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COFFEE: A BACKGROUND STUDY WITH PRIMARY EMPHASIS IN GUATEMALA

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Russell H. Brannon

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RUSSELL H. BRANNON
Research Fellow

THE LAND TENURE CENTER

College of Agriculture
University of Wisconsin

Madison, Wisconsin 53706
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INTRODUCTION

The following paper does not represent primary research, but rather a survey of some of the literature relating to coffee production in Latin America, with an emphasis on the Central American area. The purpose of the paper is to provide this student with background information concerning coffee production practices in Guatemala, for use in future field research there under the auspices of the Land Tenure Center program.

Although the proposed field research would be concerned with the economics of coffee production, it is my firm conviction that the undertaking of such a study is greatly facilitated if the researcher has a basic technical understanding of the production process of the crop under investigation prior to embarking upon the economic study. It has been observed that an ability to converse knowledgeably on the agronomic and horticultural aspects of the problem are often a good entree to other lines of inquiry.

For these reasons, this paper will reflect research aimed not only at gaining basic insights into some of the economics of the coffee industry, but also at building a foundation of technical information regarding coffee production and an understanding of the historical evolution of coffee into prominence as Guatemala's number one export crop.

-Russell H. Brannon, April 1964

I. THE MOVEMENT OF COFFEE

The history of the discovery and subsequent movement of the coffee plant throughout the world is indeed an interesting story, full of intrigue and mystery, but one upon whose main points most of the experts seem to agree.

The coffee plant has been used in Ethiopia throughout recorded history. Botanists are in general agreement that the plant is indigenous to the highlands of Abyssinia, Sudan, Guinea, and Mozambique. Although some few people have contended that coffee was indigenous to the Americas, Wellman says ". . . All botanical evidence carefully gathered from both hemispheres, shows that coffee did not come to American shores without the well-authenticated hand of man, and, at the earliest, in 1714" (10, p.30).*

The use of coffee spread from Ethiopia to Arabia, reaching there probably about the 13th century (though some authorities place the date as early as around 575 A.D. for its arrival in Yemen). From Arabia coffee spread outward from the port of Mocha, and even today the particular type of coffee from this area is referred to as "mocha" or "moca." Arab traders carried the use of coffee to Persia, Syria, and then to Cairo and Venice, from whence it went to Constantinople. The use of coffee was first introduced to Europe around the middle of the 17th century, and soon it became a favorite drink. Coffee houses sprang up throughout the world and became the meeting place of the intelligentsia of many nations. The first coffee house in England was started by a Lebanese in 1650, and a great import trade soon developed to support the growing coffee house trade. In 1688 an Englishman named Edward Lloyd started a coffee house in the Royal Exchange, where he also kept track of ship movements and other commercial information. His small coffee shop eventually developed into the now famous insurance firm of Lloyds of London.

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*Numbers in parentheses refer to the bibliography printed at the end of this report.

Up until about 1800, Africa was the world's only coffee producer of any significance. In 1713 the Dutch presented King Louise XIV of France with a single coffee tree as a royal gift in recognition of his part in bringing about the signing of the Treaty of Utrecht, which brought peaceful settlement to the disputes which had been plaguing the area for so many years.

This tree (Coffea arabica) was turned over to a young French professor with instructions from the king to study it, care for it and submit a report on his findings. This tree was housed in a greenhouse especially built for it, the first ever constructed in France. The tree did well under the care of Professor Antoine de Jussieu, and King Louis decreed that seeds from this original tree be introduced into the French holdings in the West Indies. The Dutch also carried coffee to Java, Sumatra, and other islands of the Malay Archipelago. Coffee was introduced into India about 1700 and to Ceylon soon afterward. Spanish missionaries took seeds to the Philippines from Java in 1740, and at about the same time the first coffee plant was grown in Brazil (1 and 3).

A well accepted version of the introduction of coffee to Brazil is that the first successful plantings were made from seeds obtained through the efforts of a young Brazilian envoy to French Guiana, Francisco de Melho Palheta, who charmed the wife of the French Governor of Guiana. Since the export of coffee seeds or trees was forbidden, she is said to have presented the young envoy with a large bouquet of flowers upon his departure, which contained gifts of both seeds and plants of coffee buried in the bouquet.

Coffee made its way to Cuba, Puerto Rico, Mexico and later to Central America, reaching Guatemala during the period 1750-1760. The first trees were planted in the open sun where they came into production earlier and bore more heavily, but didn't live very long. Later plantings were made under shade with better results. Today there is considerable controversy between the proponents of sun-grown versus shade-grown coffee. These aspects will be discussed in later sections.

Many authorities feel that almost all of the present production of Arabica coffee in the Americas is from seed produced from that single tree which King Louis XIV had grown in the greenhouse. This would account for the extreme homogeneity of the trees even now being produced.

There are today over fifty countries which produce some coffee, and it is estimated that 7 to 9 billion trees are under cultivation, with Brazil producing about 40% of total world coffee supplies. The American tropics provide an estimated 87-88% of total world supplies.

Some of the factors contributing to the emergence of Brazil as a primary world coffee producer, other than her natural endowments of favorable soils and climate, were the development of the beet sugar industry in Europe, following the Napoleonic Wars, which threatened Brazil's sugar industry. In addition, coffee production in Asia and Africa was seriously attacked by the destructive coffee fungus Hemiliea vasatrix; Brazil's cotton production industry was threatened by the emergence of the United States as a major cotton producer; and the mines at Minas Gerais were approaching exhaustion with the result that a large slave labor force was being released for other enterprises (63, p.4).

Today, in world commerce, coffee is ranked as number one among the "enjoyment goods", being more important than alcohol, tea or tobacco. It ranks among the top five most important agricultural commodities in international world trade along with cotton, wheat, sugar and wool. During the years 1953, 1954 and 1955, in the world export trade, green coffee was surpassed in importance only by petroleum products. As Wellman sums up the situation, coffee ". . . is of paramount significance as a world crop. It is of such consequence that it needs to be understood by the economists who deal with international relationships. It has serious political influence, both within countries and internationally" (10, pp.2-3).

II. AGRONOMIC ASPECTS OF COFFEE PRODUCTION

The Coffee Plant

Although the genus Coffea is made up of possibly a hundred species, relatively little work has been done in scientific botany on this plant because it grows in the wild state in dense jungle and is quite difficult to study. The most important species of cultivated coffees are C. arabica, C. canephora, C. liberica and C. excelsa, ranked in the order of their importance. Arabica and Canephora (often called Robusta) are far more important species than are the latter two. In the Americas, practically all of the coffee grown is of the Arabica type, with Robusta predominating in Asia and much of Africa. Therefore this paper will be primarily concerned with Arabica rather than with the other species, although they will be discussed to some extent for comparative purposes.

The Arabica is a heavy bearing plant producing very aromatic beans which generally command a higher price than do the other species, and has smaller leaves. A pound of Arabica coffee contains about 1200 dry seeds as compared to about 1600 dry seeds in a pound of Canephora and about 800 to the pound for Liberica (10, p.69. It should be noted that this is just an average estimate and will vary considerably. Wellman, himself, at another place in his book lists these weights as being 960 per pound for Arabica, 1000-1200 per pound for Canephora and 700 for Liberica.) It was estimated in 1957 by the Foreign Agricultural Service of the United States Department of Agriculture that world commercial production of coffee was over five billion pounds of dry coffee per year, and that over 80% of this total production was of the Arabica species.

In the Americas, the coffee produced in Brazil is usually known by the name of "Brazils" in world trade, whereas the coffee from Colombia and the Central American producers are called "milds." Historically, the "milds" or Colombian types, as they are sometimes called, have commanded a price advantage over the Brazilian grades. In recent weeks, however, the "Brazils" have climbed somewhat above the "milds" in futures trading on the New York Coffee and Sugar Exchange (32).

The elevation for good growth of Arabica is found to be about 2,000 to 5,000 feet. When properly pruned the trees are kept to a height of about five feet; if unpruned they will reach a height of 20-30 feet. Usually about 680 trees are planted to the acre.

Within the species Arabica there are many varieties, and in Guatemala the Typica variety is currently being replaced by the higher yielding Bourbon variety. The largest program of coffee breeding work on Arabica coffee has been carried out at Campinas in Brazil with the most important strains developed there belonging to the "Mundo Novo." The best strains of Bourbon out yield the Typica variety, which it has largely replaced, by as much as 2 and 1/2 times (14, p.160). About 50% of the coffee production in Guatemala is now estimated to be from the higher yielding Bourbon variety. The "Mundo Novo" selection appears genetically to be the result of a chance cross of Bourbon and Typica which was selected by an observant Brazilian coffe farmer. It is estimated that Brazil has replaced about 85% of her Typica production with the New Bourbon varieties and almost all new plantings in Costa Rica are of this variety (10, p.114-115). A good way to distinguish between the Typica and Bourbon is that Typica has a bronze coloration on its young tip leaves.

The Arabicas are largely self-pollinated, having a heavy pollen such that even under dry windy conditions it is estimated that there is less than 7-9% crossing. Under shade grown conditions the crossing is probably even much less than this. This is an important factor, in that homogeneous production results from reproduction by seed, whereas in the Canephoras, the plant is primarily self-sterile. Since the Arabicas are grown primarily from seed, a seed selection program is important to the maintenance of high yielding stands of trees.

Wrigley reports that "A survey of coffee in Ceylon in 1921 showed that practically half the crop came from 10% of the trees, and that 70% of the trees that were poor bearers contributed only 31% of the crop" (14, p.151). Although coffee can be propagaged vegetatively, this is not generally done. Research in this type of propagation

may hold.possibilities for the future.*

Although the Arabicas are preferred in the market place for taste and aroma, they are probably more difficult to grow than the other species. Robusta is much less susceptible to rust and pests, and it is also much easier to transplant without resultant root damage. The coffee plant flowers after the "blossom showers", with only the new wood of the tree producing blooms. For Arabica, the ratio of fruit to dry bean is about 5 to 1. When ripe, the cherries of Arabica tend to drop off, whereas in the case of both Canephora and Liberica, the ripe cherries remain on the tree.

The time required from flowering date to harvest is greatly affected by both altitude and temperature. In most of Central America, this time period may vary from about seven months at an altitude of 2,000 feet to eight or nine months at elevations of 4,500 feet or more. Most coffee in Guatemala grows at elevations of 2,950 to 3,300 feet, but it also grows from 980 feet up to 6,100 feet (59, p.14).

According to Wellman, the first crop is usually produced from Arabica coffee trees in the fourth year after the seed is planted (the third year the tree is in the field), and comes into full bearing from the sixth or seventh to the twelfth or fourteenth years, with production not dropping off appreciably until the twenty-fifth to thirtieth year. (See, however, 46, p.36. This study indicated that in Salvador and Colombia, as trees passed the age of 10-12 years, average production gradually decreased, thus increasing average production costs to the point where maintenance of the old plantings ceased to be economically feasible.)

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*While serving in Thailand with the AID Mission, I had an opportunity to visit the coffee work being carried out in South Vietnam under the direction of Mr. Dan Levandowsky, AID Tropical Horticulture Advisor, and was impressed with the possibilities of his experiments with cuttings and mist propagation. Where it is deemed desirable to be certain of establishing plantations from a single high producing tree, or group of trees, this method could be very effective, because it also speeds up the process from planting to harvest.

Soil Fertility and Fertilizers

The ideal coffee soil is generally considered to be one which is slightly acid, has a deep top soil high in humus, is well-drained and rich in nutrients. Much of the world's coffee is produced on volcanic soils, but the red lateritic soils are also good. Arabica coffee is probably more adaptable to different soil types than is Robusta.

Coffee removes from the soil more nitrogen (N) than any other major tropical crop; more phosphoric acid (P_2O_5) than any crops but sugar cane, oil palm and tobacco; and is exceeded in potash (K_2O) removal only by bananas and tobacco. Arabica coffee yielding 750 pounds per acre of dry beans removes annually from the soil 124 pounds of N, 28 pounds of P_2O_5 and 175 pounds of K_2O. Since Guatemala imported only 30,740 short tons of fertilizer in 1957 (59, p.11) and coffee production was 81,000 metric tons for the 1957/58 season (17, p.46), this would indicate that net loss of nutrients to coffee that year would have been very high even if all of the imported fertilizer had been used on coffee. (4, Actually, much of the imported fertilizer was probably applied to cotton, sugar cane, bananas, and other crops rather than to coffee.)

Perhaps the most important determinant in the production of Arabica in many cases is the adequacy of humus. In Guatemala, many of the coffee soils are of very recent volcanic origin and are composed of a white ash with only a thin layer of humus-containing dark soil. Under tropical conditions of high rainfall and high temperatures, the problem of maintaining organic content in the soils is particularly acute. With proper management in Guatemala, some plantation soils are known to have produced coffee continuously for over a hundred years and are still doing well, although in other areas of the country, repeated burning has so depleted the soil that it won't even support quality grasses now for grazing, much less coffee (10, p.175. Also 60, p.6).

In maintaining the level of organic matter in the soil, it has been repeatedly demonstrated that mulching will increase productivity of coffee. This increased productivity results from several factors such as increasing the nitrogen content in the soil, moisture holding capacity, reducing competition from weeds, etc. Although the use of chemical fertilizer alone will raise productivity considerably, as will mulching alone, the interaction response

of a combination of the two treatments raises production in most cases by a much greater percentage than the sum of the individual practices. As Wellman has noted, "Mulch acted as a mobilizer, almost as a synergistic (sic), in its effect on fertilizer absorption in coffee" (10, p.195).

It is also important to note that, in the application of commercial fertilizer, it is essential to maintain a proper balance between nitrogen and potash. Research has shown that indiscriminate application may actually result in reduced yields. There are also some indications from research in Central America that heavy applications of nitrogenous fertilizers may adversely affect the taste of the coffee.

Nutrient requirements are highest during the period when the coffee cherries are ripening. If insufficient plant food is available at this time (particularly N and K) "dieback" of the plant may become quite serious. In Central America, there does not appear to be a great deal of accurate information available on fertilizer use by farmers. The tendency seems to be to apply commercial fertilizers when coffee prices are high and to discontinue the practice when coffee prices drop. Therefore the cycles of fertilizer use by farmers are not long enough to really determine whether it is economic or not. A common observation in Latin America has been, however, that without the application of fertilizer, the Arabicas tend to have "off" and "on" years of high and low productivity, whereas with the maintenance of a proper nutritive balance, high yields can be continued year in and year out. There remains a great need for fertilizer research and particularly for research of the economic aspects of commercial fertilizer application.

Commercial fertilizer imports into Guatemala have been increasing over the past few years, though its use is still very limited. Imports as reported by Coyner from 1937-1957 were as follows: (59, p.11)

1937-1939 average	2,555	short tons
1952	9,222	" "
1953	8,743	
1954	11,248	
1955	12,566	
1956	18,751	
1957	30,740	

Climatic Requirements

Arabica coffee is fairly drought resistant, but it appears to produce best on about 75 inches of rainfall per year. Moisture requirements are greatly influenced, however, by temperature, cloud conditions, soil conditions, and cropping practices. The primary coffee-producing areas of Guatemala all receive adequate rainfall. Although all species of coffee need a warm moist climate, Arabica is more susceptible to extremes of climate than are Canephora or Liberica. It is most widely grown at elevations of 2,000-5,000 feet and in Guatemala nearly all of the coffee is grown between 1,000 and 5,000 feet.

The ideal temperature range for coffee is 65° F. to 75° F., or as close to 68° F. as possible (13, p.35). Coffee is particularly sensitive to frost; cold winds and frosts of only a few hours duration may have serious effects on the coffee production of an entire area. Present high prices for green coffee on the world market reflect the poor production prospects in Brazil this year resulting from last year's damaging frost and long drought period. In Guatemala and other Central American countries the combination of climatic conditions is especially favorable for coffee production in the altitude-determined zone called the "tierra templada" (4, p.664).

Diseases and Pests

Diseases. Since coffee yields are highly correlated with total leaf surface and the length of time that the leaves remain on the tree, those diseases which attack the leaves are considered to be the most serious. By far the world's most serious disease of coffee is coffee rust, Hemileia vasatrix, and the less common Hemileia coffeicola. Rust appears as orange colored pustules which form on the underside of the leaf, followed by lesions on the topside of the leaf and browning. The viable leaf surface area of the tree is seriously reduced and production falls off rapidly.

About 100 years ago Ceylon was the world's leading coffee producer, but within 20 years of the time that rust invaded the island, in about 1869, the Arabica coffee plantings were 90% destroyed. Rust is widespread in Africa,

Asia and Australasia, but thus far has not hit Latin America. In 1903 it was detected for a brief time in Puerto Rico, but quick control action was effective in eliminating it.

Since rust spores are windborne over long distances, there is considerable interest at this time in Latin America in research aimed at developing rust-resistant Arabicas. There is hope that resistant Arabicas may be found in the wild state in Ethiopia. Even when resistant strains are developed, the breeding and selection work must continue, because the rust organism itself appears to change and gradually becomes a serious problem on the formerly resistant strains.

The most serious disease of coffee in the Americas is the American leaf-spot, Mycena citricolor, which is caused by a fungus. This disease, usually called "ojo de gallo" or "gotera" in Latin America, occurs throughout twenty-two countries of the American tropics. This fungus does not produce "true spores," and the infection is not spread by the wind because the "spores" are too heavy. It is probably spread primarily by the splashing of rain drops, and on the hands and clothing of workers in the coffee fields.

New spots of infection with living mycelium inside produce luminescence sufficient to expose film and make a picture by its own light, if the film is exposed to it for several hours. Its damage is primarily through defoliation of the trees, and it has been serious enough that it has driven coffee out of some areas of Latin America. It is estimated that country-wide losses in Guatemala from this disease are about 20% per year, year in and year out (10, p.260). Thus far no resistant varieties have been developed and the only effective control is spraying with copper oxide sprays.

Black rot or "koleroga" is also a problem in Guatemala and other Latin American countries. This disease shows up as a silvery web on the underside of the leaf or green fruit and causes a rot or decaying of the tissues. It can also be controlled by the use of copper oxide sprays.

Pests. In a review of literature on insect pests of coffee carried out in 1956, there were forty-nine insect pests reported from the Central American region. This list has since been supplemented. Little insect damage was noted in the Americas prior to the introduction into Brazil from Africa in about 1924 of the berryborer, Stephanoderes coffeae.

This beetle lives only on coffee and does its damage by boring into the coffee cherry. So far, the berry borer, or "broca" as it is sometimes called, has not spread to the other countries of Latin America, although some parts of Brazil have suffered losses as high as 25-50%. The lesser coffee-bean borer, Araecerus fasciculatus, is found in Guatemala and the other Central American countries, but is considered to be only a minor storage pest in coffee, and of little consequence in the field. It is controlled in stored beans by fumigation and clean storage practices.

Coffee aphids are common in Central America and do some leaf damage, causing curling and stunting of young leaves. They may also be a factor in the spread of virus diseases; however, to date they have not proved serious enough to require special control practices.

The small branch borers have sometimes been quite serious in Central America in local outbreaks, causing damage primarily by boring small tunnels in the fruiting lateral branches and so weakening them that they break under the weight of the fruits. Control is cleanliness of plantations and selected pruning.

Severe losses are sometimes suffered in Central America from migratory locusts and from tree crickets. Damage is primarily to young leaves, tender wood and sometimes even the cherries. In recent years these crickets, Idiarthron subquadratum, have been quite serious in Guatemala, where they are known by the name of "chacuatete."

A good discussion of these and other insect pests such as [illegible] bugs, cutworms, leaf-cutter ants, leaf miners, fruit fl[illegible], etc. can be found in Wellman's book, pages 302-323.

Cultural Practices

Seed Selection and Care. Most of the coffee in Central America is grown from seed in carefully tended and well prepared seed-beds. Coffee seeds are rather sensitive and, unless they are properly cared for, tend to lose their germinating ability quickly. For storage, a moisture content of about 40-50% appears to be optimum and a temperature of about 50° F. In Java, work on coffee seed storage has shown that a practical method is to mix dry coffee seed with ground charcoal and store the bags above water in a cool room. In Thailand we had good results with shipping both coffee seeds

and avocado seeds in small bags of ground charcoal. Generally coffee seed should be planted not more than three months from the time of field collection for best results.

Planting. Arabica seed germinates most rapidly at a temperature of about 82° F., and if planted as dry seed with the parchment intact will take about 4-6 weeks for germination. In cooler soils it may take longer. If quick germination is desired, the process may be speeded up by removing the parchment and soaking the seed for 24 hours prior to planting in the shaded seed beds. Under these conditions, the seed can be expected to germinate in 4-5 days, and will emerge about one month later. The seedlings are usually transplanted from the seed bed to the nursery bed in the so-called "little soldier" stage of development, after the plant has emerged from the soil, but before the seed coat drops off or, alternatively, in the "butterfly stage" when the two cotyledons begin unfolding.

In Central America, these plants are commonly placed 8 to 10 inches apart in the shaded nursery bed in a diamond formation. Sufficient space is generally allowed so that a ball of earth can be taken with the seedling when it is removed from the nursery bed for transplanting to the field. Transplanting is timed to coincide with the rainy seasons and, when moved, the seedlings usually have six or eight pairs of leaves developed.

According to Coyner (59, p.2), in Guatemala, distinct wet and dry seasons prevail on both coasts but the east coast receives some rain every month, whereas the west coast may have short dry spells even during the rainy season. The amount of rainfall is affected by elevation, slope of the mountains, location, etc., but the rainy season begins in April in the lowlands and about a month later in the Central Highlands. Field transplanting is usually accomplished in June or July and the rains end in late October or early November.

Ukers states (7, p.136) that seedlings should not be transplanted to the permanent field until they have been in the nursery for eighteen months, or two years from the planting of the seed and indicates that this is the normal practice in Central America. Wellman, however, indicates that seedlings are usually transplanted to the field after one year in the nursery.

It has been found to be advantageous to dig the field holes a month or so prior to time of transplanting the seedlings from the nursery bed to the field in order to allow the soil to settle, time for some decay of nutritious debris to take place and for aeration. It is generally recommended that these holes should be fairly large, with the optimum size being determined by soil type. In the heavier soils the holes should be at least two feet broad, wide and deep, though in more friable soils the holes can be smaller. Often a layer of rich top soil is thrown into the bottom of each hole along with some plant debris.

Bare root transplanting of seedlings appears to be successful if seedlings are transplanted while young, when about six pairs of leaves have formed. In using this technique, the roots of the seedlings are kept moist in wet gunny bags while transporting from the nursery bed. If the seedlings are older, however, it appears to be better to take a ball of earth with each seedling. Some researchers have reported faster growth and greater production with ball-planted seedlings than with the bare root method in El Salvador.

Recent research in El Salvador has shown that an average of 94 man/hours of work are required per thousand plants in the seedbed and an additional average of 338 man/hours per thousand for nursery bed operations (65, p.117). In both the seed bed and the nursery bed it was found that soil preparation required most of the manpower.

There is no general agreement as to optimum distance between trees in the plantation. Different varieties require different spacings and an important determinant of the amount of spacing required is the lateral-root distribution of the individual tree. Arabica is often planted at the rate of 680 trees per acre, or a spacing of 8 by 8 feet, though some authorities feel that this is too close for optimum root development. Spacing recommendations must be developed through research on local conditions as well as on variety.

Mulching. Since humus content in the soil has been found to be so important to coffee culture, the methods by which organic matter may be returned to the soil have received considerable attention in the more scientifically oriented coffee producing areas. Green manures are sometimes grown among the coffee trees for the dual purpose of providing organic matter when cut and for the fixation of nitrogen in the soil. A problem, however, is that the main lateral roots of coffee and the fine feeding roots that

branch off from them are fairly shallow. As a consequence, the competition of weeds, grasses and even green manures for moisture and nutrients may seriously reduce coffee yields. Therefore, some researchers say it is best to mulch around the coffee trees with dead plant material and supplement this with commercial fertilizers. Wellman notes that the problem of mulching, though basic, ". . . is not much touched on in Latin America. It deserves serious attention there if coffee production is to be perpetuated as a profitable agricultural cornerstone in coming centuries in that large geographical area" (10,p.205).

In Africa and in parts of the orient coffee growers are coming to realize the importance of mulches. Many of the more progressive growers devote large areas of their land to the production of mulching materials. Although this recognition has not really come to Latin America as yet, in some of the areas of Central America where severe dry seasons occur, interest is beginning to develop. There is a need for scientific research on mulching practices from a cost and return standpoint.

Sun vs. Shade. Whether coffee should be grown under shade or in the open sun is not a question that is susceptible of simple solution. The determination of which practice to follow is dependent upon many variables such as rainfall, soil structure and fertility, ground cover, etc.

When Arabica is grown under open sun it tends to yield much more heavily in the first few years, but it also feeds much more heavily. Therefore, if the loss of soil nutrients is not replenished by heavy applications of fertilizer, the life of the tree may be greatly shortened and in the long run the shade grown trees may yield more coffee. On the other hand, under conditions where the soil moisture table is low, shade trees may furnish too much competition for the available moisture supply. This appears to be the case in some parts of Brazil where sun-grown coffee is the general practice.

In Guatemala shade-grown coffee is more usual. One of the preferred shade trees in this country is the leguminous silver oak, Grevillia robusta; trees of the genera Gliricidia and Inga are also important. One advantage of growing shade trees in conjunction with the coffee planting is that the trimmings provide an important source of fuel wood for kitchen fires in some of the Central American countries. It has also been observed that in cases where plantations are

not given a great deal of care, shade-grown coffee tends to suffer less than does sun-grown coffee from this neglect.

Cultivation. In Central America both Bermuda grass, Cynodon dactylon, and Grama grass, Paspalum fasciculatum, are serious pests in the coffee fields and offer competition for available nutrients and moisture. Various types of weeds also present a problem to the coffee grower. Although weeding practices vary from country to country and area to area, the ECLA/FAO survey found that in Guatemala new coffee fields are usually only weeded once or twice a year.

In recent years the use of herbicides to control weeds in coffee plantations is becoming more and more important on some of the more progressive coffee fincas of Guatemala. The most common method of weeding and cultivating, however, is with machetes and other hand tools such as work hoes.

Pruning. There are many different systems of coffee tree pruning throughout the world and although there is far from universal agreement as to the "best system", there is general agreement that some type of pruning is necessary for optimum results. Wellman lists ten different systems of pruning and discusses each in some detail (10, pp.233-241). It has been found that pruned plantations are more likely to produce good crops year in and year out without such fluctuation of very high yields alternating with very poor ones. Since coffee produces fruit only on new wood, it is important that the older wood be cut out periodically and the vitality of the tree concentrated in the most productively bearing branches. Pruning is also important from the standpoint of keeping the trees small enough to facilitate picking.

A pruning system that has long been practiced on coffee fincas in Guatemala is called the "agobio" (from the Spanish agobiar, to bend) or "Guatemalan" system. This system probably originated in Guatemala and from there spread throughout the coffee-producing world. The technique is based on the growth habit of Arabica (and Canephora) of sending up shoots from upright limbs that are bent over and secured in a bent position. In Guatemala, as soon as the seedlings are well established in the field, they are bent over and three or four shoots are allowed to develop from the base of the young tree. After these branches bear, they may in turn be bent over and the cycle started again,

cutting out the old wood as it becomes necessary to make room for the new shoots.

Pruning of coffee trees is one of the most exacting of all the tasks connected with the coffee plantation and is one of the most highly paid operations (65, p.119).

Yields and Harvesting

Yields. Average coffee yields in Guatemala are between 400-500 kilogram (kg) per hectare (ha), whereas Costa Rica averages 500-600 kg./ha., and El Salvador over 600 kg./ha (17, p.107 A hectare is approximately 2 1/2 acres and a kilogram approximately 2.2 lbs.). Colombian production averages about the same as Guatemalan, while Brazil only about 300-400 kg./ha. On the most efficiently run coffee farms yields of up to 2,000 kg./ha. have been recorded with yields of 1,000-1,500 kg /ha. reported as being fairly common. This indicates that there is considerable room for increasing the efficiency of production on Guatemalan coffee plantations.

Harvesting. Techniques of coffee harvest differ somewhat from country to country, varying all the way from beating the cherries off the trees with sticks as is sometimes practiced in Brazil to the truly selective system that is practiced in Guatemala, Costa Rica and Colombia. Under this latter system only the ripe cherries are picked and since they ripen irregularly, it may be necessary to go over the same tree at several different times in order to complete the harvest. Wellman's description of coffee harvest time, a portion of which is reproduced below, makes it appear to be a gala time indeed.

> The actual time of picking and collecting becomes a pleasant activity in coffee countries. The vigorous and industrious worker can make very profitable use of his time. Working in the open air, in the sun and shade, is as nearly idyllic as anything the peasantry ever experience. Everyone looks forward to it. It is something which all, not too indigent or too infantile, can join. The work can be

> hard or reasonably easy, depending on the person. Children, the old, and the weak are given preferential selection of the best trees to pick. In some places, such as in all nations of Central America, school vacations are regulated so that children may be available to help during the harvest season. In cities with streets that know beggars, the mendicants are often furnished transportation to nearby plantations, where they join in the harvest programme. Mothers bring the whole family, making an outing of it, with blankets, and mats in the shade for the youngest, and the grandparents gently picking or sorting near-by, to keep an eye on the toddlers and the littlest workers (10, p.363).

The selective method of picking as practiced in the Central American countries is said to result in a more uniform, higher quality product than that achieved by the other harvesting techniques, but it also requires a great deal more labor input. In Guatemala coffee is harvested generally during the period September through November at the lower elevations and February through April in the higher elevations (58).

III. PLANTATION COFFEE PROCESSING

The quality of the final product is greatly affected the techniques used in preparing the harvested coffee for market. Poor preparation can seriously decrease the market value of the product; after harvesting the cherries must be freed of sticks, stones, dirt and other extraneous matter. In addition it is necessary to squeeze the two beans from each of the fresh cherries and to clean off the slimy coating, sometimes called mucilage or pulp, which surrounds the parchment shell of the bean. There are two distinctly different methods of preparation in common use, the wet preparation and the dry preparation. Brazil uses primarily the dry method whereas Colombia and the Central American countries use the wet method (7, 13, 10).

Dry Method. When this method is used, the cherries are brought in from the field and spread out in the sun on drying areas which are often cement or brick slabs. As the sun and the wind dry the cherries, they are periodically turned to allow uniform drying. On the more progressive and better equipped plantations machine drying is practiced, thus reducing the drying time required from the usual 4-8 days to approximately 1-2 days. Where drying machines are not available several days of good weather are required and this is often a problem.

One advantage that is sometimes seen in the dry method is that it permits handling at the same time of cherries of different ripeness. This is an important consideration in Brazil where selective picking is not widely practiced. Another reason why the dry method is often used is that many areas lack an adequate supply of the clean water which is required in the wet method.

After the cherries have thoroughly dried, the husks are removed either by pounding them or with the use of a hulling machine. The dry method usually brings a lower price on the world market than does the wet method.

Wet Method. In Central America this method is more commonly used and the product is called "washed coffee." It is considered to be of a milder flavor and a generally superior grade product; however, consumers in some parts of

the world do express a preference for the stronger flavored coffees produced by the dry method.

The wet method requires a much higher capital investment in equipment and consequently the small growers must either take their produce to one of the larger operators for processing or employ the dry method. Plenty of clean water is required and the processing equipment is often located on a stream where water power is also available.

The first step in the process is the removal of the outer pulp of the cherries with a pulping machine, the freshly picked cherries having been floated from large receiving tanks directly into the machine. It is important that the cherries be pulped the same day they are picked, if possible, or the next day at the latest, to avoid premature heating and fermentation which would affect the quality of the coffee. The two main types of pulpers are the disk-type and the cylinder type. When using this technique it is important that no green cherries be mixed in with the harvest because the machine may not fully remove the pulp from them and thus adversely affect the quality of the entire batch. For this reason selective picking is quite important to the success of the wet method.

Next, the pulped cherries are put into fermentation tanks where the remaining mucilagenous material is removed through enzymatic and bacterial action. The fermentation stage is considered to be the most critical in determining what the flavor of the final product will be. If the process goes too long and the vinegar stage is reached, the color of the beans may be adversely affected and the market value lowered. The time required for the fermentation process may vary from about 24 hours to more than two days dependent upon prevailing temperatures in the fermentation vats.

When fermentation is complete there is a layer of light pulp floating on the surface which is removed by draining off the water from above. The beans are then washed thoroughly to remove any remaining gummy materials. This process usually takes place either in a separate washing tank or in mechanical washers.

The beans now have been cleaned of everything but a thin layer of parchment that surrounds them and they are ready for drying. This may be accomplished in the same manner as the dry method, by either spreading them in the sun or drying grounds or with the use of machine driers.

The final step, after drying, is the removal of the remaining parchment with the use of milling and polishing machines. This step may be carried out at the plantation, at the port of export or by the importing country after it arrives. Most of the coffee imported by the United States has already been polished.

A new method of removing the mucilagenous matter from the bean with the use of sodium hydroxide solutions is being tried in El Salvador. This technique makes it possible to complete the depulping and washing as a continuous operation (65, p.13).

Grading. After polishing, the beans are screened and sieved and the bad beans are picked out by hand and discarded. This is an important step because uniform grades bring a premium price on the world market. Often small producers are not equipped to do a good job of grading.

In addition to the physical grading of the product, when the coffee is to produce a certain prescribed quality and flavor, it is also taste tested by men who have made a career in this field. They become quite expert at differentiating among the many subtle differences in flavor and assigning to the lot of coffee the proper classification which is called a "chop" or "mark." The sacks of coffee beans are stamped with symbols denoting the chop or mark, and at this point the coffee is ready for export.

IV. SUPPLY AND DEMAND CONDITIONS AND PRICES

Supply

In the coffee season 1960/61, total world production was 3,856,400 metric tons, whereas total world exports of coffee in 1960 totaled only 2,592,000 metric tons (17, p.46 and p.56). Although a portion of the non-exported coffee is consumed by the producing countries, much of it represents over-production with no market outlet. In 1958/59 the exportable coffee output of Central America was 31% greater than the averages for the years 1950/51 to 1954/55, and exportable production in Brazil increased by 77% during the same period (46, p.34).

There has also been a shift in the positions of relative importance among the coffee producing nations in recent years, with Africa beginning to seize a larger and larger portion of the market. For several years the important producers have been Brazil, Colombia, Ethiopia, Mexico, El Salvador and Guatemala, ranked in decreasing order of importance. The following table, however, indicates the rapidly rising importance of Africa in competition with Latin America for the world market.

ANNUAL COFFEE PRODUCTION OF LEADING PRODUCERS -- LISTED IN ORDER OF IMPORTANCE DURING 1960-61 SEASON (THOUS. METRIC TONS)
(Adapted from data found in 17, p.46)

Country	1956/57	1957/58	1958/59	1959/60	1960/61
Brazil	979.3	1,409.3	1,695.8	2,646.0	1,800.0
Colombia	365.2	468.4	462.0	480.0	480.0
French West Africa	95.7	110.0	160.0	144.2	168.0
Uganda	62.1	79.2	84.3	103.7	120.0
Angola	81.0	77.1	81.0	100.0	120.0
Mexico	97.3	121.9	102.0	122.0	114.0
El Salvador	91.3	84.0	92.8	98.1	92.9
Guatemala	73.6	81.0	80.0	96.0	91.5
Indonesia	59.1	65.4	65.0	75.0	75.0
Costa Rica	33.8	45.6	51.4	51.3	70.3
Ethiopia	51.9	57.0	48.0	45.5	54.0

There are several primary factors which have contributed to the rapid rises in coffee production by the African nations (46, pp.34-35). Of considerable long-range importance has been Brazil's attempts over the years to support world coffee prices. By so doing, a protective umbrella was provided under which production in other areas could be profitably undertaken. In the pre-war period both Africa and other Latin American countries benefited and increased their shares of the world market. Presently all of the Latin American countries are cooperating jointly to support world coffee prices, but Brazil still has a major share of the burden.

There is a need to get African producers to cooperate, but actually they have been encouraging expanded production. These aspects of production control are discussed later in the paper. Another factor is that some European importing countries are giving preferential treatment to African producers through duty and tariff structures.

As the European Common Market develops, Europe may make more use of its own African and Asian sources. The ECM levy on coffee coming from outside the French zone of African producing countries was 9.6% in 1963. In addition West Germany and Italy have internal taxes equalling about

150% of the price of the green coffee. Also of importance are the lower wage levels which prevail in Africa and the higher yields of Robusta over Arabica which have aided in making African plantings profitable.

The increased use of soluble coffees in the United States and some other consuming nations has had an important effect, which is discussed in the section on demand. As the ECLA/FAO Report says, "The increased competition by non-Latin American producing regions has therefore become an important and permanent feature of the world coffee market. In the difficult period ahead this competition is almost certain to become still stronger" (46). The same report notes that judging from current trends, for the next several years, Latin America can expect its surplus to be at least one third of total output (46, p.39).

Demand

Although world coffee acreages between 1946-60 almost doubled, consumption was unable to approach this phenomenal increase. World coffee production increased 29% in the 1957/58 season over the 1956/57 season and 15% in the 1958/59 season over the 1956/57 season; at the same time world consumption increased only by about 2% per year (46, p.32).

The demand for coffee is usually considered to be quite inelastic, especially for high and medium prices. One study indicated that the demand curve is an almost vertical line at high prices with an elasticity of -0.08, whereas at one point in the lower range it is -0.5 (49). Wellman notes that the U.S. housewife starts to reduce purchases of coffee when its price rises above $1.00 per pound and says that ". . . there is something psychological about that figure" (10, p.419). Compuzano has observed that in the midsummer of 1954 roasted coffee was selling at $1.40 per pound and consumer demand was so affected that the marketing trade reported sales decreased by 10-12%. 2, p.155.) According to ECLA findings, the price elasticity of demand for coffee depends primarily on per capita income levels as well as the price level itself and the average price elasticity of demand is estimated to be about -0.2. They note further that if this coefficient could be used:

> . . the difference between actual world imports in 1957 and the world exportable crop in 1958/59, some 13.5 million bags, would have been absorbed by an uncontrolled market only at prices between 10 and 15 cents a pound in New York, if average price elasticity were to remain at -0.2 over such a wide range of prices (46, pp.32-33).

According to the Waterman study, however, we could expect the demand to be more elastic than -0.2 at these extremely low price levels. Research carried out by the FAO shows that demand is more price elastic in the less wealthy nations for which a range of -0.4 to -0.6 was found (for Italy and Greece). Income elasticity seems to fall off rather rapidly as per capita income rises. In running regression analyses of per capita coffee consumption on price and income elasticities for ten selected countries, a high correlation (R^2 of 0.7 or more) was found for five of the countries in this same study. (Coefficients of determination of 0.922 for Canada, 0.885 for Finland, 0.824 for the U.S., 0.815 for Germany and 0.759 for Italy were found. 17, pp.31-32).

The United States is by far the world's largest market for coffee, importing each year about half of all the coffee entering world trade. Imports by the U.S. from Africa have greatly increased with the growth of the soluble coffee industry ("instant coffee") which makes extensive use of the cheaper Robusta coffees that are produced there. During the period 1955-59 U.S. imports of African coffee increased by more than 70% while imports of Latin American "milds" were increasing only by 5% (63, p.16). The U.S. Federal Trade Commission in 1954 reported that instant coffee consumption increased from 30 million dollars in 1946 to two hundred million dollars in 1953, and "instant" cups, which made up only one out of every sixteen cups drunk in the United States in 1946, had jumped to one out of every four by 1954 (10, p.426). Research has shown, furthermore, that it takes only 0.014 of a pound of green coffee to make an average 5 fluid ounce cup of drinking coffee from instant, whereas it requires 0.027 of a pound of green coffee per average 5 ounce cup of coffee prepared from roasted beans (10, p.427). This is an excellent example of the adverse effects that improvements in technology may have on certain producing regions. The sharp increases in the use of soluble coffee in the U.S. appear to be leveling off, however, in recent years. The Pan American Coffee Bureau lists the following

statistics in terms of thousands of sixty kilo bags of green coffee used for soluble coffee in the U.S. from 1954 to 1962 (64, p.25).

GREEN COFFEE CONSUMED AS INSTANT COFFEE IN THE UNITED STATES
(Thousands of 60 kilogram bags)

Year	Estimated Consumption of Soluble Coffee	% Increase in Consumption over Preceding Year
1954	2,003	
1955	2,235	11.6%
1956	3,021	35.2%
1957	3,205	6.1%
1958	3,433	7.1%
1959	3,673	6.9%
1960	3.827	4.2%
1961	3.841	0.4%
1962	3.879	1.0%

U.S. import statistics over the past few years also provide an indication of the increasing importance of the Robustas in the U.S. coffee trade.

UNITED STATES COFFEE IMPORTS BY ORIGIN - 1950/52 to 1959
(Thousand metric tons) (Adapted from data found in 17, p.64)

Country of Origin	1950-1952	1955-1957	1955	1956	1957	1958	1959
Brazil	612.2	529.8	462.1	594.0	533.3	447.2	633.6
Colombia	255.0	272.7	296.0	273.4	248.8	254.7	294.1
Mexico	44.9	69.7	72.2	62.5	74.4	72.1	65.2
Guatemala	49.6	49.2	49.0	48.9	49.8	52.9	59.3
Belgian Congo	11.9	25.7	23.0	23.4	30.6	30.8	48.8
Portugese Africa	21.8	43.5	33.8	47.6	49.1	42.8	45.2
British East Africa	12.9	35.3	32.3	27.6	46.0	46.0	43.9
El Salvador	58.9	42.7	51.3	36.2	40.6	43.4	37.2
French Africa	1.5	26.2	16.5	31.3	30.8	28.1	23.3

From looking at the above data, it does not appear that U.S. imports from Latin America have been reduced, even though imports from Africa have increased substantially. The major coffee importing countries ranked in order of importance on the basis of imports in 1959 are: 1) The United States; 2) France; 3) Germany; 4) Italy; 5) Sweden; 6) Canada; 7) Belgium; 8) The United Kingdom; 9) The Netherlands; 10) Switzerland; 11) Spain; 12) Portugal (17, pp. 59-64).

The ECLA survey people feel that if the overproduction of coffee and the underproduction of food in Latin America continues, there will be a gradual shift in the relative price structures in favor of food production, which may ultimately have some effect on resource allocation (46, pp. 41-42). Indications are that some of the marginal coffee areas in Brazil have already been shifted to the pasturing of dairy cattle and the production of other crops. However, in Central America there have been few such shifts. Transportation, handling and processing of other crops are at a cost disadvantage compared to coffee, which has a high value per unit weight and is relatively unperishable. The lack of experience or knowledge of commercial agriculture with crops other than coffee also presents a problem in much of Central America.

Since coffee requires a labor-intensive type of culture, small units can compete on a more favorable basis than they might in some other types of agriculture, such as sugar cane planting. The ECLA Report has pointed out the fact that with high coffee prices, internal markets in the coffee producing countries have developed rapidly with great increases in demand for all food and agricultural commodities and noted that, "Many of these could be produced in areas now mainly specialized in coffee growing" (46, p.39).

A question arises, however, as to whether these coffee lands are, in general, adapted to the growing of food crops. In this respect, Professor Parsons has made the observation that:

> . . . the process of adjustment or accomodation, between coffee and a modernized food economy would be chiefly through labor-use, rather than land-use. Coffee growing is limited to areas with peculiarly adapted soil, climate and altitude. The best coffee land is pre-eminently suited for coffee growing, and food crops would not appear to be near competitors -- in a truly economic sense.*

This is an area of investigation that should prove to be quite important to the Central American countries in the coming years as a policy issue.

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* Kenneth H. Parsons, "Tenure and Labor Aspects of Agricultural Development in Central American Economic Integration: A Comment on Research in Relation to Policy," CEPAL, Mexico City, 1961 (mimeographed for classroom use at the University of Wisconsin by the Land Tenure Center, November 1963), p.19.

Prices

Historically, coffee prices seem to follow a "boom and bust" cycle which takes about seven years. With high prices, there are increased plantings, more use of fertilizer and more intensive culture of coffee with resultant overproduction and a decrease in prices. This in turn brings about a cutback in production and later rising prices as a result of reduced supply. Thus, the cycle starts again. Because of the lag time between new plantings and their reaching bearing age, the length of this cycle has proved fairly predictable (3, pp.209-211). Non-cyclical disturbances are also quite important in their effect on world coffee prices. The Coffee Bureau, in commenting on the high prices in 1954, stated that:

> . . . it was in that year that spot prices reached all-time highs following the frost in Brazil in the summer of 1953 and consequent severe damage to a large portion of the coffee trees in that country. Reflecting the prospective reduction of world coffee availabilities, prices of all coffees rose in the latter part of 1953 and in the first months of 1954 (64, p.8).

In discussing the same situation, Wellman has reported that the high prices in early 1954 were more the result of unreliable market information regarding the frost in Brazil in July 1953 and that actually the frost had had little effect on coffee production. Although the world price rose from 58 cents a pound to 96.5 cents a pound for green coffee, there were millions of bags of surplus in storage anyway. He feels that the basic problem was the lack of accurate knowledge of the supply and demand situation and emphasizes that coffee does not operate in a truly competitive world market (10, p.420).

In 1954 average annual spot prices for green coffee in New York were close to 80 cents per pound for Latin American produced coffees. Since that time they have fallen greatly, as is evident from the following table.

AVERAGE ANNUAL SPOT PRICES 1958-62; NEW YORK
(Cents per pound, adapted from data in 64, p.9).

Country	1958	1959	1960	1961	1962
Brazil	48.41	36 [illegible]	36.60	36.01	33.96
Colombia	52.34	45.[illegible]	44.89	43.62	40.77
El Salvador	50.17	42.47	41.54	37.93	35.86
Guatemala	49.81	42.62	41.33	37.55	35.83
Mexico	49.93	42.89	41.61	37.53	35.87

This data indicates that the Central American countries and Mexico all receive about the same price for their coffee, whereas Colombian coffee brings a higher price and Brazilian coffee a lower price on the average. The Robustas from Africa in past years have brought a considerably lower price than have the Latin American Arabicas. For example in 1962 African Robustas were bringing only about 21 cents a pound on the average.

In recent months, coffee prices have again risen sharply and interestingly enough, Brazilian coffee at the present time is slightly higher priced than are the "milds" of Colombia and the Central American countries. According to the Wall Street Journal coffee prices are now the highest they have been since May of 1958, with Brazilian grades selling at about 50 cents per pound and Colombian types at about 49.5 cents per pound (32). This rise in prices of green coffee in turn has brought about a rise in prices of the vacuum-packed coffee used by consumers (52 and 53). General Foods (Maxwell House) raised wholesale coffee prices by 4 cents a pound on March 3, making the third four-cent-a-pound increase so far in 1964. The other increases were made on January 7th and January 17th. Chase and Sanborn and Chock Full O'Nuts followed this lead and have also raised their prices.

At the present time a U.S. coffee expert is in Brazil making an on-site inspection of Brazil's coffee crop to determine the effects of adverse weather on that country's crop. It is anticipated that there will be about a twenty per cent reduction in production, making the second lower-than-average harvest in a row for Brazil. This, of course, has been the basis of the recent sharp rise in coffee prices (45).

U.S. government specialists have announced, however, that there is plenty of coffee available; in fact, last September world coffee carry-over stocks were tallied at 68 million bags. If these rising coffee prices stimulate increased plantings as has occurred in the past, we can anticipate an even more serious surplus problem in the next few years. Also of considerable importance is the fact that high coffee prices in recent years have caused considerable substitution of tea for coffee in the United States and some small tea plantations are being expanded in Guatemala, Peru and Argentina (10, p.426).

V. PRODUCTION CONTROL

Valorization Schemes

Coffee production has been under various systems of artificial control for a longer period of time than any other commodity of world importance. The first proposal for the regulation of the production and marketing of coffee was made in 1898 by J.A. Olavarria, a Venezuelan (63, p.5).

As early as 1902 the state of São Paulo, Brazil, prohibited coffee planting for several years. The first valorization schemes were simply price support programs in which the state government would purchase coffee on the world market and store it for later resale. The program was handled primarily by the state of São Paulo with financial assistance from foreign loans and from the Brazilian federal government. Some of the early success of the valorization schemes was due to circumstances other than the government activity alone. For example, in the second "crisis" in Brazil toward the end of the first World War, São Paulo purchased three million bags of excess market coffee and stored it. Subsequently, because of adverse weather, the harvests in 1918 and 1919 were quite small; the war ended and coffee prices went up. São Paulo was then able to sell its stored coffee at a good profit (10, pp.420-423).

In later years, however, the valorization schemes did not prove so successful and overproduction began to present a serious problem. Large quantities of coffee were purchased for destruction by burning or dumping into the sea in efforts to maintain the price. It has been estimated that between the years 1931-1944 more than 78 million bags of coffee were destroyed (63, p.8). Through the years the Brazilian Congress has created numerous agencies to address the overproduction problem, among them the Coffee Institute, the Institute for the Permanent Defence of Coffee, the Conselho Nacional do Café (CNC) and the Departamento Nacional do Café (DNC).

International Agreements

On October of 1936 the first Pan-American Coffee Conference was held in Colombia for the purpose of bringing together the coffee producing nations of Latin America to discuss what action might be taken in regard to falling coffee prices. Up to this time Brazil had unilaterally borne the burden of attempting to support prices through her valorization schemes. Although many proposals were discussed, no agreements were reached.

Subsequent conferences were held in Cuba in August of 1937 and in New York in June of 1940, but again no action was taken. The First Meeting of Foreign Ministers of the American Republics in 1939 had set up the Inter-American Financial and Advisory Committee which in turn appointed a subcommittee on coffee to see what action might be effected through cooperative effort. The negotiations of this subcommittee culminated in the signing by fourteen producing nations and the United States of the Inter-American Coffee Agreement on November 28, 1940. This agreement was ratified and became effective on April 15, 1941.

Under this agreement quotas were established for each of the producing countries that participated and the U.S. agreed to limit imports from non-participating countries to 355,000 bags a year. The Inter-American Coffee Board administered the agreement and was empowered to adjust quotas. Voting power on the Board was set at 12 votes for the U.S., 9 for Brazil, 3 for Colombia and one each for the remaining 12 countries (66, pp.20-22).

With U.S. involvement in World War II and the cutoff of European markets, revisions in quotas were necessary. In 1945 all quotas were abandoned and the entire agreement was terminated on September 30, 1948. At this time the Inter-American Coffee Commission was formed under the Inter-American Economic and Social Council of the Organization of American States. This group proposed, in March of 1957, the formation of a World Coffee Council to address the problem.

In October, 1957, Brazil, Colombia, Costa Rica, El Salvador, Guatemala, Mexico and Nicaragua concluded the "Mexico Agreement" to try to regulate exports for a year by holding back part of their crops. In early 1958 the International Coffee Organization was established with

headquarters in Brazil for the purpose of stimulating world trade and consumption of coffee and to improve production conditions. In June 1958 an International Coffee Study Group was established in Washington, D.C. and the Latin American producers within this group reached an export retention agreement for the period October 1958 to September 1959 (46, p.32).

The International Coffee Agreement signed in 1959 set up export quotas for each country, these quotas to apply to sales of green coffee in established markets but excluding sales of soluble coffee and sales to new markets. The agreement, which expired in 1960, was extended to 1961 and again to September of 1962 (63, p.11). This short-term agreement was subsequently extended through March 31, 1963, and then for an additional six months or until the long-term International Coffee Agreement approved by the International Coffee Conference of 1962 came into force.

To become effective the long-term Agreement required ratification by twenty coffee-exporting countries representing at least 80% of 1961 foreign shipments and by ten importing countries representing at least 80% of the coffee imports for the same year. The Agreement, negotiated under the auspices of the United Nations in 1962, is to cover a five-year period lasting until October 1, 1967.

On October 22, 1963, the United States House Ways and Means Committee approved the bill to implement the agreement. The bill, as approved, would limit U.S. contributions to the cost of administering the agreement to 20% of the total (34). The House subsequently passed the bill and on December 27th, 1963, the United States registered with the United Nations their ratification of the Agreement, thus bringing the Agreement into full force (36). The Senate still must approve the Agreement even though the U.S. has announced ratification.

The Agreement is based upon a system of export quotas for each of the participating producer nations. The International Coffee Council is responsible for adjusting these quotas and exacting penalties for non-compliance with them. To assist in the administration of the Agreement "certificates of origin" must accompany all shipments of coffee by members of the Agreement which certify that the coffee was produced or processed in a specified country. The Coffee Council can then check these "certificates of origin" for compliance with the established quotas. The importing member countries agree to prohibit the import of any coffee from a member

country that is not accompanied by a certificate.

On March 5, 1964, the Senate Finance Committee approved the bill authorizing U.S. participation in the International Agreement. It approved an amendment, however, that provides that if Congress

> . . . passes a concurrent resolution, finding that there has been an unwarranted increase in domestic coffee prices attributable to the operation of the Agreement, the President would forward the resolution to the Coffee Council . . . and if the President finds the Council has not taken 'necessary remedial action' within 30 days after receiving the resolution, he is required to post notice of the withdrawal of the United States from the agreement (43).

As a result of current high prices of coffee there has been building in the U.S. some opposition to the Agreement coming primarily from coffee importers and roasters. At the time of this writing, the bill has not yet come before the full Senate for a vote and Senator Hubert Humphrey has announced that it will not come up before the Civil Rights Bill. Some supporters of the bill would probably just as soon not have it come up right at this time of rising coffee prices anyway (43).

The International Coffee Council has already raised the previously set quotas for export in an effort to offset the rising coffee prices. On February 13, 1964, the Council increased export quotas by 2.3 million bags (of 132 pounds each). This constitutes an increase of 5% in the quotas. Seven producing countries were granted increases in their export quotas under this decision. They are: Guatemala; Honduras; the Malagasy Republic and the Organization of French African Producers; Peru; Portugal; Trinidad and Tobago; and Uganda (25).

As pointed out by the ECLA group there will probably be difficulties within the individual countries of Latin America in carrying out the necessary production control practices. They have noted that there is little prospect that individual producers will reduce their plantings in response to price by anywhere near the necessary magnitude. If a government program were instituted to take lands out of coffee production, presumably it would concentrate on the marginal farms. If so, it is estimated that an effective

program which would achieve equilibrium between supply and demand and stabilize prices would require the elimination of over half of all the present Latin American coffee plantings, and would affect millions of people (46, p.39).

It will be interesting to see what form the administrative machinery for limiting production will take in the various producing countries. Acreage allotments would probably bring the same results as they have in the United States, i.e. more intensive culture of the better lands and continued chronic overproduction. This problem might provide an interesting one for field research in Latin America.

VI. PRODUCTION EFFICIENCY AND LABOR

Inefficient Production Techniques

Although low productivity is considered to be a major problem of coffee production in Latin America, very little attention has been paid to the relative efficiency with which coffee is produced in the various countries. In the coffee survey work in Colombia and El Salvador the ECLA group found that primitive production techniques were practiced on a large proportion of the coffee farms. Although El Salvador is considered to employ the most advanced methods in Latin America, even there little attention is given to the use of fertilizer, disease and pest control, soil conservation, etc. About 50% of all coffee farms in El Salvador have less than one hectare (2.5 acres) of productive planting each, which makes it ". . . extremely difficult to apply efficient techniques. . ." (46, p.36).

In describing conditions in Guatemala Whetten lists five factors as being quite important in explaining the inefficiency of coffee plantation operations in that country (11, pp.127-129). Absentee ownership is seen as a major problem in that managers are seldom well trained and have often come up through the ranks from laborers, knowing little of scientific agriculture. In Guatemala only about 10-20% of the large coffee plantation owners actually live on their plantations and direct operations.

Another factor is insufficient capital and a reluctance to reinvest profits in production. Plentiful land and labor for exploitation is also noted as being important in the effect it has had on reducing efforts to attain maximum productivity per man. Also the fact that about 85 or 90 of the coffee plantations which occupy some of the best coffee soils have been inefficiently run by the government since their expropriation from Germans during World War II. The last factor which Whetten lists is the prevalence of primitive production methods and the lack of research to develop and adopt improved techniques.

Contributing to the slow adoption of improved technology, as pointed out by Coyner, is the existence in Guatemala of high duties on many imports of necessary

agricultural production commodities. She states that "Practically all imported items which farmers need are subject to extra levies in addition to import duties. Only unmixed fertilizers are free of both customs duties and other levies" (59, p.127). It should be noted, however, that the government has realized the importance of insect control in increasing coffee production and has removed all restrictions on imports of insecticides in order to encourage their expanded use (59, p.11). Coyner substantiates Whetten's observation that most of the owners of coffee plantations live in the city and leave the operation of the plantation to a hired manager.

Labor and Labor Costs

Coffee requires more hand labor than any other large-scale agricultural enterprise in Guatemala. Plantations are cleared of brush and undergrowth several times a year by hand and the selective picking system also requires going over each tree several different times at harvest. The usual employment practice is to keep a minimum number of permanent laborers on the plantation and to supplement them with temporary laborers at the peak seasons. The permanent laborers usually receive a small plot of land for growing their subsistence crops and they are also furnished with living quarters.

Although coffee is the main cash crop in Guatemala, much of the agriculture is of a subsistence type and is carried out on many small farms primarily owned by Indians in the Central Highlands. This area has become densely populated and many families now have too little land to support themselves. Therefore, many of these small holders supplement their own production by hiring out as seasonal labor on the large coffee, sugar and banana plantations. Coyner has observed that "Wages are low and payments in kind (corn, beans, etc.) are more important to the laborer than cash" (59, p.10). Although mechanization on some of the other plantation crops such as cotton and bananas is taking place fairly rapidly, the production of coffee is still primarily by hand.

Beaumont and Fukunaga (1953) estimated that harvesting costs in Guatemala were 41.4% of the total costs of production, whereas in Brazil where the cherries are flailed from the trees rather than being harvested by selective picking, harvesting costs ran only 13.5% of the total costs of production (10, pp.367-368). Throughout Latin America

it has been estimated that total labor costs constitute over 70% of all current operating costs of coffee production (46, p.37, footnote 12).

Wernimont has seen a problem in the fact that in many of the Latin American countries a surplus of inefficiently used rural labor has been attracted to the cities. Although this increases the supply of cheap labor for the manufacturing industries, it also greatly increases the problem of providing an adequate food supply. These rural laborers who have migrated to the cities to seek employment no longer have access to a patch of land where they can grow subsistence crops. "Thus the goal of self-sufficiency in basic foodstuffs, at least on a regional basis, may be more fundamental to the long-term industrial progress of Latin America than new automatic machines for factories . . ." (50).

The whole area of cost studies of intensive versus extensive coffee farm management is an important one, the surface of which has only been scratched in Latin America. It is becoming increasingly important to undertake an assessment of present and expected future labor supplies, the quality of the labor force, its productivity and its changing status. Such data is essential to the decision making process. For example, does selective picking as practiced in Guatemala yield a high enough premium on the final product to be economically justified? Would it be profitable to engage in widespread use of commercial fertilizers, insecticides, mechanization and other improved technological practices? Are the owner-operated coffee plantations actually more efficiently and profitably run, and if so, how much more so? If an absentee-owner system is to be practiced, would it prove profitable to hire a well-trained plantation manager and pay him the salary necessary to attract him? These are just a few of the questions that need study.

In both El Salvador and Colombia the ECLA coffee survey found a strong positive correlation between labor inputs and yields of coffee per unit of land. This survey showed that in El Salvador, with a labor input of 300 man/hours or less per hectare, coffee yields averaged 146 kilos per hectare, whereas when more than 2,000 man/hours were applied per hectare, yields climbed to an average of 1,050 kilos per hectare (65, p.121). These higher yields were not associated with a uniform increase in types of work performed.

It was found that on the more labor intensive plantations, greater attention proportionally was given to improved practices such as fertilizer, erosion control, plant

protection, etc. The study group arrived at the conclusion that in countries like El Salvador as long as underemployment exists maximum productivity per unit of area under coffee cultivation should be a goal rather than maximum productivity per man (65, p.123).

In looking at the same problem of low productivity, Wellman concluded that the goal should be to maximize the productivity of the individual coffee tree with the use of less land and labor and noted that production efficiency of coffee would have to be increased in order to compete with the less expensively grown tea. Since coffee production and prices run in cycles, laborers are paid more when prices are higher and there is a greater need for labor. However, labor wages are more "sticky" downward as coffee prices decrease and the coffee planter finds that he must develop lower cost production through the use of improved technology if he is to remain in operation during the years of lower prices. He hires fewer laborers but pays them more and uses better practices (10, pp.425-429).

Input-output studies similar to the ECLA/FAO study and tied to costs of production and returns on investment are needed in Guatemala.

VII. SOME GENERAL COMMENTS ABOUT GUATEMALAN COFFEE PRODUCTION

Historical Background. An early study of coffee production by J.M. Walsh reported that Guatemala ". . . produces the finest, ranking in intrinsic merit with that of any variety grown" (8, p.163). At that time he observed that the "Coban" variety grown in the Coban district rivalled or excelled all other varieties with the next best coffees in Guatemala being grown in the Costa Chica and Costa Grande mountains.

In the period 1906-1910 Guatemala was the world's fourth most important producer of coffee, after Brazil, Venezuela and Colombia. In about 1840 Central American countries began shipping coffee to the United States; the imports by the U.S. in that year from Central America amounted to less than .10 per cent of the total from all world sources. By 1911 U.S. imports from Central America were about 6 per cent of her total coffee imports (16, p.13). Even then coffee was the principal cash crop of Guatemala and the number of plantations were continuing to increase.

Graham reported in 1912 that the scarcity of labor ". . . has been and continues to be the main obstacle to a more rapid increase in the extensive lands so well suited to the growth of the tree. It is estimated that the gathering of the crop at the present time furnishes employment for about one-half the population" (16, p.40). At that time the majority of the coffee plantations were located in the departments of Amatitlan, Escuintla, Sacatepeques, Chimaltenango, Solola, Suchitepequez, Retalhuleu, Quezaltenango, San Marcos, Huehuetenango, and Alta Vera Paz. The cultivation of coffee in Alta Vera Paz was largely controlled by German and American settlers. By 1943 more than one-fourth of Guatemala's coffee production was centered in the department of San Marcos and almost sixty per cent in the three departments of San Marcos, Quezaltenango and Suchitepequez.

Prior to World War II almost all of Guatemala's production and export of coffee was under the control of foreign owners. Wylie reports, for example, that in the crop year 1935/36 sixty-four per cent of the coffee exported was under German control; eighteen per cent under American control; seven per cent under the control of the Netherlands; British

control four per cent; and other countries two per cent; and under Guatemalan control only five per cent of the total (56, p.201).

During World War II German holdings were expropriated by the Guatemalan government and operated under State control as national farms. During the Arbenz administration many of these farms were split up into small farms for landless workers under an agrarian reform program. Following the overthrow of the Arbenz regime, however, these farms were taken back by the government.

In 1962 Guatemala exported 745,972,000 bags of green coffee (60 kilo bags). Of this total, the United States took 48.1% and Germany 27.7%. Before World War I Germany took about 60% of Guatemala's coffee export but since that time the United States has been the principal market, although Germany was again quite important for a period in the 1930's.

One problem in Guatemala has been the holding of uncultivated land by large land-owners. Many of these large holdings have been handed down from original grants by the Spanish crown. A decree in March 1956 to encourage the development of idle land by its owners provided that each landowner who had over 208 acres was required to file a statement regarding land type and usage patterns. Within a one or two year period, depending on how the land was classified (five classes were set up according to soil type, topography, water and accessibility) the owner was required to bring the idle land into production or be subject to a new land tax.

Production Areas. The two principal coffee production areas in Guatemala are the Pacific Piedmont and the Coban region of Alta Verapaz. The Pacific Piedmont area is a narrow band along the southern slopes extending from Mexico on the west to the department of Santa Rosa near El Salvador on the east. It is in this region that most of the coffee is grown. The Coban region of Alta Verapaz is located in the north central part of the country. Although the majority of the coffee is produced in these two regions, there is some coffee produced in all of the departments except the Peten and Totonicapan (11, p.125).

Most large-scale commercial farming other than coffee is carried on in the Pacific Coastal lowlands where the land lies flat enough to allow irrigation and the use of mechanized equipment. It is estimated that about 16.2 million acres (62% of the total land area) are in forest in Guatemala and about 12.4 million acres are commercially productive (59, p.6).

Coyner reports that most of the recent expansion in agricultural production has been on the western slopes of the central mountain range, but also notes that there are large land areas suitable for expanded agricultural production in tropical lowlands. Numerous authors have also suggested that Peten holds great potential for development in future years as transportation and communications systems are improved. There appear to be excellent future possibilities for both a profitable logging industry and food production after the land is cleared (59, p.1).

Farm Size. The census of 1950 showed that the median farm size in Guatemala was only 3.9 acres and the mean size 26.3 acres. This skewed distribution reflects the influence of the large plantations. The census also revealed that approximately 87 per cent of Guatemala's coffee was being produced by about 5 1/2 per cent of the farms, each of which produced more than 200 bags (quintales) per year. For all types of farming it was found that only 2 per cent of Guatemala's farm operators had farms larger than 111.5 acres, but that these plantations comprised 72 per cent of the total farm land.

These large plantations are oriented toward the production of cash crops for export. In 1954, according to Whetten, 94.2% of the value of all Guatemalan exports was represented by the four crops of coffee, bananas, cotton and hemp. Coffee alone accounted for 77.5 per cent of the total value of exports in that year (11, p.85). Whetten has also made the observation that plantation agriculture as it is practiced in Guatemala is wasteful of land because most plantations encompass much more land than is used for productive purposes (11, p.125).

Coffee Production and Value. In the crop year 1961/62 Guatemala's exportable production of coffee totaled 1,525,000 sixty-kilo bags of green coffee which represented a total value of $74,034,000. As noted earlier in this paper the United States took 48.1 per cent of Guatemala's total coffee production and Europe took 46.9 per cent. Of the European importers, Germany was by far the best customer, taking 27.7 per cent, followed by the Netherlands with 6.5 per cent (64, appendix pp.49-95).

VIII. IMPORTANCE OF COFFEE TO THE UNITED STATES

Coffee vies from year to year with petroleum as the most valuable of all the United States' imports. In 1958 West reported that the annual value of U.S. coffee imports was approximately 1.5 billion dollars and that the coffee industry in the United States including processing and distribution was estimated to be a 2.5 billion dollar industry (51). In 1962 the United States imported $989,644,189 worth of green coffee alone. The per capita consumption of coffee in the United States among the civilian population ten years of age or older was 20.4 pounds of green coffee annually (64, appendix pp.49-95). In 1958 it was estimated that creaming agents used in coffee in the U.S. accounted for the annual consumption of 300 million gallons of dairy products having a value of about one-third of a billion dollars (51, p.1504).

Of particular interest to the United States is the fact that about forty per cent of the dollar earnings of Latin American coffee exports are in turn spent on U.S. products. It is, of course, a well known fact that Latin America provides a good market for our manufactured products. The magnitude of U.S. agricultural exports to Latin American coffee producing nations is not such a widely recognized fact. A study by Adcock has showed that the Latin American coffee growing countries provided a market for thirteen per cent of all U.S. agricultural production (21, pp.10-11). The foreign earnings received by the Latin American countries, as a result of coffee exports, stimulate the demand for increased food consumption at a much faster rate than their domestic food production can meet. This, coupled with increasing population, provides an expanding market for U.S. and European agricultural products.

The Adcock study revealed that of the total amount produced on U.S. farms, the percentages exported to coffee producing Latin American countries were as follows: dried whole milk, 85%; dried beans, 70%; lard and edible tallow, 38%; rice, 36%; wheat flour, 35%; evaporated milk and non-fat milk solids, 25%; wheat, 12%; butter, 11%; and grains other than wheat, 7% (21).

In 1962 the value of U.S. imports from Guatemala was $62.7 million and the value of U.S. exports to Guatemala was $61.0 million, showing an unfavorable balance of trade of $1.7 million. Over the three-year period 1960-62, however, the balance of trade has totaled only $-.2 million. With El Salvador, for the same three-year period, the U.S. showed a favorable balance of trade of plus $5.4 million and with Costa Rica plus $21.2 million. The balance of trade for the same period with Mexico was plus $841.4 million (64, p.74).

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