result in reduced soil fertility (and therefore lower yields), erosion and weed infestation (increasing labor requirements) (Clarke, p.170). Many of these problems are becoming common in the longest settled areas of the Selva Lacandona.

Another problem associated with shifting cultivation in the Selva Lacandona has been the burning of large expanses of forest. This has been, in part, the result of inexperienced farmers using uncontrolled burning to clear land for farming. Large areas have also been cleared with fire by colonists seeking to secure tenure over the land. It is commonly believed that forested land is unclaimed.

If poorly practiced, shifting cultivation can lead to erosion. Farmers in the Selva Lacandona are increasingly using slash-and-burn farming techniques on steep hillsides. Unless care is taken to quickly introduce a ground cover (as do the Lacandones in their milpas with root crops and bananas), heavy rains can result in rill and gully erosion.

In terms of economic development, Eckholm (p.139) finds that shifting cultivation alone is inadequate:

> Production may be fairly secure, but the system makes no provision for the accumulation of investments that is the key to higher productivity and wealth...Material poverty is the inescapable condition of the traditional shifting cultivator.

Once migrant families have achieved subsistence, they generally seek to acquire cash income. It is difficult for migrant farmers to generate large surpluses of milpa crops with their slash-and-burn techniques. At that point in the development of a farmstead, farmers must select an enterprise or a group of enterprises for commercial production. Tree crops such as fruits, cacao and coffee all require maturation periods, and have poorly developed markets and low prices. The market for chile is also unsure and labor demands in chile production are high. Extensive cattle production is one of the few systems available to farmers in the Selva Lacandona that offers a relatively rapid means of generating cash income with their limited resources. Cattle in the Selva is one of the only commodities that is well linked to regional and national markets. Labor demands are also relatively light in extensive cattle systems.

Extensive Cattle Production

Cattle production has expanded rapidly in the Selva Lacandona. Today at least one third of the northern half of the Selva Lacandona is in pasture. As much as one third of all ejidal land in the region may now be devoted to cattle production. This expansion has been part of a wider expansion in the Southeast. Extensive cattle operations in the Selva have benefitted directly and indirectly from government support of the industry. Extensive grazing systems are generally non-sustainable under current practices and conditions in the region. Their expansion threatens the longrun viability of the agricultural economy of the Selva.

Extensive cattle production is practiced in the Selva Lacandona by both small and large land holders. Large and small private ranches were established in the 1940s and 1950s. Many of the colonists who settled ejidal lands also became cattle producers. Cattle production among ejidatarios in the Selva Lacandona began in the early 1960s. Many of the Highlanders had experience working on the large ranches in their municipos before migration. Others had migrated seasonally to work on ranches in the lowlands of Chiapas, Tabasco and Veracruz. Many of the small ranchers in the Selva also came from these cattle producing regions on the Gulf Coast.

Extensive grazing systems are relatively easy to establish and expand for migrants in the Selva Lacandona. Grass is planted in the milpa near the end of the cropping cycle. The area in pasture can be expanded at a rate of two to three hectares per year within the cropping cycle. With a few thousand pesos, a farmer can establish a breeding herd within a few years. Calves are easily marketed at the farm gate. Two calves yield an income that is equivalent to the average income from one hectare of milpa. All of these factors make cattle an attractive enterprise for the small farmers of the Selva. The economic returns to grazing are, however, short lived.

The problems with extensive grazing systems arise primarily from the basic ecological imbalances inherent in extensive grazing systems in the Humid Tropics. Most cattle operations in the Selva Lacandona result in land degradation. Unlike a well managed shifting cultivation systems with

adequate fallows, extensive grazing in tropical forested areas involves the total removal of tree cover for extended intervals. Forest is converted to stands of African or native grasses. Ruthenberg (pp. 47-48) notes the weakness of grasses as a cover in the Humid Tropics:

> Grass in the tropics,...,does not have the same ability as bushes or trees to remobilize nutrients and to accumulate organic matter. Trees alone have the necessary depth of rooting, the capacity to make use of a large part of the rainfall throughout the year, and the ability to maintain, in their own structure and leaf litter, a substantial portion of the nutrient material available. Land that has been under pasture is frequently incapable of regenerating secondary forest growth or of sustaining crops due to a lack of nutrients and damage to the soil structure.

Another serious problem resulting from the conversion of forest to pasture is an acceleration of erosion. Pasture does not protect the soil as well as a tree cover. In Columbia, for example, on a relatively gentle slope, land under pasture lost seven tons of top soil per hectare per year, while land under forest on the same slope lost less than one ton (Sanchez 1976). Badly eroded pasture has become a common sight in the northern half of the Selva Lacandona. Over-grazing, which is frequent on pastures of small-holders, increases the erosive effects of heavy rains by thinning out the grass cover and exposing the soil.

The expansion of extensive cattle grazing has had a negative effect on food production in the Selva Lacandona. The conversion of forest and cropland to pasture has reduced the area available for food production. Food production, and the potential to produce food in the future, are also reduced through the declining soil fertility associated with pasture cultivation. In the future, many ejidatarios may fail to achieve self-sufficiency as a result of land degradation.

Because cattle grazing in the Selva Lacandona is an extensive industry, it has a low capacity to absorb labor. Workers are needed seasonally for weeding pastures, stringing fences, clearing land, burning and for round-ups. One 750 hectare ranch with 600 head of cattle operates with only seven fulltime workers and 25 day laborers for one month each year. Grosser et al (p.150) found that income generated per hectare is below that of crop production. In 1975, field crops were found to yield an average net return of 1250 pesos per hectare and cattle only 450 to 500.

The expansion of the cattle industry in the Selva Lacandona has also had a negative impact on the eqitable distribution of income and wealth in the region. The existence of land laws that permit individuals and families to control large ranches has been a primary factor in the development of this inequality. In the Selva, several ranches control more than 100 times as much land as the average ejidatario. It has been estimated that .9 percent of the population in Chiapas controls 44 percent of the total land area. Chiapas has been the scene of considerable strife as a result of conflict between peasants and ranchers. In recent years, disputes over the

encroachment of ranchers on ejidal land and the invasion of ranch lands by peasants have been the leading causes of agrarian problems in the state (Esteva, p.145)

The land laws have in fact required landowners to run only extensive operations to retain control of these large holdings (Sanders, p.14). Land could be expropriated if more than 500 head of cattle were grazed, or if crops were produced. These laws, and the protection of large land holdings from land reform that they provided, were recently repealed, ostensibly to promote the production of grain by ranchers. In Chiapas, in 1981, some ranchers were permitted to grow grain on their land (Redclift). The implications of recent changes in the land laws that came with the New Agricultural Promotion Law (Nueva Ley del Fomento Agropecuario) in regard to large cattle holdings remain unclear.

Under current conditions in the region's economy, ejidatarios can make more money ranching than cropping, in the short run. This will be demonstrated in subsequent chapters. It is clear, however, that in the long run, the expansion of extensive cattle grazing may lead to the impoverishment of a significant fraction of the population of the Selva Lacandona. As farmers turn their land into pasture they reduce their ability to be self-sufficient in food. This may eventually lead to a deterioration in the quality of life in the region, and reduce its potential contribution to national grain self-sufficiency.

CONCLUSIONS

The process of land settlement in the Selva Lacandona has not contributed to long-term economic development. Logging, subsistence farming and extensive cattle grazing have reduced the forested area without developing the region. The development process has not been effective in terms of moving the agricultural economy towards more productive systems. The pattern followed in the region has been the introduction of logging, with accompanying road construction, followed by colonization, and finally the conversion of colonized areas to extensive cattle pasture. This pattern has involved a progression toward extensive and less productive systems. The result has been the wasteful exploitation of the Selva°s resources, and a reduction in the productive potential of the region.

The SAM brought a new commitment at the national level to increasing food production in marginal areas, and to the improvement of the welfare of the rural population. If these goals are to be realized at the local level in the Selva Lacandona, current patterns of land use must be altered. This can only be accomplished through the successful introduction of more intensive agricultural systems. The intensification of agriculture among the migrants in the Selva Lacandona will require the identification and promotion of appropriate technologies and the establishment of supportive institutional structures. A thorough understanding of the conditions for agricultural development in the region is needed for this task. The study of these conditions begins in Chapter IV with a description of the settlements, the migrants, and the conditions under which they live.

Chapter IV

THE SELVA LACANDONA IN THE NINETEEN-EIGHTIES

After more than 30 years of colonization, the Selva Lacandona remains a relatively under-developed frontier zone. Living conditions are primitive and incomes are low. Major economic problems include poorly developed transportation and commercial systems, and insecurity in land tenure.

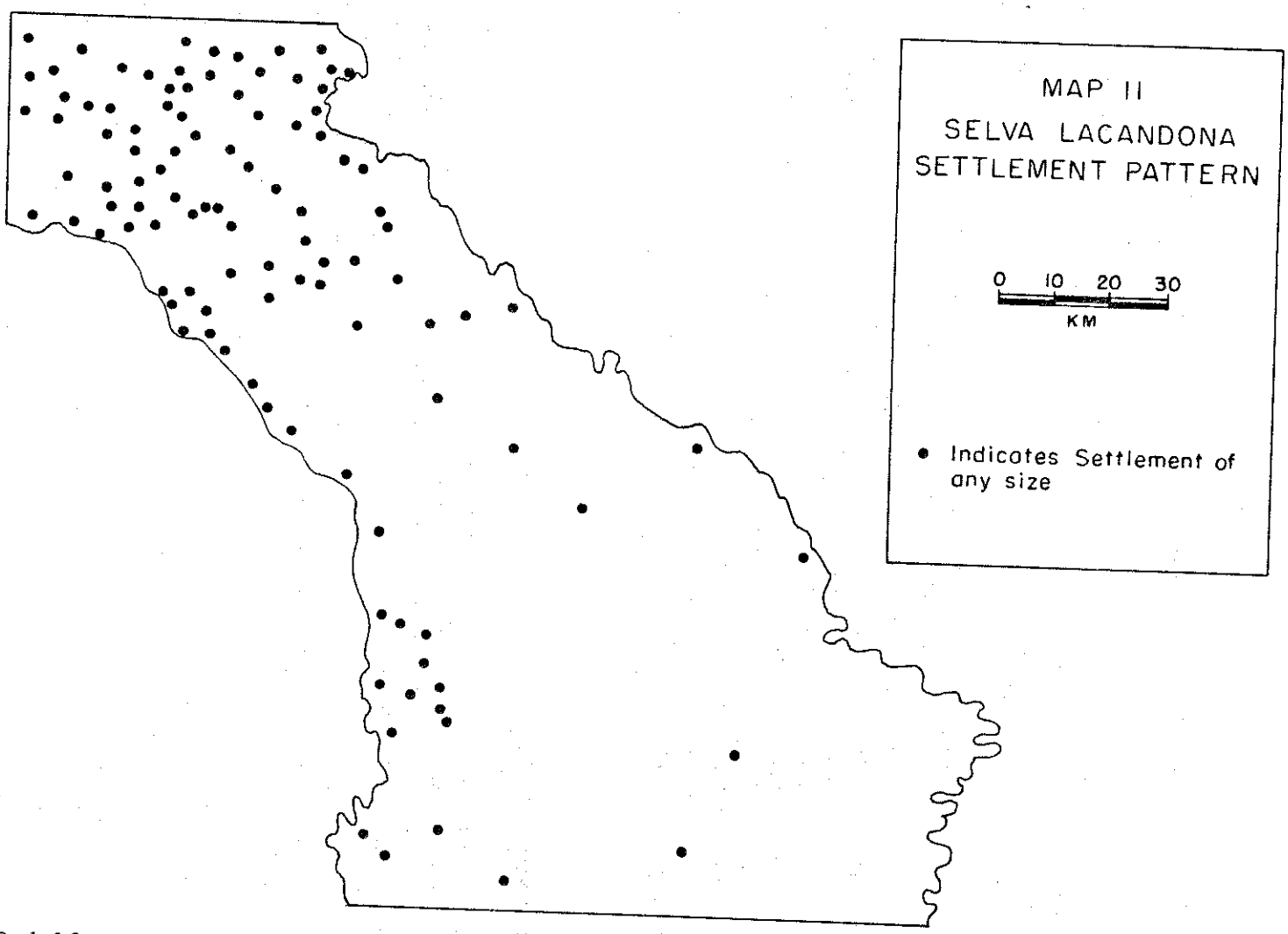
This chapter examines conditions among the colonists in the Selva Lacandona. The vast majority of settlers live in ejidos. This sector is therefore emphasized as the key target group for an agricultural development strategy. Settlement patterns and transportation systems are first considered. The colonists, their living conditions, and the social and political organization of the ejidos are then described. Section four examines land tenure issues that affect the migrants. This is followed by a discussion of commercial systems and general economic conditions. A final section is devoted to ongoing development projects in the region including road construction, petroleum exploration and directed colonization projects. Some of the possible consequences of these recent efforts will be assessed.

SETTLEMENT PATTERNS AND INFRASTRUCTURE

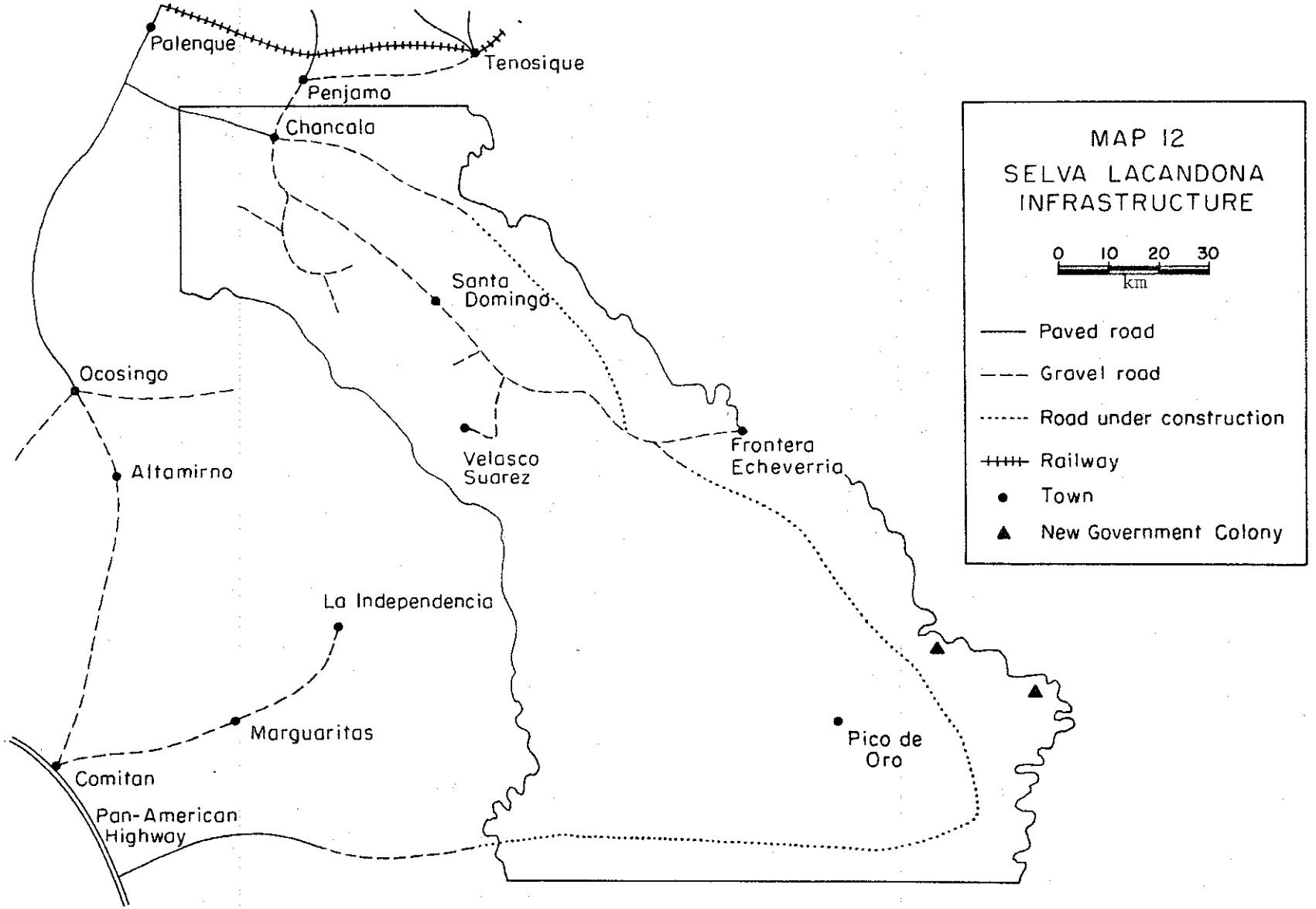
The colonization of the Selva Lacandona has occured along three fronts; southward along the Chocolja and Santo Domingo river valleys, eastward from the valleys of the Jatate and its tributaries, and along the margins of the Ucumacinta and Lacantun rivers. Map 11 shows the settlement pattern in the Selva in 1981. Settlements are concentrated in the North and West. Colonies in the central section are primarily located in the Santo Domingo valley. The few settlements in the East and South are located on the river margins.

Almost all of the settlements are located on roads. Map 12 shows the road and rail systems of the Selva Lacandona and its environs. There is no railroad in the Selva. The Southeastern Railway passes nearest at Penjamo. In 1981, there were less than 20 kilometers of paved road in the region. A paved section had been completed half-way from the Palenque-Ocosingo highway to Chancala by late 1981. Some parts of this section were potholed by 1982. The remainder of the Selva's roads are dirt or gravel tracks.

The road from the Palenque-Ocosingo highway to Chancala is the principal transport link for the region. Another graded track connects Chancala and Penjamo. The main internal transportation artery within the Selva is the former trunk road of the logging track network. This road runs the length



Source: Rudolfo Labato 1979 and Field Observations.


Palenque
Tenosique
Penjamo
Chancala
Santa Domingo
Ocosingo
Altamirno
Velasco Suarez
Frontera Echeverria
La Independencia
Marguaritas
Comitan
Pan-American Highway
Pico de Oro
MAP 12
SELVA LACANDONA INFRASTRUCTURE
0 10 20 30
km
Paved road
Gravel road
Road under construction
Railway
Town
New Government Colony

of the Santo Domingo valley, into the valley of the Laconja, and terminates at Frontera Echeverria on the Ucumacinta. Map 12 also shows several minor tracks that have been constructed off of the trunk road. These former logging tracks now connect settlements with the main road. Many of the smaller tracks are impassable during periods of heavy rain. Most of the main road is open year round. Traffic is occasionally halted by flooding or washouts. Within the region, the roads have very few bridges.

Two bus cooperatives operate in the Selva Lacandona. A regular bus service is operated between Palenque and Chancala. Another bus line makes daily trips between Velasco Suarez and Penjamo, along the main road. The buses are ancient and run-down. Breakdowns and delays are common. Chancala is roughly two and one half hours by bus from Palenque. The trip from Penjamo to Velasco Suarez takes four to five hours. In addition to the bus companies, several privately owned trucks regularly carry passengers and cargo along the principal roads.

In the first major infrastructural change to come to the Selva Lacandona since the opening of roads, electricity was brought into the Chocolja and Santo Domingo valleys in 1981. Twelve ejidos along the trunk road were linked with electric lines running from Tenosique. By 1982, most of the homes in these settlements had hook-ups. The availability of electricity was intermittent however.

THE EJIDOS

The ejidos of the Northern and Central Zones of the Selva are small villages similar to those found throughout tropical Mexico. The average population of these ejidos was approximately 500 in 1981. The largest settlements, such as Damasco, Santo Domingo and La Siria, had about 800 to 1000 inhabitants. Some of the smaller communities had 150 or less. The average number of families was about 100.

Each settlement occupies one or two kilometers along one of the tracks. The larger communities have well defined centers with a group of small shops, a CONASUPO rural store, a school, a playing field, and an ejidal hall. All of the ejidos have schools and basketball courts. In the larger communities, schools are modern construction block buildings. The newer and smaller colonies have crude schools with plank walls and corrugated roofs. The National Indian Agency (INI) is responsible for providing teachers and teaching materials. The main function of INI in the region is to promote Spanish and to overcome illiteracy.

Each family has a household plot of one half to one hectare. The family house plots are layed out in a grid pattern in the larger colonies. Small grass or mud lanes run perpendicular to the main road and are joined by latteral lanes. Trees and garden plots are planted around the houses.

The quality of house construction depends primarily on length of occupation. Recent arrivals live in huts with split wood walls, earthen floors, and thatched roofs. The family gradually improves the living

quarters over time. Most settlers eventually build a cinder block house with one room, a cement floor, and a corrugated roof. The Mexican Social Security Institute (INMSS) and COPLAMAR, an agency responsible for improving the quality of life in marginal areas, have established home improvement programs in several ejidos. The programs aid settlers in purchasing low cost building materials.

The political structure of the ejidos is quite democratic. In most of the communities, the council of ejidatarios meets frequently, and meetings are generally well attended. The state government administers the ejidos. Ejidatarios are assisted in setting up their local government through the regulation of elections of ejidal officers. The head of the ejidal council is the Comisariado Ejidal. He is responsible for the organization of collective projects such as school construction, grass cutting and latrine maintenence, and the parcelization of ejidal land. He also acts as an intermediary between the ejidatarios and the government. Most Comisariados Ejidales travel to the state capital or municipal seat several times each year. Through the ejidal government, the central government involves the ejidatarios in programs for political mobilization through the National Confederation of Campesinos (CNC).

The informal struture of the ejidos is typical of the structure of village societies in general. The communities tend to be tightly knit. Everyone knows everyone else, and many families are related. The farms are, however, run quite independently. The ejidos are not communes or collectives. There is some labor sharing, and informal redistribution of production between households, but farming is with extended family labor almost exclusively. The ethnic groups that settled the region are more communal in their homelands (Grosser ed., p.67). Social customs have been altered in the course of migration. There is a strong preference for wage labor as opposed to labor sharing systems among the migrants in the Selva today. Cash payments are usually made for harvesting or land clearing labor within the ejido. This may in part be due to the perception by these people of the money economy as being ladino[8] Many of the Chol and Tseltal migrants are actively `ladinoizing'.[9]

THE MIGRANTS

The majority of the Selva Lacandona's colonists are Tseltal Indians. They come primarily from Ocosingo, Chilon and Yajalon municipos. The Tseltals are concentrated in the Northern and Central zones, and comprise more than 75 percent of the region's population. The second largest ethnic group in the Selva Lacandona is the Choles. This Indian group has migrated to the region primarily from Palenque municipo. Some Choles live in Tseltal dominated ejidos. Many of the Choles had settled in the area that was designated as the Communidad Lacandona in 1972. The largest group of

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[8] Non-indian.

[9] Becoming Mexican and forgeting traditional ways.

Choles is found today at Frontera Echeverria. About 60 percent of the colonists in the Santo Domingo Valley speak only an Indian language (Grosser ed.). Tseltal is probably the sole language of about half of the Selva°s population.

The Tseltal and the Chol ethnic groups have retained some of their traditional cultural practices after migration. The women of both groups generally wear traditional costumes. The men as a rule do not. They are °ladinoized in their dress.

The population profile of the Selva Lacandona is relatively young. Many of the families are recent migrants with small families. Most migrants came to the region as young married couples. In the older settlements, one finds more extended families where the older generation migrated, and the younger generation and the grandchildren are now taking over the farms. Adjacent holdings are farmed by adult siblings in many older ejidos. The average family in the Santo Domingo Valley has about six members (Grosser ed.). In the more recently settled areas, families typically have two or three children, and the parents tend to be in their twenties.

Because of the youthful profile, and because immigration continues, the population of the ejidos will expand in the future at a rapid pace. It would not be unreasonable to expect a rate of population increase in the region of about the national average, approximately three percent per year. This would cause the population of the communities to double in about 25 years.

The diet of the colonists in the Selva Lacandona is based on maize. Maize is principally consumed as tortillas, and also fresh on the cob, as tomales, and as a gruel. Beans are the principal protein source. They are consumed at most meals. Supplemental sources of protein include eggs, poultry, pork, fish, and wild game. Small quantities of cassava and other root crops are consumed. Fruits, especially citrus, are consumed in season. Bananas, plantains, squash, squash seed, and some vegetables are also included in the diet. Malnutrition is not common in the region. Most families can always produce enough food, or generate sufficient income for subsistence. Actual hunger is apparently very rare. There may be some dietary problems that are less observable than actual hunger or severe symptoms of malnutrition, among the population.

Like most frontier tropical areas, the Selva Lacandona has numerous health problems. Typhoid, dysentry, malaria, other fevers, and parasites are endemic throughout the region. Almost every family loses at least one infant to diarrhea. The main problem is clean drinking water. The newer ejidos rely on brooks and streams. The more developed ejidos have piped potable water available to the households. The instalation of piped water systems in the ejidos is the responsibility of the Ministry of Housing and Public Works (SAHOP). The provision of potable water has been gradually extended from the North. Many families are aware of the benefits of boiling water, but some have not adopted this precaution.

The National Company for the Erradication of Malaria (CNEP) has been operating in the Selva Lacandona in recent years. A public health program

is concentrating on the identification of carriers and their treatment to limit malaria's spread. Technicians visit all of the settlements bi-annually. Medical facilities in the Selva are poor. Some of the larger ejidos, and the government settlements have clinics run by the INMSS, but these are not permanently staffed. Colonists must usually travel to Chancala, Palenque or Tenosique to see a doctor.

LAND TENURE

The ejidos are communally controlled agricultural land units that were formed under the Land Reform Law. Once the Selva Lacandona was officially opened to colonization, migrants had the right to petition the government for official recognition of claim to the land that they had settled. The government divided the settled areas and some uncolonized land into ejidos in the 1960s. The average land area granted to ejidos in the Northern and Central Zones is approximately 2000 hectares. The largest ejido controls over 4000 hectares, and the smallest about 900. The typical size of an ejidatario's allotment is twenty hectares. Some have as few as eighteen. This allotment usually includes both agricultural land and land unsuited to agriculture. The actual crop land alloted may range from eight to twenty hectares.

The acquisition of official rights to land by colonists was a long and complicated, and often costly process. Dotacion difinitiva, official recognition of an ejido by the Ministry of Agrarian Reform (SRA), requires several bureacratic procedures, and frequently involves large payments to lawyers in the Capital and gratuities to officials. The average interval between application for, and receipt of dotacion for an ejido in the Santo Domingo Valley was six years (Grosser ed., p.17). Some settlements in more remote areas visited in 1981 waited eight to ten years. Once recieved, the land entitlement of an ejido may be insufficient for a population that has increased rapidly through natural increase and inmigration. Many of the ejidos filed for an amplification of their entitlement after having recieved dotacion.

In some ejidos there are substantial numbers of families that were not included in the original entitlement. Some of these are later migrants, and others are the children of the original settlers. Families headed by non-ejidatarios (ie. those without land rights) may account for ten to thirty percent of all families resident in ejidos in the Selva. This percentage varies considerably between settlements. In Cuauhtemoc, a new settlement in the Northwest, almost half of the colonists were not included in the original land claim. These families must rely on land loans from ejidatarios, share arrangements, and wage laboring for a living.

Land tenure has been a major problem in the development process in the Selva Lacandona. It has been noted that poor definition of land rights has led to the eviction of colonists by ranchers, the government (in the case of the Land Grant), and the Army (in the case of the burning of 'illegal'

settlements in the late 1970s).[10] It w was observed that the burning of large expanses of valuable timber stands has been attributed to land tenure insecurity. There have also been numerous land disputes between ejidos, between ejidos and ranches, and between ejidos and the Lacandones, over land tenure issues.

Instability in land tenure has had an impact on agricultural land use patterns. Farmers who are insecure about their land rights may be loath to leave land as forest or fallows for fear that their claim to it might be questioned. Planting land in pasture may give them an added feeling of security. Farmers who are unsure of the future may also be less inclined to make long term investments in their holdings. In this respect, land tenure difficulties may, for example, limit the development of tree crops that take several years to become productive. Planting pasture or simply continuing subsistence cropping could be the result. Planting pasture after land has been cleared for milpa has almost no capital or labor costs.

THE RURAL ECONOMY

The material possessions of the migrant families are few. Most have only their farming implements, cooking utensils and a few clothes. Some of the families have purchased transistor radios and kerosene lanterns. Most families make only a few hundred dollars in cash income each year. Some colonists are better-off. A few families have aquired trucks. Trucking is a particularly lucrative enterprise that will make these wealthier truck owning families even more successful.

In the early years, the agriculture of the colonists is almost exclusively for subsistence. The family clears one or two hectares, and grows enough maize and beans to survive. In areas of recent colonization, hunting and gathering are also fairly important to the settlers' subsistence. In the first years of colonization in the region (and currently in areas of more recent colonization), there are few possibilities for commercialization.

The main constraint to production for market is the transportation system. As the roads are improved in an area over time, merchants enter and provide market outlets. When the marketing opportunities are few, prices tend to be low. One or two merchants often dominate an area and extract large profits through their entrepeneurial role. The low prices discourage farmers from producing surpluses of some products.

Grosser et al (p.87) estimated that in two ejidos in the Santo Domingo valley, the percentage of all produce that was marketed was 58 percent in one, and 48 percent in the other. Muench (p.140) gives a lower figure of 30 to 35 percent for the Selva as a whole.

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[10] See Appendix A.

Farmers in the Selva are rarely satisfied with a meager subsistence. After a few years of colonization, a farmer has cleared sufficient land to enable him to begin producing surpluses. For most, the first commercial product is maize. Surpluses of maize may result from a particularly successful season, or from a large planting. Maize is not, however, an attractive crop for commercialization for several reasons. Yields are uncertain, and the price is not very rewarding for the amount of effort involved. Maize also stores poorly in the humid climate. There are few profitable alternatives to maize. The most popular commercial activity has been cattle production. Other alternatives to maize include chile, coffee, cacao, fruits, and small livestock. These crops have less well developed infrastructure than that for cattle, generally poor prices, and are relatively demanding in expertise and effort. The tree crops also require three to seven years of growth before production begins while cattle can yield more rapidly.

Within the ejidos there is some commerce. In all of the settlements there are families that run shops. They buy small quantities of such necessities as kerosene, cooking oil, and matches, and 'luxury' items such as candy, coca cola, and cigarettes, from itinerant merchants or in the towns. These products are resold at a high mark-up to their neighbors. There is also some barter and trade in local products between families. The majority of farm-families are basically self-sufficient.

For farmers to market products in Palenque or Tenosique is costly. Transportation on buses and pick-ups has become prohibitively expensive. In January of 1982, the doubling of gasoline prices resulted in a doubling of fares. The fare by bus or pick-up from Palenque to the ejidos in the Upper Laconja valley was about 100 pesos after the price hike. From Chancala to Santo Domingo was 40 to 50 pesos. Charges for hauling goods is negotiated between the driver and the farmer. Few farmers will haul maize because of the high price of transport. Small livestock and such higher value products as coffee are the most common goods that the farmers take to town themselves. There are no established local or regional markets in the Selva Lacandona.

Most of the commerce in the region is conducted by itinerant merchants called coyotes. These merchants travel the Selva in trucks buying, selling, and bartering among the settlers. The principal commodities purchased by the coyotes are maize, coffee, chile, bananas, oranges, hogs, and chickens. Commercialization of these individual products will be discussed in detail in the following chapter. In general, prices offered for most products by the merchants are well below those recieved in Palenque from wholesalers. Maize and coffee prices are, however, relatively close to the guaranteed government prices. Chicken and hogs, for which there is a strong demand in the towns, command relatively good prices. The prices for fruits are very low and subject to wide fluctuations. The price of chile is highly variable, and based primarily on stocks on-hand at central markets. Cattle are marketed at the farm gate at prices that are belows those received in Palenque, but considered good by local standards.

Wage laboring is important in the economy of many the colonists. Wage laboring jobs are found in the ejidos, primarily at harvest time. The private ranches employ numbers of day laborers seasonally. Logging provides a small number of jobs. Additionally, some colonists travel outside of the region in search of work. There is an overabundance of day laborers available in the Selva Lacandona, and jobs are generally hard to come by. Wages in the region are very low. The standard wage in the northwestern section of 80-100 pesos per day in 1981 was less than half of the official minimum wage. In the Santo Domingo Valley, wages averaged 150 pesos per day, and in the Marquez de Comillas, 200 pesos per day (80 percent of the minimum). No explanation for the wage differentials was available.

The majority of the region's adult males work a few weeks for wages each year to supplement agricultural income. Grosser et al (p.87) estimated that 40 percent of heads of household in the Santo Domingo Valley ejidos worked off-farm at some time in the year. Those with well established cropping or cattle enterprises rarely work off farm. Younger men often work for two to four weeks each year. Those without land rights frequently work for two or three months per year.

DEVELOPMENT IN THE 1980S

In 1980, petroleum exploration began in the Marquez de Comillas zone following earlier discoveries across the border in Guatemala. The discovery of reserves near Pico de Oro has led to an influx of population in the area. The government has also begun to colonize the Marquez de Comillas zone with directed settlement projects. Approximately 30,000 people are to colonize the margins of the Ucumacinta, Chixoy and Lacantun rivers in the early 1980s. In 1982, there were a few thousand colonists in the region, primarily concentrated in settlements at Pico de Oro and Venemeritus. Agriculture in the zone is to be based on maize and cacao production. Rice and oil palm projects are also being considered (Aguilar p.c.).

The construction of a new road in the Selva Lacandona began in 1981. The road is to run from Chancala to Bonampak, south into the Marquez de Comillas zone, and than west along the Guatemalan border to Lagunas Montebello (see Map 12). It seems likely that the increasingly unstable situation in Guatemala has inspired this project. The oil reserves of the Marquez de Comillas zone are currently isolated and within a short distance of disturbed areas in Guatemala.

The extraction of petroleum in the Selva Lacandona may result in considerable disruption of the environment. In Tabasco, where petroleum production has expanded rapidly in recent years, the countryside has been devastated by the construction of pipelines, the erection of oil rigs, the opening of tracks for moving heavy equipment, and by air and water pollution. In return for these possible depredations, petroleum will provide little employment or income for the inhabitants of the Selva. Most of the workers will almost undoubtedly be brought in.

The strategic road that is under construction in the region will open large areas to colonization that were previously isolated. Map 12 shows that the new road is to run closer to the Ucumacinta than the current trunk road, through an uninhabited area. The new road construction is of a higher grade than the trunk road through the center of the Selva. Concrete bridges have been constructed, and the road is to be paved. The construction of this new road will not improve economic conditions in existing colonies.

Until a sound development strategy is devised for the Selva Lacandona, encouraging further colonization through road construction will lead to the waste of more of the region's resources. Settlers along this new road will almost inevitably follow the patterns of earlier colonists that have proven unproductive and often destructive in the past. The movement of thousands of families into the isolated Marquez de Comillas Zone is, additionally, strongly reminiscent of past resettlement projects. There is little reason to expect the successful establishment of permanent and productive agricultural systems in this most difficult of the Selva Lacandona's environmental zones. Much of the Marquez de Comillas Zone is inundated part of the year.

Chapter V

THE FARMING SYSTEMS OF THE MIGRANTS

In order to design an alternative development strategy for the Selva Lacandona, the farming systems of the migrants must first be understood. In this chapter, the systems will be described and compared. Emphasis will be placed on the identification of practices that are well adapted to local conditions. Problems in production and marketing, and institutional obstacles to agricultural development will also be assessed.

Analysis of the farming systems of the Selva Lacandona reveals a basic rationality in decision-making by the region's farmers. Resources (primarily land and labor) are allocated to various enterprises in pursuit of farm-family goals. The primary objective is to maintain subsistence. Production strategies tend to be designed to minimize the risk of crop failure and hunger through intercropping and enterprise diversity. Resource allocation decisions are made using the farmer's experience and knowledge of the performance of crops in the local environment. The quality of these decisions depends on the farmer's knowledge. Some of the colonists have a superior understanding. These farmers have developed or adopted practices that work relatively well in the Selva's environment. The alternative development strategy suggested in the final chapter is based on the improvement and promotion of these more highly adapted practices.

THE FARMING SYSTEMS: OVERVIEW

The farming systems of the migrants in the Selva Lacandona are divided between subsistence, semi-commercial, and commercial groupings. Subsistence systems have little or no marketed products, and function almost exclusively with family labor. Semi-commercial systems have some important cash products, and will occasionally employ non-family labor. Commercial systems produce goods purely for market, and use primarily hired labor.

In the first years of colonization, almost all families struggle for susbsistence. The importance of the subsistence sector of the farm economy gradually declines over time. Maize, beans, and squash, as well as many minor food crops are grown. There are two cropping seasons. Temporal, the major crop, is planted at the start of the heavy summer rains. Tornamil is the minor crop which is planted in the dry season. Small livestock including swine and poultry are also kept.

Labor is generally provided entirely by the farm-family. Most agricultural activities are done by the men and boys. Women may take part in weeding and harvesting. The primary role of the women and girls is domestic. Women haul water, grind maize, cook, wash, care for childern, and tend small livestock. Children are valued as sources of labor on the farm, especially boys. The enterprises on a farm are often expanded as the number of sons over the age of nine or ten increases.

Once subsistence is achieved, farmers will seek to maximize income. Income is maximized subject to the maintenance of subsistence, in most cases. Commercial production is almost always secondary. Decision-making with commercial products is based on knowledge of the performance of crops and markets. Farmers select products and production systems that give the highest average returns to land, labor, and other available resources. Farmers may adopt a mix of enterprises that produces both food and cash products. These systems are labeled semi-commercial. The first commercial products are generally maize and other milpa crops. Chickens, turkeys and pigs may also be produced for market. In some systems, the collection of forest products is also important. Tree crops are common commercial products in mixed systems after several years of settlement. Farmers plant fruit trees, coffee, and recently, cacao. As the area in cash crops is expanded, some labor may be hired.

Some farmers in the Selva Lacandona are purely commercial producers. The greatest part of these are cattle ranchers. This group will be studied in the following chapter. The second most common group of commercial farmers are chile growers. Dried chile is produced almost exclusively for market, and generally with hired labor, in larger enterprises. Few of the migrants are primarily commercial producers. The economies of the majority of farms in the region are dominated by subsistence production.

In the following sections, the farming systems of the migrants in the Selva lacandona are broken down by product. Maize is given the most detailed treatment because it is the principal crop, and many crops are grown in association with it. Maize production paractices such as clearing and weeding can also be generalized to other crops. Of the cash crops, coffee is given the most attention because the hectarage in this crop is expanding rapidly. A wide range of other products and their prospects are also discussed. A final section will examine four mixes of farm enterprises, and compare labor demands and economic returns to enterprise strategies.

MAIZE

Maize is the principal staple of the migrant farmers in the Selva Lacandona. It is grown by almost all farmers who grow crops. The cropping systems of the migrants generally revolve around the maize cycle. No purchased inputs are used in maize production, except in rare cases. Maize is grown in both intercrops and in monoculture. The greater part of the production is for on-farm consumption, but most farmers sell some quantity of maize in average years.

Origins of Regional Maize Systems

Migrants brought maize seed with them from the highlands in the first years of colonization. Over time, the environment and the farmers have selected in favor of some of these Criollo varieties. In the western areas of the region, migrants moved from contiguous areas with relatively well adapted seed for the Selva's conditions. Later migrants acquired these better adapted seeds from earlier settlers. Colonists from Veracruz state came to the Selva Lacandona with their Veracruzano variety in the 1960s. The Veracruzano variety is better adapted to the humid tropical conditions of the region than the highland varieties, and has been widely adopted by local farmers. Grosser et al (p.77) found that approximately 40 percent of the farmers in the Santo Domingo valley had adopted the Veracruzano variety by 1975. With these maize varieties, the migrants have evolved cropping systems that have provided a relatively dependable food source, and made the region a net exporter.

Temporal Clearing and Planting

Farmers in the Selva Lacandona will plant maize on almost any type of land, but level or gently sloping land is preferred. When level land is unavailable farmers plant on hillsides, and occasionally on steep slopes. Boggy or low lying land is avoided for the temporal crop. Well drained soils are the most popular for maize production. Maize is quite sensitive to waterlogging.

The maize cycle generally begins in February or March with the clearing of vegetation from a plot. Ten to fifteen man days are required to clear one hectare of acahual, or about forty days to clear one hectare of virgin forest. Clearing is accomplished with machetes and axes, and more recently with chainsaws in some ejidos. Most farmers ring the bark from the trunks of larger trees to kill rather than attempt to fell them.

The debris is allowed to dry for one or two months. Burning begins in April. Logs and brush are piled up to facilitate a more complete burn. Most farmers also pile brush around the parimeter of the plot to control the spread of the fire to adjacent vegetation. A second burn is sometimes necessary. The ash from the burning is raked across the surface of the plot as fertilizer.

The size of the cleared area is variable, depending on the goals and needs of the farmer, and the resources available to him. The regional average is two to three hectares (Grosser ed., Muench, Labato 1979, Preciado). This area is often divided between two plots. Some farmers clear more than three hectares while others may clear as little as one half hectare. Factors affecting milpa size include length of occupation of the farm, the quality of land, family size, labor availability, and enterprise mix.

With the onset of the rains in May, planting begins. Milpas cleared from acahual are generally planted in fairly straight rows, with seeds

planted at one meter distances. In the first few seasons after virgin forest is cleared, the milpa is cluttered with logs and stumps. Maize is planted wherever there is a bit of open ground. Three to five seeds are planted togther[11] in a hole made with a digging stick. The hole is covered with earth using the foot.

Weeding and Doubling

Weeding may or may not be practiced. When grown in association with squash there is little weeding of maize because the squash inhibits weed growth.[12] The amount of weeding needed is dependent on several other factors. The number of seasons of continuous cultivation has an effect; weed infestations grow worse with each successive cropping. The quality of the burn also influences weed growth. A good burn will sterilize a large fraction of the weed seeds in a milpa. The quality of burn is related to the age of the vegetation that was cleared. An older acahual or forest provides more material than a young acahual, and therefore gives a better burn.

When weeding is necessary, it is usually done about thirty days after planting. This is a critical time for competition between the maize and weeds. In later months, the maize gains sufficient height to compete, but it is vulnerable in the early stages of growth. Weeding is done with a machete. About ten to fifteen man days are required to weed a hectare of maize. Some farmers will also replant sparse parts of the milpa while weeding to fill in gaps left by poor germination or pest damage. Weeding is not done in dry periods to avoid parching the soil (Muench, p.131).

The maize is left unattended until mid to late August. After four or five months of growth, the maize reaches a height of from 1.5 to four meters, depending on the variety and growing conditions (higher stands are preferred because they are more weed competetive). In August the maize is doubled. The farmers bends the stalk over the blunt side of a machete, and folds the plant over, below the ears. The doubling kills the plant and commences the drying process. Doubling also makes the maize less susceptible to animal predation, and protects the ears from rainfall. About four man days are required per hectare for doubling in a typical milpa. At the time of doubling, weeding may also be done. Milpas frequently become undergrown with weeds, sometimes above the height of a man. To get at the maize to double it involves much slashing with a machete in some milpas. Farmers may also plant more crops in a relay fashion between the maize at doubling. This necessitates weeding.

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[11] Planting in bunches facilitates weeding and havesting, and aids in supporting the stalks.

[12] The importance of squash in the milpa strategy is detailed in another section.

Harvest, Storage and Yields

Thirty days after doubling, the crop is harvested. Harvest is generally in September and October. The ears are pulled from the stalk with the husk intact. Harvesting maize takes about ten to fifteen man days per hectare. Hired labor is used by farmers with large plots. Some harvesting is also done with share arrangements.

Because fields are often more than two kilometers from the homestead, bringing the crop in is an arduous task. Trails are usually too narrow for loaded mules or horses to trod, forcing farmers to carry the maize out on their backs. Much of the harvest is stored in rudimentary field barns awaiting hauling. This results in some losses from pests as the maize may remain in the field barn for several months. Some farmers carry the grain home only as it is needed for consumption. At the farmstead, maize is stored in the house, in outbuildings, and on the farmyard drying floor. The grain is usually kept on the cobb and in the husk to give greater protection from pest losses. Post-harvest losses are estimated at 10 to 20 percent in the region (Grosser ed., p.152). The maize tends to deteriorate after a few months in storage in the humid environment. Maize weevils and earwigs are major problems.

Estimates of the average maize yields in the Selva Lacandona range from 1200 to 3000 kilograms per hectare (Grosser ed., Munench, Labato 1979, Preciado). The SARH estimate of 1300 kilograms per hectare that has been used as the base figure for the SAM program participants is roughly equal to the average yields reported by farmers in this survey.[13]

Yields can vary enormously. In a bad year, yields can be less than one ton per hectare on some plots. A very good year may see yields of up to five tons per hectare. For an average family in the Selva (five consumption units)[14] the annual consumption of maize is estimated at 1200 kilograms (Muench, p.133). In a bad year for maize production a family would experience a shortfall of perhaps one half ton. Such shortfalls are not uncommon. Most farmers reported occasional years in which half of all maize consumed was either purchased or borrowed.[15] From an average temporal crop, a farmer with two hectares of milpa may have a surplus of between one and two metric tons of maize. In an exceptionally good year, surpluses may exceed three tons, but this is rather uncommon.

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[13] This is also approximately equal to the national average (Nacional Financiera).

[14] Grosser et al defined the average family as 2 adults and 4 children or five consumption units.

[15] Crop failure is apparently a local phenomenon, regional food scarcity has not been reported.

Tornamil

The tornamil maize crop is a type of 'insurance policy' for the farmers of the Selva Lacandona. In an average year, the dry season crop is roughly one quarter the size of the temporal crop. The tornamil plot may be larger if the temporal yield was insufficient. In this respect, it is primarily designed to make up shortfalls from the principal season. In better years the tornamil is a supplementary cash crop over and above the rainy season harvest. The dry season crop also provides fresh grain to replace deteriorated stocks from the wet season.

The tornamil crop is, however, less dependable than the temporal. The main problem is drought. Most farmers don't risk a large crop in the dry season, and therefore only plant about one quarter the area of the temporal. Only the best land tends to be planted in tornamil to improve its chances of success. In the Marquez de Comillas Zone, where the rainfall is greater than in the northern or central areas, tornamil is the principal crop because the temporal season the soil moisture content is too high for maize.

A number of tornamil cropping practices exist in the Selva Lacandona. The most common is to simply cut the temporal stalks[16] and weeds, lightly burn, and plant. This is accomplished in November and December at the start of the dry season. Occasionally, two or three year old acahual is cleared and planted, but this is not usually done for maize. In most temporal milpas there are secondary crops scattered about that remain in the field for more than one growing season. To protect these plants (bananas, sugar cane etc.), the burning in tornamil is very controlled. Most typically, fires are in small patches, and the whole milpa is not burned.

The cropping practices of the dry season closely resemble those of the rainy season. One significant differnce is that the lower lying parts of fields are generally selected for dry season plantings to take advantage of residual moisture. Plantings are more widly spaced to reduce competition for water, and also to reduce the risk of pest losses (pests are more prevalent in the dry season). As with the wet season crop, three to five seeds are planted in each spot. Weeds can be more of a problem than in temporal because there is less burning to sterilize weed seeds. Harvest is in February or March. Yields are typically lower per hectare than in the temporal. Grosser et al (p.75) estimated that yields per unit area were about one half to one quarter of temporal yields. This is probably due to the less favorable growing condtions, pests, and lower cropping densities.

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16 Maize stalks are not used, apparently because they have little value as livestock feed after drying in the field.

Fallows

All field cropping systems in the Selva Lacandona require fallows at intervals. The purpose of the fallow is to replenish nutrients, and to inhibit weed and insect infestation. Most commonly, a forest fallow is used, but occasionally grass fallow systems are also encountered. A forest fallow is created by abandonning a milpa. Successional growth emerges rapidly in unweeded or unfired milpas within a few months. Grass fallows emerge more quickly than bush. Cropping in grass fallow rotation does, however, require considerable weeding because of the rapid regrowth of grasses.

The type of fallow used by a farmer is determined by the quality of the land, his need for the particular plot in his production strategy, and the type of crop to be planted. Several types of bush or forest fallows are used. Most typically, the duration of a bush fallow is about six years. The length of fallow depends primarily on how fast the successional forest regrows. If the soil is relatively fertile, and if the period of cropping or pasturage is brief, forest will return in a few years. Extended periods of use will inhibit regrowth. Some common fallow cycles are: one year cropping/six years fallow, two cropping/six fallow, one cropping/three fallow, and one year of cropping to one year of fallow. The last combination is only possible on the best soils.

Variability in Yields

The better maize cropping systems in the Selva Lacandona have abundant yields in good years. These yields are not, however, consistent. Variability in maize yields is the biggest problem for the region's farmers. Two types of variability can be identified; variation between farms (or plots within farms), and variation between years.

The great differences in yields between crop years result from variability in weather and pest problems. In Chapter II it was shown that the weather in the Selva is highly variable. Rainfall is the most crucial factor. Most frequently there is too much. Because most of the best land is level or relatively low lying, excessive rainfall can have a substantial impact. Flooding and waterlogging reduce maize yields in many years. Very heavy showers early in the growing season may also harm the young maize plants, and erode planted hillsides. In some years, the rainfall is insufficient or ill-timed. In the dry season this is frequently the case. The dry season can also experience temperatures low enough to inhibit plant growth.

Insects and diseases are the most frequently cited problems by farmers in the Selva Lacandona. A variety of grubs, worms and other insects infest maize plants. Plagues of insects are most common in the dry season. In the rainy season fungi and other micro-organisms attack the crop. The humid and hot conditions of the rainy season make a perfect environment for these pests. Mammals and birds also take their toll on the crop. Nocturnal jungle animals are particularly destructive, according to

farmers. Animal predation is worse in the dry season because food is scarcer in the forest at that time.

The causes of variation in yields between farmers are less obvious. Grosser et al (p.74) found certain ejidos in the Santo Domingo Valley to have superior land endowment. In their study, it was found that the deeper soils of the valley floor had higher yields than hilly land. Several ejidos have more bottom land than most. Communities in the Northwest are less well off. Many ejidos there have only sloping or inundated land.

Other differences between farms are more qualitative. Management is clearly a factor. Some farmers have a keener understanding of their agro-ecosystem. In general, these farmers do less mono-cropping of maize. Detailed studies of yield differences between intercrop mixes are unavailable for the Selva Lacandona. For the most part, information on inter-crop relations is quite limited.

Many of these better adapted farmers put less emphasis on surplus maize production. Maize is a difficult crop in the Selva, with uncertain yields. The more 'expert' forest farmers in the region have highly diversified production strategies.

Marketing

Most farmers in the Selva Lacandona market some maize in a good cropping season. The range of annual marketings is between one and three tons in more settled areas. The average for the Santo Domingo Valley ejidos was estimated at 2300 to 2500 kilograms per year by Grosser et al in 1975 (pp.76 and 203). At the average price received in 1981 of 6550 pesos per kilogram, this would have provided a farm income of 14000 pesos. In former years, prices in the region changed drastically from month to month, and were generally very low (Labato 1979, p.103). In recent years, prices have been stabilized through the actions of CONASUPO. The government staples agency controls some fifty percent of all regional maize marketings. The regional maize price is, effectively, set by CONASUPO. The half of maize marketings not handled by CONASUPO is in the hands of the coyotes. The price paid by merchants in the Selva is typically ten percent below the guaranteed price.

CONASUPO°s market share is not larger for several reasons. Labato found quality standards to deter farmers from selling to the agency. Moisture content requirements are difficult to meet in such a humid area. This study found transport to government granaries to be the chief constraint. Farmers living in Ejido Granizo, for example, would not haul maize one kilometer to the Santo Domingo CONASUPO terminal to gain 500 more pesos per ton. CONASUPO warehouses also cannot receive grain at times because of transportation bottlenecks. Maize is sometimes stored in granaries, or in the open in CONASUPO dumps, for months, reducing the agency's capacity to handle the region s production. The advantage to farmers in selling to coyotes is that they pick up the harvest at the farm gate. A problem with the coyotes is that they are not dependable. Maize may be stored on the farm for long periods awaiting their arrival, resulting in storage losses.

OTHER FOOD CROPS

Beans

Black beans are the principal protein source in the diet of the colonists in the Selva Lacandona (and throughout rural Mexico). They are consumed boiled, or as mashed and fried refritos. Grosser et al estimated that the average ration of beans per consumption unit among the migrants is .3 kilograms per day. This is an average of about one half metric ton of beans per family per year. Most of the beans are locally produced, but supplemental purchases of beans are much more common than for maize. The region is a net importer of beans (Aguilar, p.c.).

Beans are grown in many ways. There are two principal types; climbing and bush beans. Each requires different practices. There are several planting schedules. Many farmers plant beans in such a manner as to harvest frequently, rather than count on larger harvests and longer storage. Beans are planted in small plots when grown in a monocrop, and are most frequently found in intercrops.

A common practice is to plant climbing and/or bush beans at the time that temporal maize is doubled. The weeds around the maize bunches are cut down and three to four seeds are planted in each hole with a digging stick. Climbing beans are planted at the base of the maize. Bush beans are planted between the maize bunches at distances of 40 to 50 centimeters apart (Muench, p.126). At maize harvest, the beans may receive some weeding. This planting strategy combines and coordinates the labor in doubling-weeding-planting, and harvesting-weeding. The beans are harvested in January.

A common tornamil practice with beans is the clearing of temporal milpa after harvest, and the planting of beans or maize and beans in association. In this system, bush beans are most often used, but climbing beans may also be planted. Areas of one quarter to one half hectare may be planted in rows of beans as a monoculture in tornamil. Several seeds are planted in holes at distances of from 40 to 50 centimeters. Beans are also occasionally planted as a monocrop on land cleared from two to three year old acahual. In association with maize, beans may be grown in blocks of several meters square surrounded with maize, or intermingled with maize. In temporal and tornamil plantings, beans can be found interspersed with maize or in blocks surrounded by maize.

Beans are unquestionably a problem crop in the Selva Lacandona. They are a weak link in the subsistence economy. Very few farmers plant large areas in beans alone, making yield estimates difficult. By most accounts, one ton of beans per hectare would be considered an excellent yield. Intercropped with maize, the bean harvests are typically 200 to 500 kilograms per hectare.[17] For the average family, two hectares of beans grown in a maize intercrop will only provide the subsistence requirement in

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[17] The national average is approximately 600 kilograms per hectare (Nacional Financiera).

better years.

Marketing of beans by the region°s farmers is very limited. Few sales of more than 500 kilograms were reported. In years when beans are sold, the amount marketed per farm rarely exceeds 300 kilograms. The reported price in 1981 of 20 pesos per kilogram in the Selva was higher than the national guaranteed price of 16.5 pesos per kilogram. The rural price was high throughout Mexico that year. Beans are purchased by coyotes as with maize. There is also some local trading in beans between and within ejidos.

Bean production in the Selva Lacandona is severely limited by agronomic problems. Low bean yields have several causes. Beans are highly susceptible to drainage problems, which are common in the region. Muench (p.133) suggests that yields may be adversely affected by high nitrogen content in milpa soils. This could induce excessive vegetative growth, and limit fruiting. Some farmers report better yields on hillsides (where fertility levels tend to be low). Beans are also reportedly more susceptible to insect and disease damage than maize, and less competetive with weeds. Some work has been done by the government in the improvement of bean production. Muench reported that the Jamapa bean variety was introduced in the northwestern area of the Selva with some success (Muench, pp.91 and 133). The Jamapa variety has been selected for the SAM crop improvement program.

Beans may play an important role agronomically in the milpa system. Legumes fix nitrogen, and this is beneficial for soil fertility. Some experiments have shown that maize yields better when intercropped with beans under some conditions than in monocrops (Amador et al.). The nutrient flow systems and crop interactions in milpa systems like those in the Selva are currently under investigation at the Agricultural College at Cardenas, Tabasco (Gliessman p.c.)

Squash

Squash is commonly intercropped with maize. Its prominence in the cropping system is due as much to its usefulness within the milpa as for consumption or sale. Squash seed is planted at spaces of from two to three meters in the milpa. The vines spread rapidly across the floor of the milpa and shade it with broad leaves. This shading effect reduces weed growth and the impact damage of rain on the soil. Squash leaves may also chemically inhibit weed growth (Gleissman 1981).

Squash yields well, in general, for the Selva's farmers. No estimates were available for the tonnage of squash produced per hectare. The fruit itself is of minor importance, only small quantities are consumed. Much of the crop is left to rot in the field. Squash is one of the last crops to be harvested. The temporal squash is brought in in January. The most important squash variety is the Shihua. The seeds of this variety are the most valuable product of squash in the Selva. The seeds are removed from the fruit in the field, and are dried at the farmstead. The family

consumes some fraction of the seeds, and the rest is marketed. Roasted and salted squash seeds are a popular Mexican snack food. The price of squash seed to producers in the Selva in 1981 was about 5 to 10 pesos per kilogram. The typical quantity marketed by a farmer in a year may be about 50 kilograms, but this is a rough estimate.

Bananas and Plantains

Bananas and plantains are an important carbohydrate source in the regional diet. Bananas are consumed the year round, and are eaten almost every day. Plantains are either boiled or fried. They are sometimes used as a substitute staple between maize harvests, or when maize yields poorly. Many varieties of both crops are grown in the region. Most farmers plant plantains and bananas in their milpas at first planting. The harvest is usually in the following year. These crops are examples of the complex temporal structure of milpa cropping. A milpa may serve various purposes over time, and produce crops for several years. Bananas and plantains may continue to be harvested from bush fallows for several years.

Each farmer in the Selva Lacandona typically has 100 to 150 banana and plantain plants in production at any given time. They are present in the milpa, in acahual, around the home, and in cacao or coffee plantings. They are crops that require little attention after planting, and they continue to produce for several years. A farmer may harvest a mat of bananas or plantains for ten or more years before it becomes unproductive.

Most banana and plantain production is for home consumption. On older farms, more of these crops is often produced than the family needs or desires to consume. Unfortunately, the market for bananas and plantains in the region is poor. The principal problem appears to be the bulkiness of the commodities. Coyotes haul some bananas out of the region, but they prefer to load their trucks with grain or livestock, which are of higher value by weight. Bananas and plantains are perishable, and cannot be stored between the merchants' infrequent visits. Most farmers only have a few stems for sale at any given time. This makes collection difficult for merchants, and bulk sales by farmers infeasible. The price to producers of bananas and plantains in the Selva Lacandona in 1981 was 15 pesos per stem. The stems vary by weight. Roughly equivalent stems, when sold at retail in Palenque, brought about ten times the price. There is evidently some potential for increasing farm income from plantains and bananas through improved marketing. There is also room for increasing yields and quality through reductions in pest damage. There are currently no government programs that aim at assisting farmers with the production and marketing of bananas and plantains.

Minor Food Crops

A number of fruits, vegetables, and root crops are produced for home consumption and for sale. These products add variety to the diet, and provide some cash income. Minor food crops can be divided into two catagories; milpa crops, and home-garden crops.

In the milpa, some root crops are planted. Cassava (yucca) is the most common, but other varieties are also found. Root crops are generally consumed as vegetables and not as starchy staples. In times of crop faliure, or between maize harvests, root crops may, however, be substitute staples. Cassava is reported by farmers to yield well, but they have no use for large quantities. There is no market for surplus cassava production. Cassava does have several avantages for the Selva's farmers. It produces relatively well on infertile land, it is easy to grow, and it can be stored as a living plant for more than a year.

Home garden plots are an important part of the regional farming systems. Within the confines of the farmstead, a wide variety of food crops is produced. The dominant tree crops include citrus (limes, oranges, grapefruit and tangerines), avocado, mango and banana. Other fruit trees present are mamey, gunabana and guava. Most families literally live in tree gardens. The household plots typically contain fifty or more food producing trees. Some families also have small gardens alongside the house where cabbage and other vegetables are grown. The gardens are usually only about two meters by five meters in size. Sugar cane, chayote (Sechium edule), pineapple, papaya, and some vegetables are also grown around the house.

Fruit production in the older ejidos is bountiful. There are fruits in season at various times in the year. The local population consumes fruit regularly, and fruits are probably the most important vitamin source in the diet. More fruit is often produced than can be consumed. This is especially true for citrus. Some fruit is sold to merchants, but prices are extremely low. Oranges are the most commonly sold fruit. The prices recieved for oranges by the region's farmers would seem to be inordinately low. For oranges that are of excellent size and quality, the price paid in January 1981 (at the peak of production), was only 300 pesos per thousand. In the same month, in the public market at Palenque, merchants got three pesos each for oranges of inferior quality.

Sugar cane is another minor crop in the milpa. Cane is typically planted on the milpa's periphery. This is because it must mature through more than one season and must be protected from burning at the time of weed clearing. Only small quantities are grown. Sugar cane is consumed during breaks from field work. A cane is cut down, stripped, and chewed. The juice provides liquid refreshment and an energy boost from the sugar. The cane is also brought home for snacking. There is widespread evidence in the Selva of tooth decay among habitual cane chewers. Sugar cane is also pressed in wooden hand presses, fermented, and distilled into a cane whisky by some families.

Two local vines are commonly produced in the milpa. Chayotes are a starchy vegetable that resembles a squash on the vine. They are planted at the base of stumps or shrups that support the vine as it climbs. Chayotes are eaten fresh like a fruit, or can be boiled and eaten in a soup as a vegetable. Nescafe is another climbing vine that is planted in the milpa, most frequently at the base of maize bunches. Nescafe produces a pod that contains several beans. Once dried and ground, nescafe is used as a coffee substitute. Production is almost exclusively consumed on farm, but small quantities are sold in village shops. Nescafe is harvested as time permits during November, December and January. The beans are dried in the farmyard. Another minor crop is callabash (gourds). Dried gourds of various sizes serve as vessels. Farmers in the Selva also produce many herbs for condiments, and medicinal purposes.

COFFEE

Origins and Growth

The Central Highlands of Chiapas is an important coffee producing area. Coffee is the principal cash crop of Ocosingo, Yajalon and Chilon municipos. Many of the migrants brought experience with coffee production with them to the Selva Lacandona. Today the western part of the region is developing into the principal coffee producing area of the Selva. Its culture has gradually spread from adjacent areas in the highlands. In these highland areas, the infrastructure for coffee is well developed. The focus of most of the Selva Lacandona's commerce is, however, on the North. The lowlands around Palenque and Tenosique are not coffee producing areas and services for coffee producers are not well established. This is a reason for the relatively slow pace of development of the coffee industry in the region.

Another cause of coffee's slow growth in the Selva is the less favorable lowland environment of the region. Coffee grows best at higher elevations, and in areas with a well defined cool and dry season. INMECAFE, the Mexican coffee institute, labels coffee from areas between 1000 and 1200 meters in elevation to be high quality. Production from elevations below 500 meters is termed of marginal quality. The flavor of mountain grown coffee is generally superior. Most of the areas in the Selva where coffee has been planted are in a range between 500 and 1000 meters above sea level.

Although the quality of coffee may be reduced at lower elevations and in more humid-tropical areas, its culture is well suited to tropical agro-ecosystems. A coffee planting can mimic the forest. Because tree cover is maintained, both in the shade canopy, and by the coffee shrubs, the soil is protected from rain and solar radiation. The annual brush cutting, and deadfall from the canopy contribute organic matter to the soil as well. These factors combine to make coffee culture a more viable and permanent system than field crop production, or cattle grazing. Most coffee plantings in the Selva Lacandona do not exhibit land degradation.

Production

There are several types of coffee cultures practiced in the Selva. Some of these involve the production of food crops in association with coffee. The simplest system is a thinned forest with coffee planted under non-economic shade trees. A more complex system uses fruit trees for shade. The most sophisticated system is a mixed cropping practice where a wide variety of crops are grown with coffee. This last system involves diversity in both a spatial and temporal sense. Various plants are grown at different times and in different positions within the coffee system.

Farmers generally begin coffee planting after they have farmed long enough to have several hectares of mature acahual (five to ten meters tall). In some recently settled areas, farmers have also been observed to plant coffee in logged areas after clearing the underbrush. There is a tendency to select upland soils with good drainage for coffee plantings. Redish soils of light texture are preferred. There are several strategies for planting open to the farmer. Seedlings are prepared in nurseries that are usually located near the farmstead. After about one year the seedlings are ready for transplanting. In the simplest case, the underbrush of the acahual is cleared, and seedlings are planted at distances of from 1.5 to two meters under the shade trees.

Alternatively, the farmer may clear the acahual and plant a temporal milpa. Care is taken to only top the young trees in the acahual. This allows them to regrow quickly as shade trees for the coffee. The burning is done carefully. Typically, the brush is piled and burned, but the entire milpa is not fired. This is also done to protect the saplings. The milpa is planted basically as described above. The first crops in are often banana and papaya. These are rapid growing treelike crops that will eventually form part of the early shade canopy. Fruit trees, including avocado and other varieties, are also often planted at the start. These trees will also serve as part of the shade canopy. After the temporal crops are harvested, preparation for the tornamil is done following precautions against damaging the saplings. Some farmers don't burn at all for tornamil, but only cut down weeds and push them aside to clear spots for crops.

After the tornamil has been harvested, an open canopy has begun to form of the saplings and fruit trees. Within a few months, there is sufficient shade for the coffee seedlings to be transplanted. The farmer may continue to grow food crops as the coffee matures. Sugar cane, cassava, maize, beans, pineapple, papaya, banana, and other crops can be found growing in associaltion with young coffee. These intercrops may continue to be grown for as many as six years as the coffee matures. Eventually, the shade canopy becomes too dense for many of the food crops, and they are deleted from the system. Some farmers intentionally limit the density of the canopy and continue the intercropping with mature coffee.

Labor

The coffee plantings are expanded gradually. Most farmers begin with only a few hundred trees on a quarter to one half hectare. Coffee requires three to six years before it commences production. There is considerable labor investment required in planting the crop and maintaining the planting before the first harvest. Recent migrants cannot afford to devote more than a few weeks to an activity that doesn't contribute to immediate subsistence. It is generally several years before coffee holdings reach one or two hectares. As time passes, farmers clear acahual adjacent to the coffee planting, and gradually expand it. The average size of a coffee holding in the Selva Lacandona may eventually reach from one and one half to three hectares, with from 1500 to 3500 coffee plants.

Labor becomes the key constraint in coffee production after a few years. The plantings must be cleared of undergrowth regularly. Until the coffee forms a ground cover, after three to six years, the holding must be cleared twice each year. One clearing per year is required thereafter. Young holdings are cleared at six month intervals. Approximately fifteen man days of labor are needed for each clearing. Labor demands more than double once the plants come into production. Twenty man-days are required for the harvesting of each hectare. This is generally spread out over the months of November, December, and January. Clearing of mature plantings is done at the same time. This is the slack period in the regional agricultural cycle.

In addition to clearing and harvesting, the beans must also be prepared and dried before marketing. Drying coffee is the responsibility of the women and children. Additional labor is also required for pruning and pest control. The entire process involves approximately forty to fifty man days of labor per hectare for all activities. A typical holding of two hectares would require almost all of the farmer's labor during the late rainy season and early dry season. To manage larger coffee holdings, a farmer must either have many sons or hire labor. Few holdings have reached three hectares in the Selva. Many farmers are, however, expanding their coffee plantings. Farmers will often begin planting larger coffee holdings as their sons approach working age, in expectation of their future labor contribution.

Yields and Problems

Coffee yields in the Selva Lacandona were unreported in previous studies. The Grosser et al study in 1975 makes almost no reference to the crop. Munench and Labato (1979) make some note of coffee but primarily in reference to the western areas. Judging from this, and from the level of development of coffee plantings observed in this study, coffee has expanded rapidly in recent years. Few farmers have marketed enough coffee to make accurate assessments of future yields. The yields that might be expected will depend on several factors; the varieties currently planted are diverse, the conditions in the region are varied and variable, and practices differ widely between farms.

Farmers in the Selva Lacandona plant both traditional varieties from the highlands, and improved varieties. The traditional varieties are hardy, and well adapted to the highland environment. The trees grow tall and spindly, and therefore need pruning. Yields in Ocosingo municipo, where traditional varieties are dominant, average 640 kilograms per hectare (Muench, p.172). The average density of stands is 1200 plants per hectare. Improved varieties have been introduced in Chiapas by INMECAFE. These varieties are shorter and bushier, and therefore need little pruning. The improved varieties have yield potentials of up to 2400 kilograms per hectare. Many farmers have acquired improved seeds either directly or indirectly from INMECAFE. Most coffee plantings observed in this study had some improved varieties.

Coffee is susceptible to a number of pest and disease problems. This is especially true for improved varieties. The higher yielding varieties trade yields for reduced resistance. A wide range of insects attack coffee. Inchworms and leafcutter ants defoliate, and an array of beetles attack the beans. Nematodes effect the roots, and fungi damage leaves and beans. Insects and disease can also damage the shade trees and thereby harm the coffee. Soil fertility can become a problem in older holdings. This is a major problem with the improved varieties.

Few of the coffee growers in the Selva Lacandona practice pest control. None were found to use fertilizer on their coffee. The most commonly observed pest control practice is the poisoning of leafcutter ants. This is relatively easy beacuse the ants cut a trail to their nest that the farmer can follow. An effective pesticide is available in stores in Palenque and Tenosique. Occasionally, farmers will spray for fungal infestations, but this is not very common.

In the highlands, INMECAFE has been active in promoting coffee production. Nurseries have been established to produce improved variety seedlings. Technical assistance has been made available to smallholders for pest and disease control. INMECAFE also purchases coffee from the producers at a guaranteed price. The Institute sets the national coffee price annually, and is the national export monopoly.

The Selva Lacandona has not benefited from INMECAFE. Officials of the Institute describe the Selva as an 'intransitable' area, and a marginal producer. No services are provided to the region°s producers. INMECAFE has no personnel in the region. There is also no government purchasing of coffee in the Selva.

Farmers in the Selva Lacandona sell coffee to merchants who visit the settlements. There is a merchant who handles coffee in Chancala, and it can also be sold in Palenque. Because the Selva remains a minor producing area, and because it is considered a producer of lower quality beans, the marketing structure is still poorly developed. Prices are, however, fairly good compared to many crops. When the guaranteed price was 35 pesos in 1981, the merchants paid 30 pesos per kilogram.

At 30 pesos per kilogram, assuming a yield of 600 kilograms per hectare, the gross income from three hectares of coffee would have been 54,000 pesos

in 1981. The total labor involved would total approximately 130 man days. This is far superior to the local wage rate in 1981 of 100 pesos per day, for the same amount of time. It is also well above the expected return to three hectares of maize. This would explain the growing interest among farmers in the Selva with coffee as a cash crop.

OTHER CASH CROPS

Chile

The culture of chiles was brought to the Selva Lacandona by migrants from Veracruz state in the 1960s (Muench, p.144). Production was originally done with hired labor directed by the Veracruzanos. Today, production is primarily in the hands of Tseltales. Two varieties are grown; Jalepeno (Capsicum annum), and the Meco chile. Both of these variaties are grown in Puebla and Veracruz states for canning as green chiles, called chilipatle. They are also used fresh in cooking. In 1979, the Selva Lacandona led the nation in production of these chiles in their dried form. Dried chiles are used in cooking, and in the processing of salsa (hot sauce). The reason that the Selva is the primary producer of these chiles is probably that the labor costs are low enough to permit the labor intensive drying of chile to be economic. The drying initially began because transportation costs were too high for the heavier fresh product. The Veracruzanos also wished to avoid the coyotes by marketing the chile themselves. They could carry significant quantities only of died chiles.

Chile is planted in tornamil, between November and December. This is a high value, high cost and high risk crop by regional standards; only the best land is used. Chile patches are thoroughly cleared and burned. The land is left bare of all but ash. The crop is very sensitive to weed competition. About six days of labor per hectare are required to plant chile in addition to clearing and burning (Muench, p.178). Some chile is also transplanted as 10 to 15 cm high seedlings. There is some use of herbicides, fungicides and insecticides during the growing period. Weeding and harvesting are done twice, both in June and August. Harvests are highly variable. Yields depend on the weather, input use, and the severity of pest problems. A good harvest for a year will yield seven tons of fresh chiles per hectare. This will reduce to approximately one ton of dried chiles (Labato 1979, p.104). Harvests can vary from 200 to 1200 kilograms per hectare.

Harvesting and drying labor demands are high, and the work is unpleasant (the chiles irritate). For plots of more than one half hectare, hired labor is often used. Ten to fifteen man days are needed to harvest a hectare each time. The chiles are dried in drying huts in or near the plot. A pit is dug for a smoldering fire. The chiles are layed on a grid of poles over the pit. The grid is covered by a thatch roof. The chiles require constant attention for proper drying.

Chile is a very profitable crop if all goes well. The price in 1981 was reportedly 50 pesos per kilogram for dried chiles in the Selva Lacandona.

Even at low yield levels of four hundred kilograms per hectare, the returns can be over 20,000 pesos per hectare. The harvest is taken out of the region in ten ton trucks that haul it to central markets in Puebla. The crop is almost 100 percent commercial. Its price is largely dependent on stocks on hand at the central markets in Mexico City and Puebla. The price can fluctuate wildly (Labato 1979, p.104, Aguilar p.c.). Because substantial capital is involved in chile production for input purchases and hiring labor, large scale chile production involves substantial risk.

Cacao

Cacao is a recent introduction in the Selva as a commercial crop. There were no data available on its production before 1980. The importance of this crop is likely to increase rapidly in the future because many farmers were planting cacao in the early 1980s. The government has also initiated a major cacao project in the new settlements of the Marquez de Comillas zone.

Cacao is most commonly being planted in the Selva Lacandona as an intercrop with coffee. The typical ratio of cacao to coffee plants in the ejidos of the Northern and Central zones is 800 to 1000 coffee plants to about 200 cacao trees on a hectare. This intercrop has several advantages for the producer. Both crops require similar shaded conditions, and regular clearing of underbrush in the plantation. The mix of cash crops also gives the farmer some protection from adverse price movements in one or the other crop. The cacao in the settlements in the Marquez de Comillas zone is to be planted in pure stands however.

In the state of Chiapas, a major cacao producer in Mexico, the average yield per hectare is approximately 500 kilograms. The average density of plants in a pure cacao plantation is 800 trees per hectare. In the coffee-cacao intercrop, the yield from one hectare would be approximately 125 kilograms of cacao per year. At the 1981 price of 80 pesos per kilogram, one hectare of the intercrop would yield 10,000 pesos from cacao alone.

Because cacao has been planted by the migrants only for a short time, little information was available on cultivation practices, and marketing information was unavailable. There had been no marketings of cacao by farmers interviewed in the region in 1981 and 1982. Cacao seedlings are typically raised in a nursery and transplanted to the plantation after one year when they are a 25 to 30 centimeters high. Prduction begins after four or five years, reaching full production in eight years. The harvest in the Selva Lacandona will take place throughout the year, but about 85 percent of the crop will come between October and April. Brush clearing in the plantation will be done at various time in the year.

Cacao is a very labor intensive crop. The amount of labor required per hectare depends on the density of stands, the productivity of the trees, the amount of pest control that is undertaken, and the intensity of such practices as pruning. As a cacao plantation matures it generally has an

increasing labor requirement for maintenence. This is in part the result of larger yields, but primarily due to increasing pest and disease problems in plantations over time. A ten year old one hectare plantation would require approximately 75 man days per year for all activities with a moderate level of pest control (SARH 1978).

The marketing of cacao may prove to be problematic in the Selva Lacandona. At the present time there is no marketing system for cacao, and little development of the industry in adjacent areas. No buyers of cacao currently visit the region. The nearest markets are Palenque and Tenosique. In Chiapas, the primary producing areas are in the North-central region near Pichucalco, and on the Pacific slope in the Soconusco. Cacao production may also encounter growing problems with pests and diseases as the crop becomes more common in the region. Without some extension efforts, low levels of productivity might be realized by farmers.

Sesame

In previous studies, sesame was accorded a minor role in the regional farming systems. In this study, sesame was not observed. Small amounts of sesame were reportedly grown in either intercrops or as a monocrop. Seeds were broadcast among the maize on lower lying ground with the temporal planting. 300 to 500 kilograms per hectare were reported yields. The harvest was in September or October. The seeds were thrashed out of the heads and sacked. Production was entirely commercial (sesame is processed for oil).

The migrants had traditionally grown sesame in the highlands as a cash crop. It has apparently done poorly in the Selva and has been, or is being abandoned. The chief problems are probably excessive rainfall, and the inability of the crop to compete with weeds.[18]

SMALL LIVESTOCK

Poultry

Households in the Selva Lacandona typically raise flocks of chickens, turkeys, and ducks. They provide the family with meat on occasion, eggs more frequently, and sometimes cash income. The most popular bird is the chicken. When flocks are built-up, there may be fifty or more chickens of various ages in the barnyard. A family will also have two or three hen turkeys, a 'tom', and flocks of turkey chicks. Some farmsteads with swampy areas also keep ducks. Very rarely there are some geese.

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[18] See Grosser et al, p.78, Muench, pp.125 and 132, and Labato 1979, p.106. for more information.

Poultry are normally at liberty around the farmyard, where they forage. Small amounts of grain are given to the birds. Chicks are sometimes hand fed soaked and mashed maize. In a few cases birds are confined with fences. The animals are provided with elevated roosts, or rudimentary cages in the barnyard for the night.

Poultry production is greatly reduced by disease problems in the Selva Lacandona. It is common for a disease to kill 90 percent of a household's flock in a few days. Diseases will sometimes destroy most of the flocks of an entire village. Because of this it is difficult to maintain flock size. Road kills are also taking their toll on poultry as the region's roads are becoming more heavily travelled. Some families have built chicken fences as a precaution. Eggs and poultry are frequently scarce in the region. Restaurants that cater to truckers along the main road often purchase eggs and chickens from coyotes. Poultry diseases were by far the most common complaint by farmers concerning livestock in this study. There is currently no government assistance offered for poultry production in the Selva.

The production problems with poultry are unfortunate for the farmers because prices for chicken and turkey are quite favorable. The farmers received 150 pesos for chickens from the coyotes in 1981. A turkey brought 400 to 800 pesos, depending on its weight. These prices were close to the wholesale prices in Palenque at that time. If farmers could produce more birds, there is an opportunity for increased sales. Chickens and turkeys were very much in demand in nearby urban areas. Chickens and turkeys are particularly useful to farmers because they are relatively valuable by weight. The settlers usually bring birds with them when they go to town or to visit relatives (birds are often given as gifts).

Swine

Swine are raised throughout the highlands of Chiapas, and were brought to the Selva Lacandona by the migrants. They are generally produced for sale, but are also occasionally consumed. Hog production practices are fairly simple. The animals are allowed to roam free in the newer settlements, and they forage for roots and refuse. Little maize is typically fed to hogs.

Formerly, the region produced an unreported, but substantial quantity of pork, according to Labato (1979, p.107). This pork was primarily marketed in the Yucatan peninsula. The hogs of the Selva are valued in that region for their flavor. Pork from the Selva is used to make a Yucatec regional delicacy known as Cochinita Pibil. Much of the production of hogs from the Northern Zone was shipped by truck directly to Merida in the Yucatan. In more isolated areas, hogs were picked up by light planes that landed on the old chicle airstrips. These hogs found their way to the Yucatan via Tenosique. The low prices in the Selva made air shipment and ground transport to Merida profitable.

As the settlements develop, hogs running loose become a problem. They destroy gardens and get into stores of food. Most of the older ejidos have now passed regulations against allowing hogs to run lose. As with poultry, road kills have also become a major problem with hogs. These problems have reduced hog production in the region.

The custom has not been to raise hogs in confinement as it requires more labor, feed, and investment in facilities. Some farmers also believe that there are more health problems with penned hogs. In most of the ejidos studied, only a few families were raising hogs in 1981. In 1981, hogs sold for an average of 1000 pesos each. The price was 25 pesos per kilogram and the average hog is sold at 35-60 kilograms.

FOREST PRODUCTS

A number of forest products have traditionally been extracted from the Selva Lacandona. In chapter four, logging and chicle were discussed, and xate collection was mentioned. These and other forest products have declined in importance in the regional economy. This is due to the development of agriculture and the elimination of forest. Although forest products are, in general, less important in the settled regions than formerly, the newly settled areas continue to produce them. In the Northern and Central zones, honey, which is a forest product in the Selva, is becoming increasingly important. The principal forest products for the migrants today are xate, railroad ties, honey, and chicle. Xate and chicle are declining in importance rapidly however. Other products include wild game, fish from ponds in the forest, barbasco, and corozo palm.

Chicle

The history of chicle in the Selva has been discussed. At the present time, chicle is harvested almost exclusively in the more remote sections of the region. The Southwest, the Marquez de Comillas, and the Riverine zone are areas visited by chicleros. In 1973, a co-op was organized for chicle collection in the Selva Lacandona. The co-op was authorized by the government to harvest 20,000 tons per year. The national Comercio Exterior has a monopoly over the export of chicle and is responsible for the administration of the co-op. The chicleros were paid 15 pesos per kilogram in 1978. The bank received 45 pesos per kilo on the world market. Production in the region has not reached the authorized limit since the co-op's founding because of inadequate collection services by Comercio Exterior. The co-op has also not been acceptable to many chicle middlemen. The co-op system required middlemen to pay for social services for the chicleros. Chicleros have traditionally had very low standards of living (Labato 1979, p.99). Chicle production has been erratic as a result of these problems.

The natural rubber source, chicle, is the product of the chico zapote tree (Manilkara zapota L.). Chicle is primarily used as a base for chewing

gum. The trunk of this wild tree is incized, and the sap collected. A tree can be tapped once in two or three years. Collection in the Selva is between the months of August and January. The yield per tapping is about sixty kilograms of raw sap. The tree is easily damaged by overtapping. Overtapping is commonly done by chicleros for short term gain. This results in declining productivity of the trees. The chicleros do not own, or have anything invested in wild chicle trees.

Xate

Xate, also written shate, is known in the United States as the corredor palm or evergreen palm (Chamaedorea sp.). Xate is valued by florists because it remains green for 25 to 30 days after it is cut. It is used in floral arrangements and in fruit displays. The higher quality product is sent to the United States. The central market for xate is San Antonio, Texas. Lower quality xate goes to Mexico City, where it is used in produce displays in supermarkets. Xate is primarily harvested in the less populated areas of the Selva. This plant grows on the forest floor in undisturbed areas.

Xate is generally harvested by women and children. One person can collect up to 20 gruesas (the unit of measure for xate which is 124 palms) per day. Merchants purchased xate in the Selva in 1979 for 6.5 pesos per gruesa. Each gruesa was worth $18.65 in San Antonio. Approximately 70 tons of xate leaves the Selva each week in June and July (Labato 1979, p.100). The harvest is moved by truck, and in some remote areas, by airplanes from Tenosique. The collectors bring their harvest to the roadside or airstrip each week during the season.

Xate can be over-exploited. The Sub-ministry of Forestry has attempted to regulate the exploitation of xate in the Selva. A tax is levied on xate gathering. In 1975, Grosser et al reported that Ejido Santo Domingo payed 3500 pesos per year in collectors taxes (p.196). In 1981, few ejidatarios were collecting xate there. The government has been ineffective in controlling the industry, and over-exploitation has reduced xate harvests in the older settled areas. Most exploitation today is in the South-central parts of the Selva.

Other Products

Many of the colonists supplement their diet with wild game and fish. Game becomes less important as settlements become more developed. The forest environment of the game is destroyed[19] through settlement. A popular game animal is the tepesquintle or paca, a sort of overgrown guinea

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[19] Limited disruption of the forest does, however, enhance animal populations. Second growth interspersed with virgin forest is an excellent habitat for many animals (Nations and Nigh).

pig. These are sometimes taken alive and fattened. Small deer are hunted, as are other small mammals and birds. Most families have an old single-shot hunting rifle. In general, it is the boys who fish. Fishing is being affected by the silting in of lakes and streams as a result of erosion of agricultural land (Blom and Duby).

Honey is becoming increasingly important in the Northern Zone. Some families keep a few hives for home consumption or local sale. In recent years, commercial honey production has gotten underway. The Grijalva Commission runs a bee hive building co-op that is based in Ejido Damasco. INI (the National Indian Institute) has also done some work with apiculture in the Santo Domingo valley. Deposites of two or three dozen hives can be seen by the roadsides in many of the northern ejidos. In 1980, 200 tons of honey were exported from the Selva Lacandona (Aguilar p.c.). The production is collected at Tenosique. The honey of the Selva Lacandona is primarily for export to Europe. The quality is quite high, and the flavor distinctive. The price paid to producers was 30 pesos per kilogram in 1981. The retail price in Palenque was 60 pesos per kilogram.

There is some production of hand-hewn railroad ties in the region. Mexico has had a severe shortage of ties for several years (Ewell and Poleman, p.123). The ties are occasionally a byproduct of the milpa; some of the larger trees may be cut and trimmed to make ties. Some ties are also made from trees cut from the forest expressly for ties. The ties are piled at the side of the road and are picked up by trucks from Tenosique and Palenque.

Another forest product is the corozo palm (Scheelea liebmannii). This palm has an appearance that is similar to the African Oil Palm. Corozco is a native of the lower lying areas of the Selva. It is most common in the southern parts. The nut is not exploited. Only the palm fronds are used for roofing. An oil can be extracted from the kernel that is used in soaps etc. Very little information is available about this product. The fact that it grows in the region may indicate some possibility for its exploitation, or perhaps the introduction of the African Oil Palm. A study by the SARH of the prospects for oil palm in the southern portion of the Selva Lacandona has been completed (Aguilar p.c.).

In the early 1970s, production of barbasco root was an important forest industry in the Selva. Barbasco (Diascorea Composita) is a raw material for birth-control pills. Between 1970 and 1974, the state of Chiapas produced an average of 2,129,104 kilograms of dried root. The high for the period was 3,315,000 kilograms in 1972, and a low of 1,580,000 kilograms was in 1974 (SFF, p.42). No collection of barbasco was reported in this study during 1981 and 1982.

Another forest product gathered in the Selva Lacandona is wild black pepper. This product is harvested primarily in lowlying areas of the southern regions. Between 1970 and 1974, the annual marketing of pepper averaged 43,726 kilograms. Some settlers at Corozal were harvesting pepper in 1981, but no marketing data were available. The price was reportedly very low.

ENTERPRISE MIXES

In the preceding sections, the individual production systems of the Selva Lacandona were described. The more highly adapted cropping and livestock systems illustrate the depth of understanding of the agro-ecosystems that underlies farmers' decisions. In this section, the mixes of these enterprises that have been adopted by farmers, and some mixed systems that are currently evolving in the region are described and assessed. The logic behind the allocation of resources in these mixed systems will be examined. There are almost innumerable such combinatations to be found in the region. Four combinations will be examined.

In the examples presented in this section, the mixes of enterprises, and the economic details of these systems, are drawn from the information presented in the preceeding sections. These descriptive sections examined each commodity individually, and in most cases in isolation from the farming system as a whole. In this section, the interactions between various commodity enterprises in the decision making process of farmers are illustrated.

The four systems include a recently established farm, a more mature farm producing primarily maize and chile, a coffee based farm after 15 years of occupation, and a highly diverse farming system after more than 15 years of occupation. These four systems demonstrate a logical allocation of the resources available to farm families among the various enterprises. The families attempt to maximize income, subject to land, labor and marketing constraints. The first example depicts the enterprise mix of a typical recently established subsistence farm in the Selva Lacandona. Examples two, three and four demonstrate a progression toward higher levels of commercialization. The selected examples are all fundamentally self-sufficient in food production. The examples are designed to represent levels of production in average years, under typical conditions, on farms with 20 hectares of land.

Family labor is used almost exclusively in these four systems. This labor must be divided among various enterprises. Some cropping cycles are complementary, while others are conflicting in their labor demands. Chart 2 shows the calendar of activities for several of the more important of the Selva°s cropping systems.

Maize, coffee, and chile are the main products in the systems given as examples. The peak labor demands for milpa cropping systems are in February for clearing, and in September and October for harvest. May, June and August are also important months in the milpa cropping cycle. The tornamil cycle is less demanding of family labor than the summer cycle. Chile cropping requires the most labor between May and September. This conflicts with the maize cycle. Chile production by small-holders is generally limited by the size of the maize planting. Plantation crops (cacao and coffee) fit well into the milpa cropping cycle. The peak labor demands for coffee and cacao are in the dry season. The size of plantations is however limited by labor availability in that these products require timely harvesting.

Chart 2. Calendar of Cropping Activities

Product	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
Temporal Maize	clear	burn	plant	weed		double		harvest				
Tornamil Maize	double	harvest								clear	plant	weed
Beans		harvest	plant			plant		harvest		clear	plant	harvest
Chile		weed		harvest	weed	harvest				clear	plant	
Coffee									harvest	and	weed	
Cocao	harvest	prune			fumigate				harvest	and	weed	

Table 2 compares the economics of the four principal commercial crops in the Selva Lacandona, maize, chile, coffee and cocao. Prices, labor demands, and yields are drawn from the data presented in the previous sections. Plantation crop data are given for plantings in full production after approximately seven years.

TABLE 2

The Economics of Four Crops Compared

Product	Labor Man-days	Average Yield Kgs.	Price per Kg.	Pesos per hectare	Pesos per Man-day
Maize	60	1625	6.5	10563	176
Chile	80	500	50	25000	312
Coffee	65	600	30	18000	360
Cacao	75	500	80	40000	533

Maize is shown to have the lowest returns per hectare and per man-day of labor. The figures given for maize are for an entire crop year including both temporal and tornamil. Coffee gives the next highest returns per hectare, but returns to labor that are second only to cacao. Chile gives the second highest returns per hectare. The high labor demands reduce returns to labor, however, to a figure below that for coffee. Cacao gives the highest returns to both land and labor despite high labor demands because of the favorable price.

In the decision process of farmers, there are important trade-offs made between crops according to their labor demands, and the returns to labor. The systems described below illustrate certain aspects of this decision-making process.

The first example is typical of farmsteads in their fourth to eigth year of occupation. Self-sufficiency has been achieved, but production of commercial products has not yet been developed. Table 3 shows the mix of enterprises on the farm. The milpa cropping area of two hectares is on the lower end of the regional average. Few non-milpa crops are produced.

The size of cropping area is largely dependent on family size, and especially on the number of grown sons. Recently settled farmsteads typically have the labor of a man and perhaps one son available for cropping. Two hectares of milpa is near the maximum that can be farmed by a young family. In addition to maize, beans, squash, and other minor milpa crops, a small patch of chile is grown. Chile is quite labor intensive;

TABLE 3

Four Year Old Farm: One Year's Production

Product	Quantity Produced	Quantity Sold	Income in Pesos
Maize	3250 kg	1562 kg	9506
Minor Crops	-	-	200
Chile	100 kg	100 kg	5000
Coffee	25 kg	25 kg	750
Chickens	20	5	750
Turkeys	4	2	1000
Hogs	1	1	900
Fruits	-	-	200
	Total Income	18306	Pesos

labor requirements for chile are the highest of any crop in the region. A small family can only manage about one quarter of a hectare of the crop, and still maintain subsistence.

Small quantities of coffee, bananas, and other fruits are marketed. In the early years of settlement, there are few mature fruit trees or coffee plants on the farm. A few chickens and turkeys are also sold. The family produces and sells one pig in the year. Usually, the newer settlements permit pigs to run free, therefore, the pigs are not fed substantial quantites of grain.

In Table 3, the cash income received from each enterprise is presented. Maize sales of 9,500 pesos are the surplus after family consumption has been provided for and net of 15 percent storage losses. The quantity produced on two hectares in temporal is 2600 kilograms. Tornamil yields 650 kilograms (one quarter of temporal). Beans are also grown in tornamil. The direct family consumption is 1000 kilograms, Other uses such as chicken feed total 300 kilograms, and losses in storage are about .5 tons. This leaves 1463 kilograms for sale at 6.5 pesos per kilogram. The chile patch of .2 hectares yields 100 kilograms of dried chile. At 50 pesos per kilogram, cash income from chile is 5000 pesos. Totals for income from other sources are also shown in the table. Annual income is 18,306 pesos.

TABLE 4

Ten Year Old Farm: One Year's Production

Product	Quantity Produced	Quantity Sold	Income in Pesos
Maize	4225 kg	2291 kg	13543
Beans	700 kg	200 kg	4000
Minor Crops	-	-	300
Chile	250 kg	250 kg	12500
Coffee	150 kg	150 kg	4500
Fruits	-	-	500
Chickens	20	4	600
Turkeys	4	2	1000
	Total Income	36943	Pesos

The enterprise mix of a more developed farm is depicted in Table 4. This example is more typical of a farm after ten or more years of occupation. The farming system is based on field crop production; primarily maize and chile. All of the labor is provided by the family except for 15 days of hired labor for the maize harvest, at 90 pesos per day. The family is more mature than in the first example. The man is aided in the field by two grown sons. The cropping area is fairly large by regional standards. A farm that can sustain this size of cropping area would require a large proportion of its entitlement to be cropland, and for the land to be of relatively high fertility.

Three hectares of maize are planted in temporal. About 1.5 hectares are intercropped with beans, squash, and other crops. The tornamilpa is quite small, only .5 hectares. This is for the replacement of spoiled stores and for some bean production. Land preparation for chile occupies much of the family's labor in the dry season. Sales of milpa crops are shown in Table 4. The returns to maize production are net of labor costs for harvesting (1350 pesos), 15 percent storage losses, and 1,300 kilograms for consumption.

Chile is the second most important field crop. About one half hectare is planted in chile. Based on an average yield of 500 kilograms of dried chile per hectare, total income from chile is 12,500 pesos. One half hectare of this crop is near the maximum that a family could crop with such

a large area of maize. Because of the risks associated with chile price fluctuations, and the need to invest in pesticides and hired labor for large chile plantings, the family also relies on maize for cash income. Maize has a guaranteed price. A large area of maize planted will generally assure some income with little cash investments in the production process.

The farm also has mature fruit trees and coffee plants. The labor demands of the field crops mitigate against large plantings of the relatively labor intensive coffee. One quarter hectare of coffee is in production, much of it around the homestead where it can be tended by the women and children. Using an average yield of 600 kilograms per hectare, income from one quarter hectare of coffee totals 5625 pesos. A small amount of income is earned from fruit sales. The family has many mature orange trees, and produces quantities of bananas. The market is poor, however, and income from sales is only 500 pesos. Turkeys and chickens are sold as on the first farm. The farm has no pigs because of a local regulation against allowing them to run, which is typical of the more settled areas. Total sales provide 36,943 pesos of cash income.

The third sample farm is a mature coffee based operation after 15 years of occupation. Table 5 shows the enterprises of this farm. The milpa cropping area is near a minimum for subsistence; about 1.5 hectares. Many farmers in the Selva find maize to yield insufficient returns to labor for it to serve as the principal cash crop. Maize and beans are produced at the family's consumption level, and a small surplus of maize from temporal is marketed. Coffee is the only significant commercial product. Two hectares of coffee are in production. Coffee offers higher returns to labor than maize. The coffee would require most of the available labor on the farm from September through December. This reduces the labor available for temporal havesting, and tornamil land preparation and planting. The total production of 1,200 kilograms is marketed for 36,000 pesos. Small quanities of minor products are sold for a total of 2,250 pesos. Total income is 43,270 pesos.

This farm is an example of what some farms are evolving towards in the region. Few farms as yet have two hectares of mature coffee. The income from the coffee plantation could be high by regional standards. This farm is, however, highly susceptible to market fluctuations because of the overwhelming importance of coffee in the system. There is also greater risk of loss of income from problems such as weather or disease, because of the dependence on a single crop. Subsistence in maize and beans is, however, guaranteed in most years by the 1.5 hectare milpa.

The fourth example is a farming system that some farms in the region are developing. This farm is more than fifteen years old. The farmer has adopted a highly diversified production strategy for generating cash income and providing subsistence. Table 6 shows the enterprise mix for the fourth example. The milpa cropping area is of about average size (two hectares). The combined harvests of temporal and tornamil yield 3,250 kilograms of maize and 500 kilograms of beans. After on-farm consumption and losses, 1,300 kilograms of maize are sold. Chile is a secondary cash crop, with one quarter hectare planted. Returns from chile are 6,250 pesos.

TABLE 5

Fifteen Year Old Farm: One Year's Production

Product	Quantity Produced	Quantity Sold	Income in Pesos
Maize	2438 kg	772 kg	5020
Beans	500 kg	0	0
Minor Crops	-	-	150
Coffee	1200 kg	1200 kg	36000
Fruits	-	-	500
Chickens	20	4	600
Turkeys	4	2	1000
	Total Income	43270	Pesos

The farmer has established a mixed plantation of coffee, cacao, and fruit trees. One and one half hectare of plantation yields about 25,000 pesos in cash income. The mixed plantation offers greater diversity of cash crops than coffee alone. The milpa and chile areas are matched in an effort to balance between gaining cash income and maintaining subsistence. Some honey is produced. Poultry are sold as with the other farms. This farm also raises pigs in confinement which is currently quite rare in the region. Each of the three pigs raised requires 50 kilograms of maize. Total income from all enterprises is 57,200 pesos.

The farm in this example is using family labor near its maximum. The main cropping activities require only about 200 man-days per year, but in several months during the cropping cycle labor resources would be stretched to the limit. The months between October and February would be particularly busy with land clearing for chile, harvest in the plantation, and the tornamil clearing. The mix of enterprises gives the farm family substantial protection from market fluctuations and production problems, and maintains subsistence.

The four farming systems that have been presented in Tables 3 through 6 demonstrate what farmers in the Selva Lacandona are actually doing, and what some farms are evolving towards. The farms described in Tables 3 and 4 are characteristic of recently established farms. Those in Tables 5 and 6 are projections of what some farms are evolving into. A comparison of these four examples gives an indication of what is possible, of the nature of farmers° decision making processes in enterprise mix selection, and of

TABLE 6

Highly Diversifed Farm: One Year s Production

Product	Quantity Produced	Quantity Sold	Income in Pesos
Maize	3250 kg	1300 kg	8450
Minor Crops	-	-	400
Chile	125 kg	125 kg	6250
Coffee	720 kg	720 kg	21600
Cacao	150 kg	150 kg	12000
Fruits	-	-	1000
Honey	100 kg	90 kg	2700
Chickens	25	6	600
Turkeys	6	4	2000
Hogs	3	2	1800
	Total Income	57200	Pesos

the relative productivity of several enterprise mixes. In the first two examples, the farmer has little choice in his selection because the length of occupation mitigates against plantation crops. The older farms have evolved plantation systems as the principal source of income. The last of the four systems, which is depicted in Table 6, is given as an 'ideal' farming system that uses available resources at near peak efficiency. Such a mix of enterprises could offer settlers in the Selva Lacandona a relatively permanent and dependable source of income, under the resource constraints faced by farm families.

SUMMARY AND CONCLUSIONS

Farming systems have been developed and adopted by farmers in the Selva Lacandona that are highly adapted to local environmental and economic conditions. In the early years of settlement, migrants are primarily subsistence farmers. Over time, mixes of subsistence and commercial enterprises are adopted. Multi-product systems are designed to maximize income, subject to the maintenance of subsistence, and subject to the

availability of resources. As shown in tables 2 through 6, these systems have potential for relatively high levels of productivity and income generation. Many problems with both production and marketing have, however, resulted in the limited realization of this potential.

The technical and economic difficulties that affect the farming systems of the Selva Lacandona have limited the competitiveness of cropping and small livestock systems with beef cattle production. The following chapter examines the extensive cattle sector in the region. It will be demonstrated that cattle systems offer superior opportunities for generating cash income than cropping systems (in the short run), under current conditions in the Selva. It will also be shown that in the long run, most of the small-holder cattle systems are unstable and unproductive systems that result in land degradation.

Chapter VI

EXTENSIVE CATTLE PRODUCTION

Extensive cattle production in the Selva Lacandona is a rapidly expanding industry. The expansion of cattle production has had deleterious effects on the region's agro-ecology. The effects of this expansion may grow increasingly more destructive in the future. This chapter examines the extensive cattle industry in order to identify the economic rationale behind the cattle expansion and possible means of creating or promoting alternatives that are acceptable to the region's farmers.

In the previous chapter, several production systems and enterprise mixes that are potentially profitable, and that are relatively well adapted to the Selva's environmental conditions were described. It was demonstrated that farmers select enterprises according to labor and land requirements, and the returns to factor use. Colonists are increasingly turning to cattle production for economically rational reasons. The economic conditions for cattle production in the small-holder sector are generally more favorable than for other production systems. However, extensive cattle production, as it is practiced by most of the small-holders in the region is a non-sustainable system. These systems remain profitable only for a few years.

This chapter is divided into three sections. The first section details the causes of the expansion of the extensive cattle industry in the Selva Lacandona. Economic, social, and institutional factors are considered. Section two examines the commercial sector of the region's cattle industry. Large commercial ranches are important as the focus of much of the small-holder cattle production in the Selva. Small-holders generally produce feeder calves for commercial operations. The practices of commercial ranches are also of interest because these larger operations have relatively sound production practices. Ejidal operations are compared to the commercial ranches to highlight some of the weaknesses of the practices of small cattle production. The third section describes and evaluates several types of ejidal cattle systems. The production and marketing practices and economic returns of these types of enterprises are compared. Attention is also given to the record of cattle collectives in the region.

CAUSES OF THE EXPANSION OF GRAZING

Migrants in the Selva Lacandona have adopted cattle production for economic and social reasons. The primary attraction of grazing operations for small-holders in the region is that they offer better and more rapid returns than many other production systems. The relative profitability of cattle operations is due to the advantages of cattle, and to the weaknesses of cropping systems.

The expansion of cattle production in the Selva Lacandona is part of a wider national expansion resulting from growth in demand for beef. Increased demand for beef in urban areas has been rapid in recent years. This growth in demand has been associated with the expansion of Mexico's middle class (USDA). Mexico is also an exporter of beef. Export demand was a more significant factor in the expansion of the cattle industry in the 1960s and early 1970s than it is today. Exports as a percentage of total production has declined in percentage terms since the mid-1970s.[20] Production for export is generally of a higher grade of cattle from the northern regions of Mexico. Production in tropical areas is in part to replace exports on the domestic market with lean beef (Nations and Komer). Most of the Selva's production goes to Villahermosa, Tabasco, and to Mexico City.

The cattle industry in southeastern Mexico is inherently expansive (Feder). Extensive grazing systems in general are land intensive. Sustainable stocking rates in the region are estimated at close to one animal per two hectares of pasture (SFF 1975). Land laws have made it difficult to expand the size of a commercial ranch. The laws governing rangeland holding size define the allowable hectarage in terms of the number of cattle that the land can support. The maximum allowable herd size is set at 500 head. Rather than invest in the intensification of land use for increasing the stocking rate, commercial ranchers often use small-holders to expand their operations. By doing so they avoid the greater capital outlays and associated risk that intensification involves.

Ejidatarios and small private ranches serve the expansion of the commercial cattle industry primarily through the provision of cheap pasture for rental, and through the provision of feeder cattle for fattening operations. Commercial ranchers rent pastures from small-holders on a per head basis to fatten steers. Renting land is an illegal practice for ejidatarios, and it is therefore difficult to get information about rental agreements. Grosser et al (p.188) estimated that about eight percent of ejidatarios in some Santo Domingo valley ejidos rented pasture in 1975. Payment for rentals in 1981 typically may have been about 35 pesos per head, per month.

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[20] Exports of beef as a percentage of total production were: 1960-3 percent, 1970-5 percent, 1975-1 percent, 1980-1 percent (Yates, FAO, USDA 1978 and 1980).

Small-holder cattle producers supply the commercial ranches with young steers for fattening. This has the advantage for ranchers of increasing the ratio of market animals to breeding stock in their herds. Some commercial ranches are exclusively fattening operations using calves purchased primarily from small-holders (Feder). Ranchers from many parts of the Southeast truck cattle out from small-holders in the Selva Lacandona. Calves are also sold to commercial ranches within the region. Ranchers in some instances provide small-holders with brood cows in a share arrangement known as al partir, in which the calves produced are divided between ranchers and small-holder. Since calving and calf rearing are the most risky parts of cattle operations (McDowell, Williamson and Payne), the losses associated with calving and calf rearing are avoided with this system.

Government involvement in cattle production has had some impact on the expansion of extensive cattle production in the Selva Lacandona. Credit has been provided through the government to ejidatarios who form collectives, since 1974 (Grosser ed.). The Fideicomiso Instituido en Relacion con Agricultura (FIRA) has been active in financing small-holder cattle operations. Loans for herd expansion have been made available to ejidatarios in the Selva through several government agencies. Government sponsored credit has been almost exclusively for the purchase of breeding stock.

Capital appears to be the greatest constraint for small-holders in the rapid expansion of grazing operations. Unless a share arrangement is employed, cattle must be purchased for farmers to begin production. Capital is also needed for fences, horses, and occasionally, labor. Most farmers buy their first cattle with capital accumulated from the sale of crops, or from wage laboring. For this reason, ejidatarios, and small ranchers generally start with one or two cows and gradually expand the herd through the production of heifers. Where credit has been available there has been more rapid expansion of cattle production. This is evidenced by the area in pasture and the number of cattle found in several ejidos in the Santo Domingo Valley, where credit has been available, at least intermittently, since the 1970s. Ejidos in areas where credit has not been available generally have fewer cattle.

For many of the colonists in the Selva Lacandona, extensive cattle production is the easiest type of farming operation to manage. This is an important reason for the adoption of cattle systems. In many respects, cattle production is less demanding than cropping systems. Pastures require little labor to establish if grass is planted in areas cleared for crops. Pasture weeding and burning require little skill or agronomic knowledge. Grass produces consistently relative to crops; cattle production is therefore viewed as a more consistent source of income by the migrants. Cattle are cared for minimally; labor demands are fairly low.

Ecologically unsound cropping practices can also cause farmers to adopt extensive grazing. If land is severely degraded from inadequate fallows, or other practices, pasture may be the only economic use for the land. Farmers with poor soils or seasonally inundated land may also be unable to derive sufficient income from cropping. Pasture can tolerate inferior

agronomic conditions and is therefore planted on marginal land for lack of an alternative use.

The Indian peoples of the Selva Lacandona are apparently attracted to cattle grazing because it is seen as being ladino. Ranching is viewed as socially progressive by many of the region's inhabitants. In many parts of Latin America, and in particular in Mexico, ganadero (rancher) is a term of respect (Parsons, p.126).

Cattle are seen by the colonists as a store of wealth. Market cattle can be 'stored' on pasture at little or no cost for sale when cash is needed. Maize and other crops store badly in the region's environment. Cattle may also serve as insurance against disaster (Grosser, p.148). The cattle of a small-holder may be the only product available for market in a very bad crop year.

The price paid for cattle in the Selva Lacandona has attracted farmers to grazing. The price of cattle on-the-hoof has increased annually in the region at least since 1977. The percentage rate of increase has been declining, however. In 1977, a steer weighing approximately 500 kilograms sold for about 5,000 pesos. The price increased by about 1000 pesos each year until early 1982, when a steer generally sold for 10,000 pesos. These prices compare favorably to other production systems, especially if several steers are produced annually. In 1981, one grown steer sold for the equivalent of the average production of one hectare of maize sold at the guaranteed price. Typical returns to cattle enterprises will be discussed below.

THE COMMERCIAL CATTLE SECTOR

Consideration of the commercial sector of the cattle industry in the Selva Lacandona is important to this study because the commercial ranches in the region are the focus of much of the small-holder production. The larger ranches also have more productive systems than those of small-holders. These ranches have developed sustainable extensive systems because of the quantity and quality of resources available to them. Practices in the commercial sector are used as a basis for comparison for the less productive and less stable small-holder systems.

Private ranching operations were first established in the Selva Lacandona during the 1940s and 1950s, when it was possible for individuals to purchase large holdings. The most important ranches, both economically, and in terms of their impact on the growth of the region's cattle industry are a few very large commercial operations. In addition to these, there are more than 100 smaller private ranches ranging in size from 10 to more than 300 hectares (SFF 1975).

Large Ranches

The size of the large ranches is difficult to estimate. Information on land tenure in the commercial cattle sector is not generally available. Three ranches were identified in this study that are believed to be of over 1000 hectares. The Santa Clara ranch, located near a lake by the same name in the Riverine zone, is the largest private holding in the Selva. An SFF report (1975 p.135) listed the Santa Clara ranch as controlling 10,000 hectares, and belonging to several proprietors. Sources in the Selva reported in 1981 that the ranch had 6,000 hectares, and was divided between six family members. Santa Clara remained very isolated in 1981 and was not visited. A large ranching operation exists in the central Santo Domingo valley that is of approximately 1000 hectares, with perhaps 500 head of cattle. The ranch was visited in 1981, but no information was made available. A third large ranch, called Diamante, is located in the northeastern section of the Selva near lake Metzabok. The Diamante ranch has approximately 1000 hectares. Only at Diamante ranch was it possible to get fairly detailed information about the operation. Most of the examples in this section are drawn from a study of this ranch.

In addition to controlling large areas relative to other land holders, the big ranchers may also have some of the best agricultural land in the Selva. The 750 hectares of pasture at Diamante are on well drained, level or gently sloping land. This is the best type of cropland in the area, and is in particularly short supply in the Northeast. Ejidos in that area have primarily hilly or low lying land.

Diamante ranch is run by a hired manager with six full time workers. The owner is in abstentia. In addition to the full time workers, 25 to 30 day laborers are employed for one month to six weeks each year for pasture weeding and planting. Workers are also occasionally hired to string fences, and for round-ups.

In 1981, there were an estimated 600 head of cattle on the ranch. Fifteen high quality bulls were kept. The ranch also had a herd of fifteen to twenty horses. Between 100 and 150 fattened cattle have been marketed annually in recent years. Marketings are in 50 head lots that are trucked directly to Mexico City. Annual labor and management costs were estimated at 400,000 pesos. No estimates were available for other production costs. Returns net of labor and management costs, from the sale of 125 head of live cattle (including transportation costs of 1000 pesos per head) sold at 12,000 pesos each in Mexico City, total 1,050,000 pesos.

No information was given at Diamante ranch on the number of feeder cattle typically purchased in a year. One such transaction between the ranch manager and an ejidatario was observed. Using data on offtake rates, herd size, and average sales, an approximation can be made of the number of feeder cattle purchased. A typical cow of the Zebu breeds found on the ranch, under the extensive conditions of the operation, will calve for the first time after three to three and one half years. She will probably yield one calf per year for six years. She would normally be culled in the eighth to tenth year. Under conditions at Diamante, steers will attain a market weight of 450 to 550 kilograms after about three years.

Calculations reveal that marketing 125 head of cattle on an annual basis could be accomplished without purchased feeder cattle. To market 150 head, with a total herd of approximately 600 cattle, as held at Diamante, would, however, require the purchase of 25 to 30 yearling calves. The production of 150 animals for market in a year without calf purchases would require a larger herd. Calves are purchased locally for 5000 to 7000 pesos in 1981. The net profit from the sale of 150 head of fattened cattle (after labor, and marketing costs) for an operation like Diamante is calculated at 1,260,000 pesos, as compared to 850,000 pesos without the purchasing of feeder cattle.

Pasture management is a key factor in maintaining a sustained and profitable grazing operation in the Selva lacandona. Several exotic grasses thrive in the region under good conditions and management. The most common pasture grasses on commercial ranches are African Star and Pangola. The land at Diamante is reasonably good. The depth of the topsoil and the gentle terrain reduce the incidence such problems as infertility and erosion. This relatively favorable factor endowment makes sustained grazing possible.

Pasture quality is mainatined through rotational grazing and weed control. Both of these practices are more easily followed by larger, better endowed ranches. Weeding is accomplished either with a machete, or with herbicides. Pastures will rapidly become infested with weeds and shrubs if not weeded annually, or in some cases bi-annually. Pasture weeding on reasonably well maintained pasture requires about two to three man days per hectare. Pastures are also burned each year to encourage the growth of young, more palatable shoots, and to help control weeds.

Rotational grazing serves several functions. If cattle are concentrated on pasture for too long, the grass is cut excessively low and regrows slowly, or may die off. On the other hand, if pasture is allowed to go too long an interval without cutting or grazing, the grass becomes woody and less palatable for cattle. Tropical grasses become lignified and have reduced nutritive value when mature (DeAlba, McIlroy). Rotational grazing also has the effect of concentrating manure on the pastures. While commercial ranches have sufficient pasture area to rotate, small-holders have too little land, and therefore are incapable of following these pasture management practices.

Animal Husbandry

The animal husbandry practices on Diamante ranch contribute to the profitability of the enterprise. Considerable attention is given to breeding practices. High quality bulls are used, and other males are castrated. Bulls of many breeds are available to commercial ranchers from breeding farms that specialize in the production of registered bulls, throughout southeastern Mexico. In 1981, the stock show at Palenque exhibited more than 20 breeds from ranches in Veracruz, Tabasco, Chiapas and Campeche. Bulls on the larger ranches in the Selva Lacandona are generally valued at between 40,000 and 60,000 pesos. Commercial ranches in

the region have almost exclusively Zebu (Bos Indicus) breeds, including Gir and Indo-Brasil. Criollo breeds (Bos Taurus) that are common in other parts of Chiapas, and found on some ejidos in the region, are not used in the commercial sector.

Supplemental feeding is employed as a means of increasing herd size relative to pasture area at Diamante. Cut forages also serve to reduce the risk of weight loss in cattle in the dry season when pasture can become scarce. A cane grass (Elephant grass) is grown in dense stands near pastures and near corrals. The grass is cut when it is three to four meters in height. The cut forage is either spread on the pasture or chopped in a hand powered mill, and fed in troughs, sometimes with molasses. Mineral salts are also given to cattle regularly. Cattle are separated into herds according to sex and age to manage feeding. Market cattle, including steers and cull cows, are grazed on the best pasture to promote rapid weight gain; weight being the basis of sale for cattle from commercial ranches. Smaller operations have no access to scales and must sell by the head.

Animal health practices in the commercial sector are also better than in the ejidal sector, but health problems exist none-the-less. At Diamante, the cattle are vaccinated against several diseases but receive little treatment for such problems as endoparasites. Control of ticks, a major problem in tropical cattle production, is practiced through the use of dip tanks. The government has been involved in the promotion of dip tank construction in the region. Vampire bats are considered to be a minor problem. Diamante ranch reported the loss of only six cattle to health problems in 1980.

Commercial Practices

Commercial ranches have a definite advantage over small-holders in financing and marketing. Credit has been readily available to large ranches and is arranged in either Palenque or Tuxtla Gutierrez. The larger ranches have marketing advantages in that they tend to deal directly with buyers and slaughter facilites, thus avoiding the price of middlemen. There are also economies gained by commercial ranchers through larger shipments of cattle in transport costs and in cutting through red tape. The movement of cattle in Mexico requires considerable documentation. The official matters are frequently handled through the cattlemen's associations (asociaciones ganaderos), which have expedited the expansion of the industry in the Selva Lacandona.

Cattlemen's associations serve commercial, social and political functions in Mexico. In cattle areas, the associations are often the most important organizations in the community. In Palenque, the largest building is the Cattlemen's Hall. The primary function of the associations is to assist ranchers in the production and marketing of cattle. They provide technical and commercial information, credit assistance, and help the government with cattle development programs such as regional tick control projects. The associations also serve as buying co-operatives for

veterinary supplies, seed, and other inputs. Stock shows are also organized by the associations.

Because cattle is a major commercial sector in the state, the cattlemen's associations have generally enjoyed considerable influence in the political arena (Feder). This is a major cause of the continued existance of the large ranches in Chiapas in the face of the land reform laws. Political power may also have influenced the favorable treatment that government agencies have given the ranchers in terms of credit and technical assitance.

Two cattlemen's associations have influence in the Selva Lacandona s cattle industry. The Palenque Cattlemen's Association is the dominant group locally. This is because most of the cattle of the region are marketed through Palenque, or are sold to ranchers in the municipo. The Tabascan Cattlemen's Association, centered in Villahermosa, also has considerable influence in the Selva because it controls the nearest slaughter facility. The association has control over who sells to the abatoir (Casco). The Palenque Cattlemen's Association has been working for years to develop its own slaughter facility in order to get out of the control of the Villahermosa group. By 1982, the Palenque facility was only in the planning stage.

Small Ranches

The smaller private ranches fall into two catagories; those that raise finished cattle, and those that raise feeder cattle. It is difficult for a ranch of less than 50 hectares to sustain an operation that raises and finishes cattle. According to SARH, the minimum viable size for a ranch in the Selva Lacandona is 100 hectares (SFF, p.60). A ranch with 100 hectares of pasture cannot sustain a herd of more than 60 cattle under typical extensive conditions.[21] The annual offtake from a herd of 60 would be a maximum of 15 fattened animals. Most ranches in the region have less than 100 hectares and are feeder cattle producers, or fattening operations which rent pasture.

The smaller ranches cannot arrange transportation and marketing (because truckers prefer to haul larger loads), and therefore must sell at the farm gate at prices below those received at market. In 1981, the price in the Selva Lacandona was approximately 10,000 pesos per head at farm gate. The gross returns from the sale of fiften head would have been 150,000 pesos in 1981. The maintainence of 100 hectares of pasture would require more labor than a single family could provide. Some hired labor would be needed. There would be additional expenses for materials etc. The return net of labor, fencing, and operating expenses could be as little as 100,000 pesos per year.

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[21] The herd would include approximately 50 market cattle between one and three years of age, 20 brood cows, 6 replacement heifers and heifer calves, and one bull. This is approximately 60 animal equivalent units.

Most operations are smaller than 100 hectares. It is evident that the small ranches with less than 100 hectares of pasture, that produce finished cattle are only marginally viable economically. A ranch of 50 hectares would have difficulty producing more than six or seven market animals per year on a sustained basis. This would yield a net income of approximately 40,000 pesos per year. Many of the smaller ranches have less than 50 hectares (SFF). Most of these produce only feeder cattle.

There is often a tendency to attempt to make up for the lack of land by increasing herd size on smaller ranches. The resulting overstocking of pastures is inevitably destructive. There were reports in the Metzabok area of ranches with about 50 hectares losing herds to starvation in the 1981 dry season because of overstocking. The existence of these ranches is precarious.

Not all commercial ranching is on private land. Some ejidatarios have established herds of over 50 head. Larger herds are maintained by ejidatarios through the rental of pastures from other members of the ejido. This can lead to income inequality within an ejido. There are few ejidatarios in the Selva Lacandona who can aquire sufficient capital for commercial scale ranching. One example of this type of operation was identified in the Santo Domingo Valley. Significantly, relatives of this ejidatario operated a private ranch nearby, giving the ejidatario access to foundation stock, reducing his capital requirement.

CATTLE IN THE EJIDAL SECTOR

The ejidal sector in the Selva Lacandona is the only area that offers significant potential for further expansion of the cattle industry in the region. No data were available for the growth in the number of cattle on ejidal land, or for the expansion of pasture area in the ejidal sector. The ejidos are however, the region's largest land-holding group in terms of total area. Further colonization in the Selva is also to be organized in ejidos.

The pattern of the growth of extensive grazing on ejidal lands is demonstrated to some extent by the relative importance of cattle in ejidos as a function of the duration of settlement. The ejidos in the longest-settled areas of the Chocolja and Santo Domingo valleys are predominately cattle producers. More recently settled areas have far fewer cattle. Interviews with farmers in the younger ejidos revealed an eagerness to engage in cattle production. It is therefore likely that the pattern of transformation of forest and cropland to pasture will continue in the future as the region is developed. Cattle enterprises in the ejidal sector are of four fairly distinct types; pasture rentals, sideline cattle operations, cattle dominated ejidal farms, and collectives.

Pasture Rentals

The simplest type of operation is the pasture rental. Farmers plant grasses on cleared land, build fences, and rent pastures to private ranchers or other ejidatarios for fattening cattle. Pasture establishment and maintenence for rentals is not very demanding of the farming system as a whole.

Grass is generally planted among other crops in the milpa during the mid-summer weeding. Grasses such as Pangola and Jaragua are seeded. Grass seed is gathered in November through January, and can also be purchased in Palenque or Tenosique. Elephant grass and Star grass are vegetatively cultivated. Cuttings are made from other pastures and transplanted to the milpa among the maturing maize. The pasture is established after about six months, usually by the begining of the dry season. Weeding and cutting of the newly established pastures is often done twice during this six month period. These practices promote the growth of healthy stands of grass. Some farmers do not make the effort, however. Weeding and cutting are the most labor intensive activities in pasture establishment in terms of man days required.

The constuction of fences represents a major investment in labor and capital for the small-holder. Fences were apparently less common on ejidal pastures in the mid-1970s than they were in 1981. The SFF (1975) and Grosser et al reports both indicated that many ejidal pastures were not fenced. In 1981, most pastures in the region were found to have fences. This increased investment by ejidatarios has probably been the result of the growth in cattle numbers, and of increased road traffic. Farmers are more inclined to fence pastures to keep other farmers' cattle off when cattle numbers increase. As herds become larger it also becomes more difficult to keep cattle from straying without fences. In the late 1970s and early 1980s, the truck traffic on roads in the Selva increased dramatically. This resulted in an increased incidence of cattle being killed and wrecking vehicles. All pastures observed along the region°s major roads were fenced in 1981.

For small-holders, much of the cost of fence construction is counted in labor. The most time consuming task is the constuction and setting of fence posts. Hardwood trees are cut in the forest and fashioned into posts.[22] The posts are spaced at three meter intervals. A typical three hectare pasture will require about 250 fence posts. A total of 30 to 40 man days are required to fence a three hectare pasture. The standard fence in the Selva has three strands of barbed wire. 2400 meters of wire are needed to fence a three hectare pasture. Barbed wire sold for about two pesos per meter in Palenque in 1981. The total cash outlay for the establishment of a three hectare pasture by a small-holder in 1981 was approximately 5000 pesos including all fencing materials.[23]

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[22] Chicle wood is often used. These posts sprout into trees and act as living fence posts and shade trees.

[23] It has been noted that cattle owners frequently provide pasture renters

Pasture rentals in the Selva Lacandona are on a per head basis. In 1981, the rate was reportedly 35 pesos per head per month. Assuming a stocking rate of .6 animal units per hectare,[24] and an ejidatario renting half of his land (10 hectares), one year's income from rentals would total 2520 pesos ($US 100, 1981). Pasture rental would not be very remunerative under these conditions. Farmers in fact tend to either attempt to increase rental income by increasing stocking rates, or use rentals as a stepping stone to cattle ownership. The stocking rate on rented pastures probably is often over one head per hectare, and perhaps as high as two head (Labato 1979).

Most farmers who establish pastures intend to own cattle. Pastures may be rented-out while a farmer works to have sufficient land in pasture to support a breeding herd, and enough capital to purchase foundation stock. Farmers may also be unable to make planned purchases of stock and therefore rent their pastures that were planted in anticipation of the establishment of a herd. Farmers who become trapped in rental situations (primarily by capital scarcity) often attempt to increase income from grazing by over stocking, resulting in overgrazing and subsequent pasture deterioration.

Small Cattle Operations

Ejidatarios in the Selva Lacandona who own cattle have varying strategies for cattle production in their farming systems. For many, cattle production is a sideline, and for others it is the dominant enterprise. Cattle operations range in size from one or two brood cows on a few hectares to herds of fifty animals that make considerable use of rented pastures.

Most ejidal cattle operations begin as small calf-rearing enterprises. Once farmers have achieved subsistence, and have several hectares of mature acahual, they begin planting grass in their milpas. In many cases, the first land planted in pasture is the least productive land for crops. Frequently, this is low lying land on which crops have failed due to inundation or water logging. In the older ejidos most of this type of land had been converted to pasture by 1981.

As the area in pasture is expanded, there is increasing competition between cropping and cattle production for the better plots of land. Farmers who elect to pursue cattle production as a minor part of a mixed enterprise system will therefore have limited land in pasture. Such a sideline enterprise might involve one or two brood cows, their calves, and

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with capital for fencing.

[24] The average maximum carrying capacity of ejidal pastures is estimated at one half that of Diamante. The reduced carrying capacity results from lower quality and quantity of available forage. This is figure is based on field observations and on comparative figures from similar regions (SAG).

a replacement heifer on about four or five hectares of pasture. With a breeding herd of this size, the farmer may borrow a bull rather than keep one. Total returns from calf sales would range from 5000 to 10,000 pesos per year. A small sideline operation would require very little labor or start-up capital. Annual operating expenses including fencing would total between 1000 and 2000 pesos. This type of cattle enterprise is quite common in the region.

Farmers who have small sideline cattle operations do not have a strong impact, as a group, on the region's economy or ecology. Only the least productive land is generally planted to pasture. The use of low lying land reduces the likelihood of erosion and soil depletion through pasture establishment. Valley soils may be more subject to compaction by cattle than some other soils, but this may not be a major problem with the low stocking rates associated with this type of system.

Expanded Cattle Systems

Several strategies can be employed by ejidatarios who wish to expand cattle operations beyond the simple sideline described above. The speed with which an enterprise can be expanded, and the size that it ultimately achieves, is a function of capital availability, the objectives of the farmer, and an element of chance. Some strategies are quite profitable in the short run, but are not sustainable in the long run.

One system that is potentially sustainable, at least on holdings with better than average land quality, is a rotation of crops, pasture and fallow. This type of rotation has not been fully developed in the Selva. Approximately 20 years of grazing would be required for the system to go full cycle. Few farmers in the region have been producing cattle in significant numbers for that many years.

The maintenence of a crop-pasture-fallow rotation on a twenty hectare holding would require very careful management. The maximum area of pasture that could be supported by the system at any given time would depend on soil quality, and the micro-environment of the holding. Conditions on some better endowed holdings indicate that one year of cropping, five years of pasture, and four years of bush fallow could be a sustainable pattern for a rotation. Assuming that two hectares are in milpa each year, the maximum area that could be supported in pasture, (of a twenty hectare holding) is ten hectares. If a stocking rate of 0.6 animal units per hectare is used, a farm employing this rotation could permanently support a herd of approximately six animal units.

To calculate the expected returns from a calf-rearing enterprise with a herd of seven animals requires a few assumptions. For example, a calf crop of 70 to 80 percent would be good by the standards of ejidal operations. Animal husbandry and pasture management are generally worse in the ejidal sector than on commercial farms. Problems in these areas derive in part from lack of capital and inefficiencies associated with small cattle operations, and in part from a lack of managerial expertise. The

foundation stock used in ejidal operations are generally of low grade because farmers cannot afford to buy, and often don't have access to, higher quality stock. Further, the breeding of this already low quality stock is frequently poorly managed, resulting in even lower quality offspring. Cattle of low genetic potential produce fewer calves, have slower weight gain, and reach smaller mature size than higher quality animals (McDowell).

The inferior stock of ejidal ranchers are less productive than their genetic potential would allow because of the conditions under which they are raised. Ejidal cattle receive little or no health care. Parasites, both external, and internal, are common. Vaccination is also almost unknown to ejidal cattle producers. A host of other animal health problems have been observed in ejidal herds including mastitis and infections from injuries (SFF).

The quality of animal nutrition in ejidal operations also has an adverse effect on the productivity of cattle. There is almost no supplemental feeding of cattle on the ejidos. Salt is only rarely given. The quality of pastures is generally poor, and seasonal forage scarcity is frequently a problem resulting in nutritional deficiencies. Pasture quality is poor because of inadequate maintenence, overstocking or understocking, and the absence of rotational grazing. All of these factors contribute to a lower level of productivity in ejidal cattle than on the commercial ranches.

With the reduced productivity of ejidal cattle, the annual offtake in calves from a herd of six animals would be no more than three on the average. At its maximum, the herd would consist of one bull,25 one heifer replacement, four brood cows, and three calves.26 The total income from the sale of three calves would be about 18,000 pesos. One cull cow would also be marketed every second year for an additional 6000 pesos. Exenditures for such items as fencing, salt and medicines would reduce this figure by some two or three thousand pesos. After subtracting annual operating expenses, the net annual income from cattle sales for a holding with a herd of six animals is approximately 20,000 pesos.

The mixed small-holding system described above could be managed by a family without hired labor. Approximately 60 man-days are required to weed and burn twelve hectares of coarse pasture. The construction of two hectares of fences annually would take an additional 25 days of labor. The timing of these operations is relatively flexible and can be fitted into the cropping system without much conflict. Pasture establishment is within the cropping system and requires very little additional labor. The small herd can be tended by a young boy alone. No horses would be needed to manage a herd of this size.

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25 It was found that small-holders usually keep a bull if they have three or more cows.

26 Calves are counted as fractional animal units.

The pasture-cropping rotation that has been suggested is not typical of what most small-holders in the Selva Lacandona actually do. The example is based on conditions on a comparatively well endowed holding, with twenty hectares of relatively high quality cropland available. Many ejidatarios face less advantageous conditions. On lower quality land the fallow would of necessity be longer, and the interval in pasture shorter. This would substantially reduce the sustainable area of pasture. Two options are commonly exercised to deal with a scarcity of land. Farmers may maintain a small area in pasture and a small breeding herd (a sideline). They may also attempt to force their holding to support a larger herd than can be sustained in the long run, in order to increase income from grazing.

The settlers in the Selva Lacandona appear to attempt to maximize returns in the short run. Pasture can be expanded rapidly within the milpa cropping cycle. An entire twenty hectare holding can be converted to pasture in four to six years (if all primary forest has been cleared previously). The cattle herd can also be expanded rapidly. After an initial investment in the purchase of three brood cows and a bull (approximately 40,000 pesos), the breeding herd can be increased to twelve brood cows in only eight years if all heifers were retained. Twelve brood cows could reasonably yield five bull calves and two heifer calves[27] for market per year, under local conditions, for a gross income of about 42,000 pesos, at 1981 prices. Two cows would be culled annually, after the sixth year, for an annual income of 12,000 pesos. Operating expenses would reduce the yearly income by about 9,000 pesos. After eight years, the herd would number almost 25 animal units if all heifers had been retained. This is double the estimated maximum sustainable stocking rate of 0.6 animal units per hectare.

The speed with which an ejidatario can develop a herd is highly dependent on capital availabiltiy. An ejidatario with little capital typically begins with one or two cows. If credit or another source of capital is available, the expansion can be more rapid. In the example discussed above, the farmer needs 40,000 pesos to start-up. If (hypothetically) he has 20,000 pesos saved from crop sales (perhaps from several seasons), and can borrow 20,000 pesos for five years at 15 percent interest, an operation begun with one bull and three cows could repay the debt in five years and make a profit in the sixth year (barring the loss of an animal in the first years). If pasture was available for a herd of 40 head (all heifers having been retained), gross sales of calves and culls in the tenth year would total about 100,000 pesos. The herd would have an approximate value of 200,000 pesos (at 1981 prices). The initial investment would have been handsomely repaid. These calculations reveal the impact that credit can have on the rate of expansion of cattle in the ejidal sector. The attraction of banks to the cattle industry in the region might also be explained by these figures.[28]

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[27] Three heifers are retained, one for expansion, and two for replacement.

[28] Credit programs for small-holder cattle operations will be discussed in a later section.

The colonists in the Selva Lacandona are keenly aware of the potential profits to be made in cattle. No other production system in the region offers an opportunity for such a rapid increase in income, or such high returns to available resources. It is unclear however, whether farmers are aware of the longrun consequences of the conversion of their entire holding to pasture, and of continual overstocking.

If a farmer plants a three hectare milpa in pasture each year, an entire twenty hectare holding can be transformed into pasture in about seven years. Avarage pasture in the ejidal sector remains productive for only seven years (Grosser ed.). In the eighth year, the first three hectares of pasture that were planted would cease to be productive under typical conditions in the ejidal sector. From that point on, the farmer would be faced with a continuously declining availability of forage. If the farmer has also expanded his herd rapidly, this scarcity of forage will result in overgrazing, the selling-off of part of the herd, or of starvation of some cattle. Under the better soil conditions in the region, the fallow necessary to replenish fertility and erradicate weeds after pasture is a least six years. If the land has been kept in pasture for a prolonged period, the fallow must be longer. After thirteen to fifteen years, a holding that was rapidly converted to pasture and heavily grazed may have almost no land in any kind of production as a result of soil degradation.

An ejidal farmer can maintain a substantial cattle operation if the herd size is stabilized after the initial expansion has been completed. The farmer must market some heifer calves each year along with bull calves, and retain only enough heifers to replace culled cows. The herd size can be stabilized at about twelve head (animal equivalents) in the eighth year. The operation is established with three brood cows and a bull. The herd would be made-up of four heifers of between one and three years of age, a bull, and six brood cows. An average of four or five calves and one cull cow would be available for market for a net income of 25,000 to 30,000 pesos each year as compared to 44,000 for the more expanded system.

Table 7 compares production, income and stocking rates for the four ejidal cattle systems discussed here ie., the sideline, the crop/pasture rotation, an expanded system, and a system with a stabilized herd size. Stocking rates are shown to be inversely proportional to net income. For the three systems other than the sideline, the data presented are indicative of conditions after seven or eight years of ranching. This is of course an evaluation of the short-run economics of these systems. Clearly, in this short run, higher stocking rates are more profitable. Strong short-run incentives unquestionably exist for over-stocking. The stocking rate on the 'stabilized' ranch in the eighth year with twelve head on twenty hectares of pasture would be about 0.6. This is superior to a rate of over one animal per hectare that would be found on a farm that retained and raised all heifers produced in the first seven years (the expanded system in Table 7) in an effort to continually expand the herd. Management practices leading to such a more sustainable system are not evident among most ejidal cattle producers. Land must be fallowed for a few years between periods of five to ten years in pasture to make this system truly sustainable. This of course would reduce income in the short run. This more stabilized system, with lower stocking rates, could prolong

TABLE 7

Comparison of Four Small-holder Cattle Enterprises

	Sideline	Crop Pasture Rotation	Expanded System	Stabilized Expanded System
Hectares in Pasture	5	10	20	20
Hectares in Crops	2	2	0	0
Hectares in Fallow	13	8	0	0
Herd Size	3	6	25	12
Stocking Rate	.6	.6	1.25	.6
Average Calf Sales	1.5	3	7	4.5
Average Cull Sales	.2	.5	2	1.00
Average Net Ret. Pesos*	9000	20000	45000	30000

*Net of operating expenses.

the productivity of an ejidal grazing operation, but not indefinitely. Where an operation that had not controlled herd size might exhaust the land in ten to fifteen years of grazing, a 'stabilized' system could perhaps last fifteen to twenty years.

Dairying

A variant on extensive beef cattle production has recently emerged in the ejidal sector in the Selva Lacandona. Dual purpose cattle have been introduced for beef and milk production. Brown Swiss-Zebu crosses have been appearing in increasing numbers in Palenque municipo in the early 1980s. These crosses have grown in popularity in northern Chiapas and in Tabasco since their introduction because they give more milk than traditional local breeds. In the Chocolja valley, some ejidatarios have developed small herds of these dual purpose crosses. In the Santo Domingo valley, a few farmers also have one or two of brood cows of this variety. The colonists generally have some familiarity with dairying from their homes in the Highlands. Ocosingo municipo in particular is an important cheese producing area. There is almost no milk consumption in the Selva; production is exclusively for consumption in Palenque and Tenosique. Transportation of fresh milk to these towns from farms in the Selva Lacandona will probably remain difficult in the future because of the poor state of the region's infrastructure. Small-holder milk production in the region is not likely to expand rapidly as a result.

Collectives

In the mid-1970s, the Mexican government initiated credit programs for the development of ejidal cattle operations in the Selva Lacandona. Credit was provided by several banks, and was administered through a variety of governmental agencies, including PIDER (The Presidential Program for Investment In Rural Development), INI (The National Indian Institute), and SAG (The Ministry of Livestock and Agriculture).

Credit was made available to groups of ejidatarios who organized themselves in Collective Cattlemen's Associations. Individual ejidatarios could not apply for credit. The associations were collectives in which all members shared equally in labor commitments, financial responsibility, and profits. Grosser et al reported that ejidatarios in the Santo Domingo valley were eager to recieve credit in the mid-1970s, and rapidly formed associations. The government agencies sought to introduce collectivization as a means of improving the efficiency of small-holder cattle production through increased size. This was part of a general promotion of expansion of the national cattle herd by agricultural lending institutions.

There were many problems with the collective credit programs in the Santo Domingo valley. Some collectives failed to aquire credit in the first year after application. The ejidatarios were required by the programs to clear and fence pastures before credit was to be given. The farmers complied by converting much of their holding to pasture. Credit was refused some Collectives on the grounds that the pastures of the members of the Collective were not contiguous. The unoccupied pastures deteriorated as the grass became overmature from lack of grazing (Grosser ed.).

In 1976, most of the Santo Domingo Valley ejidos did get credit for their Cattle Associations (Labato 1979). Loans were given for the purchase of stock at fifteen percent interest for fifteen years. The cattle herds of these ejidos were expanded rapidly, and the majority of the valley's ejidatarios became cattle producers.

The collective structures deteriorated within a few years in many ejidos and ejidatarios established independent operations with a share of the collective's cattle. The agencies had difficulty with repayment of the loans, and their involvement in many Collectives evaporated. In interviews in the region in 1981, the farmers accused the bank officials of corruption, The net effect of the collective credit schemes in the Santo domingo valley was the expansion of individual small-holder herds, and the transformation of the valley into a region of calf-rearing farms.

At Ejido Laconja, in the Laconja valley, INI directed the Laconja-Tseltal Project. The INI cattle project was quite ambitious, and included investment in facilites in addition to the purchase of stock. Four hundred heifers and eight bulls were purchased by the Laconja Cattlemen's Association with credit from INI in 1975. One hundred hectares of pasture were established in the first year, and another 100 in the second year. The plan was to market 144 male and 144 female calves each year (Grosser ed., p.80).29 INI aided in the construction of a corral, a dip tank, and scales for weighing market cattle. No specific details of the financial arrangements were available.

The Laconja scheme has not prospered. Interviews with government and bank officials in other parts of the Selva shed some light on the causes. The ejidatarios were not prepared to manage an operation on the scale that INI had set up. Inadequacies in management led to health problems that took a toll on the herd. The program's stocking rate of over 2.0 animals per hectare was probably too high, and may have caused nutritional problems. The collective organization did not work effectively, in part because INI failed to provide adequate assistance and training. The operation began to fail after a few years, and debt repayments were not made. Acts of violence were reportedly perpetrated againsts members of the Collective by unidentified men who also siezed the property of some ejidatarios. The colonists in the area are now extremely suspicious of officials and banks because they believe that the violence was ordered by INI or bank officials.

In 1981, the herd of the Laconja Collective numbered about 130 head. Most of the brood cows were old and in poor condition. Only two mature bulls were observed. The pastures of the Collective were in very poor condition. The dip tank had fallen into disuse, and the scales were broken. Most of the ejido's cattle owners kept separate herds. The Laconja scheme had clearly failed.

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29 There was no reference made to heifer raising.

In late 1981, a new collective credit scheme for cattle was undertaken by Banco Internacional30 in the Selva Lacandona. Initial organization had been completed in Ejidos Santo Domingo and Limonar by early 1982. This project is the most ambitious ever attempted in the region. In several ways, the Banco Internacional scheme was very different from previous projects. The bank planned to introduce a dual purpose dairy-beef breed in a fairly intensive and complex operation.

Some details were available for the Santo Domingo enterprise. A collective was organized with 58 ejidatarios and 836 hectares. Two technical assistants were provided by the bank for organizational management and training. The technicians are to work with the farmers for as long as three years. Credit of up to 15,000,000 pesos will be available to the Collective at 15.5 percent interest for 12 years. The stock and horses were to be purchased in May or June of 1982 in Tenosique and Balancan. The plan called for the aquisition of 600 bred heifers and cows, and 25 bulls. The operation will use a mix of Brown-Swiss and Zebu stock to implement a criss-cross breeding program. The objective was to maintain a herd of Brown Swiss-Zebu crosses that would provide both meat and milk on pasture and cut forage, without supplements.

The maintenence of a high quality dual purpose herd requires better management than an extensive grazing operation with Zebu or Criollo cattle. Banco Internacional was to assist in the construction of dip tanks, the establishment of good pastures of African Star grass, the implementation of rotations, the planting of dense stands of grass for cut fodder (for supplemental feeding), and with veterinary care. The bank representatives are also to be responsible for managing the breeding program, and for marketing the collective s production for the first few years.

The Banco Internacional project was to produce three products; beef, milk, and cheese. The basic production scheme appeared to be sound. Start-up costs were estimated at 14,000,000 pesos over three years. This included 1,135,000 pesos for labor, 11,000,000 pesos for stock, 480,000 pesos for fencing, 360,000 pesos for horses and 1,000,000 pesos for equipment and other expenses. The Collective's members paid themselves a wage of 150 pesos per day im 1982 for work on the project. The members were also to contribute 418 hectares of previously cleared pasture and 48 kilometers of fences, with a total value of 1,500,000 pesos.

The calculations made by Banco Internacional of the productivity of this system were based on a calving rate of 70 percent, and on the assumption that 80 percent of the cows will give milk. Each cow is expected to give 600 litres of milk per lactation, for a total yield of 750 liters per cow per year. The milk will either be sold locally (within the region) or processed into cheese. The operation will also produce cattle for sale. These will include steers, heifers not retained as replacements, and cull cows and bulls.

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30 The project was to be funded by the Banco Nacional de Mexico through FIRA, which was to guarantee 80 percent of the investment.

The income of the collective will gradually increase as the production of milk and cattle grows. In the seventh year income will stabilize, according to the plan, at more than 2,000,00031 pesos after operating costs and payments on interest and on the principal. This would yield an annual income of 45,000 pesos per member.

The labor requirements of the system (once established) were estimated at 14,000 man-days per year. This includes labor for pasture maintenance, herding, milking, cheese processing, and forage cutting. Each member of the Collective will be required to provide approximately 240 man days of labor per year. For the first four three years, labor will be required primarily for pasture establishment. Under the plan, the area in pasture will double, under the plan, in each of the first three years.

On paper, the project looked good for the ejidatarios, and for the bank. The members of the Collective would get a fair return for their labor by regional standards. The project offered them year round employment. The plan is also designed to pay a reasonable return to the bank. Over the twelve years of repayment, the bank will receive interest of over 16,000,000 pesos on an investment of 14,000,000. The plan proved however, to be overly optimistic in its expectations.

The Banco Internacional cattle collective at Santo Domingo was visited for a second time in June 1982. It was found that the program had not developed as planned. The technicians had organized the clearing and fencing of about 150 hectares of pasture, but no immediate expansion of pasture area was planned. The expected credit for the establishment of a dairy enterprise had not materialized. The bank had only provided sufficient credit to cover the cost of pasture establishment and the purchase of less than 100 cows and heifers. The dairy operation required much more capital. In order to insure the repayment of this credit, the technicians had been instructed to purchase steers with a small additional loan. The steers were to be fattened and sold for beef in 1983 as a short term project. The Santo Domingo collective had been reduced to an extensive operation that had come to resemble past government sponsored cattle credit schemes. Once again, credit was serving only to expand cattle production without improving productivity.

SUMMARY AND CONCLUSIONS

The cattle industry in the Selva Lacandona is an extension of a larger system that dominates much of lowland southeastern Mexico. Frontier areas, such as the Selva, serve the industry primarily as sources of cheap pasture and feeder cattle for fattening operations. The aggresiveness with which the cattle industry has expanded in the region attests to the profitability of cattle operations. The expansion of cattle production in the ejidal sector has, to a great extent, been made possible by the commercial cattle

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31 No account was taken of inflation or other price changes in the banks calculations.

industry. The existence of large commercial ranches provides ejidatarios with a market for their calves, and a source of foundation stock through share arrangements. The dominance of ranchers in the region has also had an influence on the social acceptability of ranching by colonists in the Selva. Commercial ranches in the region, and in other parts of the Southeast have often made cattle production the most lucrative alternative for small farmers.

In a short interval relative to other cash crops, cattle enterprises can be expanded to provide levels of income that are superior to almost all options available to the region's farmers. In Chapter V it was shown that in the early years of a settlers occupation of a holding, income from cropping is generally below 20,000 pesos per year. A cattle sideline operation can boost this to 25,000 to 30,000 pesos per year relatively easily. It was also shown that after ten years of farming, a family can earn about 35,000 pesos from cropping. A rapidly expanded cattle enterprise would surpass this figure by almost 20 percent in only eight years. Only after fifteen years or more can a farmer achieve an equivalent or higher income from cropping activities to that of a eight year old, rapidly expanded cattle enterprise.

Several types of systems were discussed in this chapter. These ranged from simple pasture rental operations and small ejidal cattle systems to large commercial ranches and collectives. Almost all of the existing cattle systems in the region are unacceptable, though each for its own reasons.

A commercial cattle ranch with 750 hectares of pasture and 600 head of cattle is unequitable, and its existence counters current national development policy. The ranch would provide six full-time workers with about 30,000 pesos per year, 25 part-time workers with 3,000 pesos per year, and a manager with an annual income of about 100,000 pesos. In addition, the purchase of 30 calves from small-holders would provide, perhaps, 30 families with about 6,000 pesos in income per year. One family, the owners, would receive an estimated one million pesos per year from the operation. The pasture land of such a ranch would provide a livelihood for many families if it were held as an ejido.

The SAM program calls for the increased production of food grains, and specifically for a reduction in meat production in areas where it is competing with crop production (Redclift). It has been demonstrated that the large commercial ranches generally control some of the best cropland in the Selva. The calf rearing enterprises that feed these ranches also have a deleterious effect on grain production, especially on the potential to produce grain in the region.

Small private ranches tend to be ecologically unsound. They are frequently too small for the use of sound pasture management and animal husbandry practices. The small ranches almost invariably overstock and eventually ruin their holdings. Poorly managed extensive systems are not sustainable and are a waste of the Selva's resources. The private ranches of sufficient size, and with land of adequate quality to support a sustainable operation can be criticized on the same grounds as the larger

ranches, although the inequality is not as gross. The negative effect on grain production may be as great as with the large ranches because the total area in smaller private ranches may be greater than to the total area held by large ranches.

The ejidal ranches are exploitative by nature. No ejidatario in the Selva Lacandona has a right to more than twenty hectares of land. Through pasture rentals, an ejidatario can control fifty or more hectares. Fellow ejidatarios provide pasture. These renters frequently overstock their pastures at rates of up to two animal per hectare. The life expectancy of an overgrazed pasture is only a few years, and a long fallow is required to make the land productive again. The long-run consequences of this process can be devastating for ejidatarios who rent their land to others, in terms of land degradation, and reduced potential to produce food or income. The ability of a few ejidatarios to build up large herds could also have profound implications for equality in the ejidos as income diferentials increase.

The most profound effects of the expansion of the cattle industry in the Selva have been in the small-holding ejidal sector. Farmers who operate cattle systems exclusively on their own holding are the most numerous in the region. These systems are generally poorly managed and cannot be sustained indefinitely. With the rapid expansion of pastures and herds ejidal holdings may be rendered economically useless in as little as ten to fifteen years of grazing. Less expansive systems may take up to 30 years to turn a holding into weeds and gullies. Only smaller operations that require a fraction of the holding to be in pasture at a time have a chance of being sustainable. It is clear, however, from observations in the older ejidos of the Northern Zone, that most farmers in the region will expand their cattle enterprises. The temptation to realize short term gains leads to the complete conversion of the holding to pasture. This process in the ejidal sector is not in the best interest of the farm-families, the region, or of the Mexican nation.

Collectives have been used by government agencies and by banks as a vehicle for increasing the productivity of cattle operations in the ejidal sector. The objective of these efforts has been to create operations on the scale of commercial ranches through the pooling of the resources of a group of farmers. These projects have suffered from many of the problems that have plagued small-holder development programs throughout Mexico. They have usually been paternalistic, heavily dependent on credit, technically and administratively complex, and administered erratically. The end result of cattle projects in the Selva has been the expansion of herds and pasture area, but there has been little increase in productivity. Better project management may solve some of these problems. If cattle development projects were able to develop sustainable and profitable systems, it may be beneficial for the ejidatarios. The promotion of such projects inevitably reduces the area available to crop production through the expansion of pastures. This makes cattle development schemes of questionable value in a national development perspective.

This chapter has demonstrated that strong incentives exist for small-holders to adopt extensive cattle production. It has also been shown

in this investigation that the expansion of extensive cattle production in the Selva Lacandona is counter-productive in the development of a viable regional economy, in the long run. In the final chapter, an alternative strategy will be presented for the improvement of the competitiveness of other production systems with cattle, and for reducing or eliminating the factors that have contributed to the expansion of the industry in the region.

Chapter VII

AN ALTERNATIVE DEVELOPMENT STRATEGY

The expansion of extensive cattle grazing in the Selva Lacandona has been identified as a major threat to the long-run viability of the region's agricultural economy. Halting the conversion of forest and cropland to pasture and reversing this trend should be at the core of a new strategy. Current economic (and to a lesser extent social) conditions in the Selva encourage farmers to begin and expand cattle operations. There are three suggested approaches to this problem: discouraging extensive cattle production; intensifying cattle operations; and most importantly, making other products more attractive to farmers. Farmers in the region are essentially rational in an economic sense; they will select those enterprises that they perceive as the most productive and reliable uses of their limited resources. If other enterprises offered better returns, they would be selected over cattle. A new strategy must be designed to make cropping and small livestock systems more attractive to farmers than extensive cattle production.

In this study, it has been demonstrated that farming systems have evolved, both historically, and among modern migrants in the Selva Lacandona, that are, in many respects, highly adapted to local conditions. The Maya and the Lacandone Indians developed farming practices that coped effectively with the difficult environmental conditions for agriculture of the Selva. Some modern migrants have adopted intricate cropping systems and diverse mixes of enterprises that are also well adapted to local conditions. Their farming systems typically include an intercropped milpa, a mixed plantation, a diverse home garden plot and small livestock. A wide variety of products guards against severe loss of income or failure to meet subsistence requirements, as a result of pests, weather or low prices. The new development strategy suggested in this study is designed to improve and promote these sound indigenous practices rather than replace them with crop improvement programs.

Through interviews with farmers, and field observations, problems in the individual sub-systems have been identified. Constraints on productivity and income exist in the production, storage and marketing phases of the farming systems. These obstacles stem from technical, economic, environmental, cultural and organizational problems. Solutions to specific problems with individual products and general problems in regional economic development are discussed in the following sections.

SPECIFIC RECOMMENDATIONS

Staple Crops

The farming systems of the Selva Lacandona include many sub-systems. The most important of these in the local economy are staple crops production systems. Maize and beans are the basis of the diet for the local population. The vast majority of farm families attempt to achieve self-sufficiency in these crops. In a national perspective, the improvement of productivity in maize and beans has been given a high priority. Maize yields in the Selva generally provide adequately for the needs of the colonists, and the region is a maize exporter. Yields are highly variable, however, and there is considerable room for improvement in the productivity of maize systems. Beans have been identified as a problem crop in the Selva Lacandona. Production is below the subsistence level because of a variety of agronomic problems. In bean production systems there is also room for improvement.

The staple cropping systems of the more experienced farmers in the Selva Lacandona employ inter-cropping and relay cropping practices. The most common crop association is maize, beans and squash. This intercrop apparently offers several agronomic benefits including enhancement of fertility, weed control, and a reduction of pest losses. Relay planting, the planting of several different crops in a succession on the same field, also has several advantages. This practice provides fresh food at intervals throughout the year, and maintains a plant cover on the ground, reducing the erosive effects of heavy rains. Relay planting also permits the farmer to accomplish several tasks simultaneously, thus saving labor. These practices are moderately effective, but much of the variability in yields cannot be controlled with these indigenous practices alone. Pests, diseases, and the vagaries of the climate take their toll on crop production. Innovations are need to assist farmers in overcoming these obstacles.

One of the main failings of the SARH/SAM program for staple crops in the Selva was that it attempted to impose a crop improvement package without adequate testing or site specific modification. Much more intensive study of existing systems is needed. A research program should be designed to evaluate the productivity of the various inter-crop practices, fallow strategies, and local maize and bean varieties. Experimentation is also needed on the responsiveness to fertilizer and pesticides of local and improved varieties, under local conditions. Varietal testing is needed in particular for beans. Emphasis should be placed on the testing of innovations in cropping that are low cost, and that are not heavily dependent on resources from outside of the region.

The possibility of incorporating some aspects of the highly adapted Lacandone farming system into the systems of the migrants deserves careful scrutiny. Although the Lacandone system is designed for subsistence, and is therefore inadequate for the apparent needs of the colonists, much of the agronomic and silvicultural knowledge of the Lacandones may prove useful. Some Lacandone practices that could help the migrants include correct soil selection for various crops, variety selection, intercrop

strategies, weeding, cropping sequences, and more effective use of the forest fallow for food production.

The land resources available to many colonists in the Selva Lacandona are severely limited under current practices. Much of the land in the region is seasonally inundated or steeply sloped. The improved use of some of this marginal land could serve to increase agricultural production. The Mayan civilization overcame the limitations of the landscape through the use of soil and water management practices. More experimentation is needed in the Selva Lacandona on the possible transferral of some of these ancient practices. Two of these Mayan farming techniques may have a place in the agriculture of migrants in the Selva; raised fields, and terraces.

Large expanses of low lying land are currently under-utilized in colonized areas of the Selva Lacandona. Much of this land is in or near settlements because the ejidos are generally located in valleys. The intensified use of these areas could benefit the colonists in several ways. The SARH/SAM program encountered difficulties with the promotion of input use because of the dispersion of milpa plots. Much of the cropping of ejidatarios is in the hills around the settlements, on the better-drained soils. Increased use of more accessible land could aid in the intensification of farming.

The soils of the valley floors in the Selva are relatively fertile because of the depth of the organic layer and the high silt content. When these soils are well drained they support a semi-permanent agriculture requiring only a brief fallow to reduce weed and insect pest problems. Raised field farming on these soils could produce a permanent or semi-permanent cropping system that might greatly contribute to increased food production. The creation of new cropland could be particularly beneficial for the many migrants who currently have no ejidal land rights, or in those ejidos that have too little cropland. Many of these ejidos are located in swampy areas.

There is considerable evidence that Mayan agriculture supported relatively high population densities in hilly areas through the use of terraces. It has been noted that one such terrace has been identified in the Selva. The farming of sloping land by migrants has resulted in widespread erosion. The feasibility of constructing terraces in the region should be examined. The construction of terraces and raised fields would probably require a great deal of labor. The Maya must have used vast numbers of workers for land and water management projects. Such projects in the Selva Lacandona today would require substantial government assistance. If these innovations were successful in elevating regional staples production, such an investment could be more cost effective than the current, very expensive crop improvement program.

The availability of maize and beans in the Selva Lacandona could be increased by as much as 20 percent through reductions in post-harvest losses. Innovations are need in the drying, shelling and storage phases of the region's farming systems. Improved drying and storage could also improve the quality of the grain, and thus its marketability. Another problem for farmers is the transportation of maize from milpas to the

farmstead. Many farmers store their harvest in field barns and haul maize only as it is needed. The field barns are typically infested by insects and rodents that destroy a substantial fraction of the harvest.

Marketing facilities for maize remain poorly developed in the Selva. About half of all maize marketings are still in the hands of coyotes who offer prices that are generally below the guaranteed and central market prices. CONASUPO purchases maize only at collection centers. Increases in the guaranteed price alone will have a limited impact on the supply of maize in the region. Roadside collection of harvests by CONASUPO could offer a strong incentive to the Selva's maize producers to increase output. Shelling services for small farmers could also be an effective device for encouraging the production of larger surpluses.

Cash Crops

As one alternative means of surpassing subsistence, migrants have established cash cropping systems. The improvement and promotion of these systems should be central to an agricultural development strategy for the Selva Lacandona. These crops could offer permanent production systems that would compete economically with extensive cattle production, and thus insure the long-run economic health of the region. The greatest advantages of cash cropping systems for the colonists are that they are intensive uses of the land, and yield relatively high returns per hectare. In the case of tree crops, the cropping systems are generally sound ecologically because they protect the soil with their cover.

Chile and coffee are the primary cash crops (after maize). Cacao, fruits, and minor milpa crops are currently less important economically. Chile has been an important cash crop in the Selva for about twenty years. Coffee is now being established as a major cash crop. Cacao is a recent introduction that has potential to expand rapidly in the near future. Fruit production is substantial, but of minor importance economically because of poor markets. Few established farms produce only one cash crop, and many have a mix of all or most of them. Many farms in the Selva are developing highly diversified mixes of cash crops. These systems range from coffee monocrops to plantations with coffee, cacao, fruit trees, and a variety of minor crops grown in association.

In this investigation, some superior small-holder plantation systems were identified. These systems use a sequence of crops over a period of years, and a variety of products in combination at all stages of production. The general pattern involves planting staple crops, bananas, plantains and papaya, initially. Fruit tree seedlings are planted among these crops in the first year. As the trees mature and form an open canopy, coffee and cacao are planted among them. The mature coffee and cacao can eventually be grown alone under a relatively full canopy of fruit trees, or in association with food crops under a more open canopy. There are several advantages for the small holder that such systems provide over coffee or cacao monocultures. The complex plantation system yields food and cash crops while the coffee and cacao plants mature. This could in

part overcome the problem of slow returns to plantation crops that reduces their competetiveness with cattle. It also provides a greater variety of products than cash crop monocultures. This offers the farmers some protection from market and yield fluctuations in individual crops.

As plantation crops become more common in the region, and as cacao and coffee plantings become older, pest and soil fertility problems are likely to emerge. Extension programs for small-holder plantations should be designed to deal with potential pest and nutrient problems. As the production of coffee and cacao increase in the Selva Lacandona, the establishment of efficient processing techniques for the region's small-holders will also become increasingly important. Few farms are equiped with sufficient fermentation and drying facilities. Marketing systems for these products are currently weak and will also need improvement to insure that plantation enterprises will be profitable.

A feature of many areas of recent colonization is the absence of local and regional markets. Trading patterns and systems develop gradually as a region becomes more thickly settled. In the Selva Lacandona today, there are essentially no local or regional market centers. The individual settlements are not strongly linked economically, and within the colonies there are no village markets. The lack of market centers reduces the possibility of locally initiated commercial activity. A program aimed at promoting the establishment of regional and local market centers would aid in improving income from cash crops. The organization of cooperative marketing organizations could facilitate marketing by small holders. Improved marketing opportunities would go a long way toward making plantation crops more attractive to farmers.

The wide variety of fruits that are grown in the Selva Lacandona offer a significant area for growth in income. The urban areas of the Gulf Coast could provide a market for the Selva's fruit production. Research is needed in the field of market development and, as with plantation crops, improved marketing organization is needed. A means of assembling the harvests of small producers and delivering them to market is essential to the development of a fruit industry in the Selva. Programs are also needed to assist farmers in pest control and other technical problems to improve the quality of produce.

Chile is an important crop in the Selva Lacandona, and the most purely commercial. Some chile production is relatively advanced, employing fertilizer and pesticides. Much of the production is, however, on small plots with little or no input use. Drying in these small operations is particularly primitive and labor intensive. The SARH has begun a project to construct modern drying facilities at Frontera Echeverria. The project has encountered many problems and is not yet complete. The design of this drier is relatively large scale and may not be readily transferable to smaller settlements. Attention should be given to the development of more effective drying methods and other assistance for small chile producers. It must be realized too, that the market for chile is erratic. Although chile can be a profitable crop, heavy dependence on income from chile may be dangerous for small-holders. There may be little room for further increases in chile production in the future.

Livestock

Small livestock play an important role in the subsistence and market economies of the colonists in the Selva Lacandona. Production, however, remains far below its potential. Increased production of poultry, hogs, and other animals would be economically and nutritionally beneficial for the population. There may also be some potential for the introduction of new livestock systems.

Chickens and turkeys are the most important farm animals among the migrants. They are almost universally kept. As universal are health problems in the flocks. Chickens and turkeys, and to a lesser extent geese and ducks, can be sold easily, and provide eggs and meat for the farm-family. The potential contribution of poultry to the farming systems has been far from realized because of frequent disease attacks that wipe out most of the birds. A project is needed for disease control in poultry and the upgrading of the quality of flocks.

Hogs have traditionally been produced in the Selva in large numbers, but production has been falling off for some time. Demand is apparently strong, and the price is acceptable to farmers. The problem with hog production appears to be primarily cultural. Farmers are generally unwilling to raise hogs in confinement. The formerly free roaming and foraging hogs are no longer permitted in most settlements. The resistance of farmers to production of hogs in pens may be due to several factors including the cost of enclosure construction, health problems associated with confinement, feed sources, and labor demands. Feed availability problems might be overcome through the promotion of the use of root crops and bananas that are relatively effortless to produce, and not highly marketable. A project should be undertaken to assist farmers in establishing and maintaining confined hog operations.

Small ruminants play almost no role in the farming systems of the migrants in the Selva Lacandona. Sheep are commonly kept by some of the ethnic groups of the migrants in their homelands, but the breeds employed in the highlands are used for their wool and are not well adapted to tropical conditions. Goats are kept on a very few farms in the Selva. A short-haired tropical sheep, often called the 'Tabasco' sheep, has begun to appear in the Northern Zone of the region in recent years. This sheep is popular on farms near Palenque and in Tabasco. 'Tabasco' sheep are raised for meat.

Small ruminants could fill a nitch in the farming systems of the migrants and provide meat and income for the farm-families. Most settlements in the region have several hectares of grass along the roadside, in the school yard, and between homesteads. This grass is currently cut by hand or occasionally grazed by horses. Small herds of Tabasco sheep or goats could be grazed on these grassy areas and use other forage sources. A program should be initiated in the ejidos.

Some other animal husbandry systems could have potential for improving diets and incomes in the ejidos of the region. Apiculture is an established and expanding industry in the northern half of the Selva. The

efforts of the apiculture co-operative should be encouraged and more closely integrated into a general development strategy. Another system with some promise is fish culture. Fish are an important protein source in the local diet. The establishment of fish ponds could be relatively easy in the well watered lands of the region.

Improving alternative production systems, including cash crops and small livestock, offers the best means of combating the expansion of the cattle expansion and of reducing the area in pasture. Some actions could also be taken to actively discourage the cattle industry in the region. A means of discouraging colonists from renting their pasture might be found, for example. Renting is a particularly unproductive use of a farmer°s land. Credit for the purchase of stock for the commencement or expansion of cattle operations could be limited or eliminated. Fiscal actions could be taken to reduce the attractiveness of cattle production. Taxes could be levied fairly easily on cattle in transit from the Selva because all transitable roads out of the region currently go through the town of Chancala. Administrative actions may, however, not work effectively as a result of several factors including the possibility of corruption.

Finally, existing cattle systems could be improved to lessen their negative impact on the land. Cattle enterprises in the Selva could be intensified and made more sustainable through the introduction of improved practices and stock. Programs should be aimed at improving pasture management practices, promoting the use of cut forages, improving animal husbandry practices, and establishing cooperative marketing systems. Cooperatives could also be established for sharing bulls among several farmers. This could aid in the upgrading of herds. Dual purpose dairy/beef operations may also be a viable, and more intensive alternative to extensive beef systems. Dairying could be promoted through breeding programs, and assistance to small holders in marketing milk and cheese.

Land Tenure and Employment

Land tenure problems have been an obstacle to the development of agriculture in the Selva Lacandona. It has been shown that farmers may be less inclined to make investments in longer maturing enterprises such as tree crops because they are unsure of their rights to land. Many families have also been expelled from their farmsteads in land tenure disputes. The pace of economic development could be hastened by a clarification of land rights and a streamlining of the dotacion process. Strict definition of land rights could also facilitate the protection of wilderness areas from unauthorized colonization.

Much of the impetus for cattle production among small-holders in the Selva Lacandona comes from the demand for calves for fattening on the region's commercial ranches. The status of the land tenure of large ranches has recently come into doubt. Agrarian reform could eliminate these ranches as a force in the cattle expansion, and provide more land for cropping.

Development efforts in the Selva Lacandona have completely ignored the issue of unemployment and under-employment. In this investigation it was found that an employment problem currently exists in the region, and that the lack of jobs will become an increasingly important problem in the future. Many of the migrants interviewed looked for work off farm. Most did not find sufficient employment during the year. The scarcity of wage labor jobs in the Selva is a particularly serious problem for families with little or no land. Some of these landless migrants are almost entirely dependent on wage laboring for a livelihood. Many look for work outside of the region. The majority of ejidos in the Selva Lacandona have little or no land in reserve for the children of the original migrants. In the future, there will be growing numbers of landless families as a result.

A reduction the importance of cattle production in the Selva Lacandona would eliminate an important source of off-farm employment on the ranches. This makes employment generation as an integral part of a development strategy additionally important. If cattle numbers and pasture area were reduced through the enhancement of cropping and small livestock systems, labor absorption on-farm would be improved.

There are several potential sources of off-farm employment in the Selva. The development of forest product industries could provide jobs. Small scale milling, furniture construction and paper manufacturing are industries that could be developed in conjunction with tree farming and reforestation projects. The SARH has made feasibility study for oil palm production in the region. Palm plantations and processing facilities might be particularly appropriate for Frontera Echeverria, where there is a concentration of population, low income levels, and potentially good conditions for palms. Fish production on a commercial scale could be a source of some jobs for colonists. Employment could be generated through land and water management projects such as raised field and terrace construction. Jobs might also be created in the commercial services sector in response to development of the region's agricultural systems.

An as yet untapped resource that has been acknowledged by the government is tourism (SFF). Small numbers of foreign and Mexican tourists visit the Selva each year. Most visit the Bonampak or Yaxitlan ruins by light plane, or occasionally by jeep. Groups of adventurers also raft the Ucumacinta river from time to time, and sportsmen hunt jaguar and wild boar in the interior. The natural beauty and archeological interest of the Selva could form the basis of a tourist industry that might generate jobs if properly developed.

Conservation

A final important issue in the Selva Lacandona is environmental conservation. The development process in the Selva Lacandona has inevitably meant the clearing of forest. Although the Mexican government has in principal moved to protect a large section of the forest from colonization through the establishment of the Biospheric Reserve (RIBMA), no specific action has been taken. It is widely believed that all of the virgin forest in the Selva will be gone within twenty years.

The destruction of tropical forests has been decribed as a global ecological crisis (Myers, Eckholm, Richards 1973). It has been estimated that the current rate of global tropical deforestation is 245,000 square kilometers per year (Myers, p.173). An area the size of Massachusetts is cleared each month. At this rate, all of the world's tropical forest could be gone within thirty years (Richards 1973, p.660). The three greatest causes of tropical deforestation are logging, shifting cultivation, and the expansion of pasture for extensive cattle grazing.

The danger lies in the fact that tropical moist forest are incapable of regenerating themselves under current land use systems throughout most of the Tropics (Gomez-Pompa, 1972). Succession leading to restoration of the climax forest is possible only if sufficient primary forest remains to stock the cleared areas (Richards 1973, p.660). The loss of all or most of the worlds tropical forests could have profound implications for global ecology. Deforestation may result in climatic change (Woodward), and depletion of the global gene pool (Myers, Richards 1973).

The environmental issues surrounding the colonization of the Selva Lacandona have generated considerable interest in Mexico and abroad. It is evident that the Mexican government will proceed with the colonization of the Riverine and Marquez de Comillas Zones in coming years. Only the Southeastern Zone has a chance of escaping colonization in the near future. It is likely that this new colonization will repeat the unproductive, and often destructive pattern that has been established. A moratorium on further colonization in the region should be declared until a viable development plan has been devised. Because a cessation of colonization is unlikely, environmentalists should concentrate their efforts on protecting the Biospheric Reserve. Any development plan for the Selva Lacandona should include the protection of the Reserve as an important goal.

CONCLUSIONS

An alternative development strategy for the Selva Lacandona has been presented that is based on enhancing the productivity of existing farming systems. Specific recommendations were made for improving staple crop, cash crop, and livestock systems, and for solving some general problems in the region s economic development. Several issues that merit additional research were also identified.

Current patterns of land settlement in the Selva Lacandona are generally unproductive and destructive. Without intervention, the dominant agricultural systems of the region will deplete agricultural resources and reduce the human carrying capacity of the land. Past and current government interventions have not offered viable alternatives. A new development strategy, elements of which have been presented here, is essential to the establishment of a productive agricultural economy.

Appendix A

THE COMUNIDAD LACANDONA

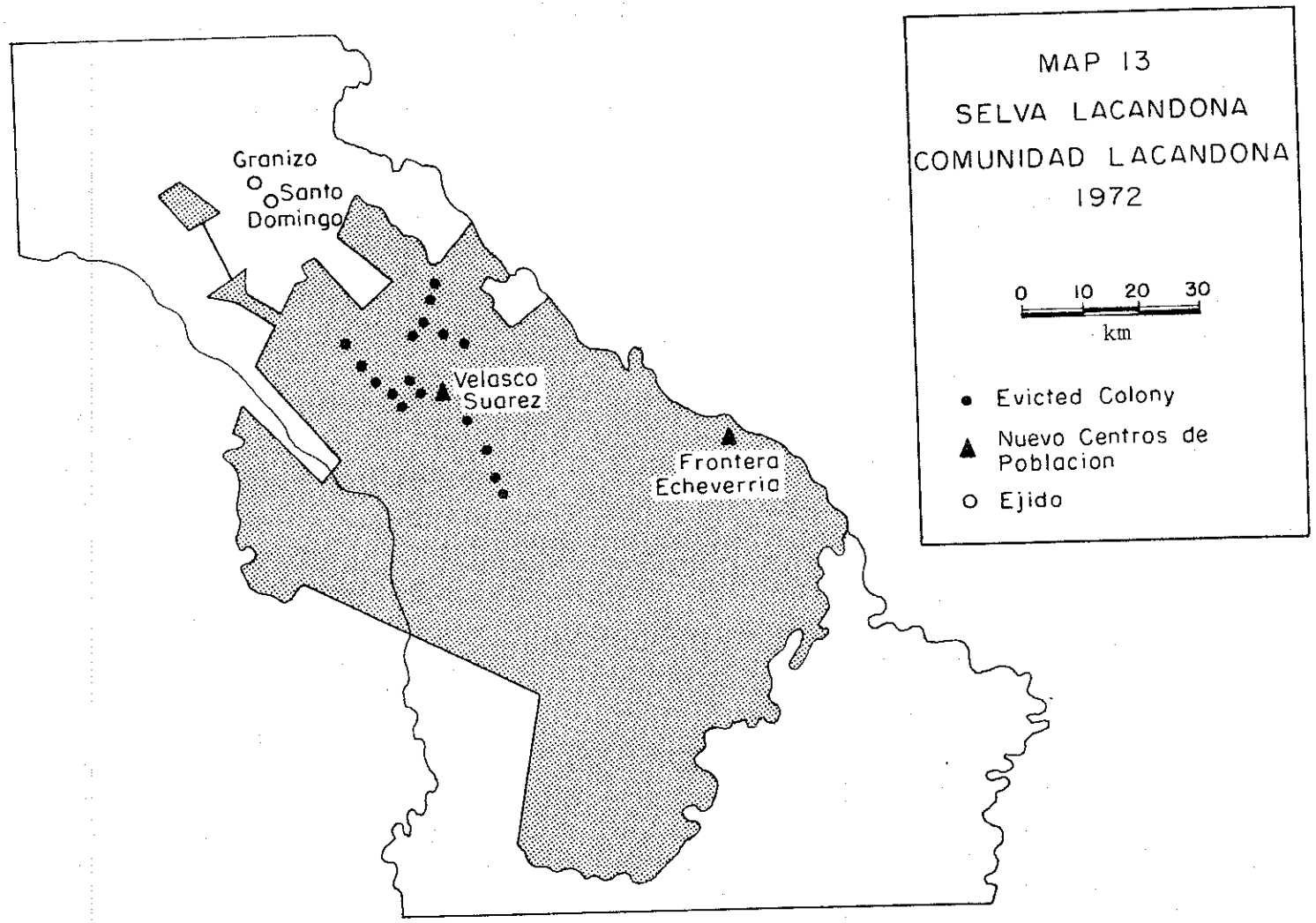
In the 1970s, the government became concerned with the course of the development process in the Selva Lacandona. Large areas of forest containing valuable timber were destroyed by independent colonists. In an effort to halt this waste, thousands of migrants were expelled from their farmsteads and resettled in concentrated settlements. An examination of the record of government involvement in the region's development is essential to this investigation for several reasons. The record reveals a great deal about the nature of the governments strategy for development in the region before the SAM. The resettlement projects undertaken in the 1970s offer another example of ill-conceived and poorly executed colonization schemes such as those of the Papaloapan Project and Uxpanapa.

GOVERNMENT INTERVENTION

In 1970, Dr. Manuel Velasco Suarez became the governor of Chiapas. He believed in strong federal and state control of the exploitation of Chiapas' resources. Velasco Suarez set out to create an integrated development plan for the Selva Lacandona and focused considerable personal attention on this effort (Labato 1979, p.89). Of particular concern to the Governor was the disorganized and wasteful nature of independent migration. The key issue was the burning of valuable timber through the controlled and sometimes uncontrolled fires used by the migrants for land clearing.

In a sweeping government intervention, the government established the 'Comunidad Lacandona'. Velasco Suarez declared twenty-three Chol and Tseltal communities illegal and ordered that they be moved into concentrated settlements. These twenty-three were recent colonies that had not yet gained official right to their land. The Governor held that the colonization of the region could more efficiently be achieved through large scale settlement projects. A law was also promulgated that forbade the cutting or burning of virgin forest within the 'Comunidad'. Map 13 shows the extent of the government controlled 'Comunidad'.

On March 6, 1972, 614,321 hectares were set aside as part of the 'Comunidad' by the federal government for the Lacandone Indians, who numbered approximately 350 people. This amounted to about 9000 hectares for each of the sixty-six Lacandone heads of household. The Lacandone Land Grant, as it came to be known, was a ruse on the part of the government to ensure its control over the timber resources of the Selva Lacandona. It would appear that the government was more eager to deal with a few illiterate Lacandones over the question of timber rights than with



Source: Rudolfo Labato 1979.

thousands of landless Chol and Tseltal migrants (Nations 1979, p.112). The plan seemed to have the full support of President Luis Echeverria Alvarez who visited the region in 1975 to give the Selva "back" to the Lacandones and the people of Chiapas (Labato 1979).

The pronouncement of the Lacandone Land Grant was expressed in terms of giving the Lacandones rights to their ancestral homeland that was being encroached upon by the Highlanders. Nations points out that this was exactly the opposite of the truth. The Lacandones were relative newcomers to the region, and the ancestors of the migrants had been the original inhabitants (Nations 1979).

In 1974, Aserraderos Bonampak came into conflict with Velasco Suarez and was forced to sell out to the Nacional Financiera. The other company that exploited the Selva's timber, Triplay de Palenque (located in Palenque and La Libertad) was also effectively nationalized. The government then proceeded to make thumb print contracts with the Lacandone leaders (appointed by the government) through the new Compania Forestal Lacandona (Cofolasa), and expelled the "illegal" colonists.

NUEVO CENTROS DE POBLACION

A total of 5000 Tseltal and Chol Indians were concentrated in two new population centers (nuevo centros de poblacion). The Choles were moved to a 20,000 hectare site on the banks of the Ucumacinta river (see Map 11) that was named Frontera Echeverria in honor of the President. The Tseltales were established in the central part of the Selva on a 25,000 hectare site named for Velasco Suarez. The settlements were established with little planning or knowledge of conditions at the sites. When these settlements were formed in 1976, there were insufficient funds for services because the Echeverria sexanio (six year term) was comming to an end. Mexican development schemes have often fallen victim to funding problems with a change of administration (Poleman 1964 1978, Scherr, Ewell and Poleman).

Frontera Echeverria, also known as Corozal, is located on a swampy plain that was completely isolated. Bulldozers cleared an area of forest and created a grid of muddy lanes that defined the settlement. Life was very hard in the first year at Corozal. Food was scarce. The land in the immediate vicinity of the settlement was too wet for maize production. Many settlers travelled up to forty kilometers to farm their old holdings. Food was also purchased from the Guatemalan settlements across the river. Other colonists relied on hunting, fishing and the gathering of xate for sale, to survive. There was no source of clean drinking water in the settlement, and many children died of diarrhea from the river water. The concentration of thousands of people in a single settlement caused other health and social problems. These people had a tradition of small village settlement and didn't adapt well to concentration (El Dia, 5 June, 1977).

The xate soon became over-exploited and ceased to provide much income for the colonists. The technical personnel pulled out at the end of the

sexanio in 1976 and the situation at Corozal became increasingly desperate. Colonists kidnapped Cofolasa personel and held them for ransom. They demanded help from the government. Nacional Financiera accepted responsibility for the colony in exchange for the safe conduct of the Cofolasa employees (Labato 1979, p.142).

In the spring of 1977, a road was constructed into Corozal and conditions improved. The government has since constructed schools and provides teachers. Some assistance is given with the transportation of xate to Tenosique, the purchasing of surpluses of maize through CONASUPO and with the provision of building materials. More recently, credit for collective cattle operations has been made available. Another government initiative at Corozal was the establishment of a fruit tree nursery through the Grijalva Commission. The nursery has produced thousands of seedlings of a wide variety of fruits. The colonists have only planted fruit tree gardens around their homes. There has been no development of commercial fruit production. The relative isolation of the colony from markets appears to be the principal problem.

Corozal now has a small but thriving port on the river that handles maize marketings from adjacent settlements in Guatemala and from the new settlements in the Marquez de Comillas. Manufactured goods are also shipped out in small quantities from the port. PEMEX (the national oil company) uses Corozal for offloading oil drilling equipment onto barges for transit to Pico de Oro in the Marquez de Comillas.

Conditions were still crude at Corozal in 1981. There was no source of clean drinking water, and the contaminated river water was still a major health problem. After more than six years, many of the colonists lacked permanent homes. Some of the lucky ones had block houses with corrugated roofs provided by the government. Many homes however still lacked materials for roofing, and some had not even the blocks. CONASUPO services were inadequate. A large stack of maize in CONASUPO bags remained in the colony for most of 1981 awaiting shipment with only a tarp for protection from the frequent downpours.

Since its founding, Corozal has been the scene of conflict between colonists and officials. Until recently, an army detachment was permanently stationed in the colony to maintain order. The colonists are greatly dissatisfied with the performance of the government in keeping promises. Many have returned to their municipos in the Highlands or moved to other areas. Those who remain, a total of 487 families in 1981, must travel ten to twenty kilometers to farm fields on higher ground to the West of the colony. The road to Corozal remains impassable in times of heavy rain.

Conditions at Velasco Suarez (also known as Palestina) were somewhat better. The settlement was located on higher ground and was connected from the start by a passable track to the trunk road. Sufficient farmland was available to the colonists nearby. Conditions in the first year were nonetheless difficult. Few services were provided. Many colonists continued to farm their old holdings. Because the settlers at Palestina were not transported as great a distance as those at Corozal, these holdings were generally within twenty kilometers (see Map 11).

The establishment of the colony followed the same general pattern as Corozal. Large areas were cleared mechanically and a muddy grid of lanes was established. The greater proximity of Palestina to the main road facilitated the provision of building materials. Most of the families had block homes with corrugated roofs in 1981. A stone church has been constructed in the Highland style in the colony. A water pump was installed at Palestina, but it has been almost perpetually broken. Water supply remains a serious problem.

That conditons were better at Palestina than at Corozal is evidenced by the fact that a far greater number of colonists has remained in the settlement. In 1981, there were 845 families at Palestina. Palestina has an irregular bus service to Penjamo. A clinic that is run by the Mexican National Social Security Institute (INMSS) is visited periodically by medical technicians. There are modern school buildings, and teachers provided by the government. The colonists subsist primarily on the slash-and-burn cropping of maize as in most of the region, but there is more production of cash crops than at Corozal. The government has also begun to provide credit for collective cattle operations recently.

Large numbers of migrants who were displaced by the Lacandone Land Grant refused to go to these Nuevo Centros de Poblacion. Some of them invaded national lands in the region illegally. Army detachment burned some illegal settlements in the late 1970s. Other migrants returned to the Highlands and organized under a Chol leader. 1830 families are currently requesting legitimization of their land claims. They protest that the Grant provided far more land than the Lacandones need and that the government simply sought to manipulate timber rights through the Lacandones. They refuse to go to the Nuevo Centros de Poblacion (Numero Uno, 11 July, 1981). Some migrants are now apparently being allowed to filter back into the 'Comunidad' area after logging is completed in some sections.

The Nuevo Centros de Poblacion, Velasco Suarez and Frontera Echeverria, were in many ways typical of some of the worst Mexican resettlement projects. Resettlement in these centers had adverse effects on the lives of the settlers. The colonists were hostile to their forced resettlement, a factor that contributed to failures in the Papaloapan Project, and at Uxpanapa (Poleman 1964 1978, Scherr, Ewell and Poleman). The conditions to which the colonists were subjected forced them to become highly dependent on government agencies. This has been a common feature of Mexican settlement schemes. Also typical was the inability or unwillingness of the government agencies to deliver services and adequate organization. The poor living conditions and slow economic growth of these colonies was the net result of government efforts.

The concentrated settlements also had an impact on the Selva's environment. Concentration of population led to the deforestation of large areas. Smaller settlements tend to result in a patchwork of forest and crops that is less disruptive of the environment. Around the Nuevo Centros de Poblacion vast areas were cleared both mechanically and by hand for settlement areas and for agriculture. The lack of sufficient seed stock limited the ability of second growth to regenerate. Long fallows will be

required for renewed cropping, and there has been much erosion due to a lack of forest cover. The longrun implications for food production in these government settlements may be grave. Directed settlement, as it has been conducted in the Selva Lacandona, has not offered a productive alternative to independent colonization.

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