FARM MECHANIZATION OF THE SMALL HOLDINGS IN SURINAM

Thesis for the Degree of M. S.

MICHIGAN STATE UNIVERSITY

Marius E. G. Olf

1962

Add

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by

Marius E. G. Olf

AN ABSTRACT

Submitted to Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

DEPARTMENT OF AGRICULTURAL ENGINEERING

1962

Approved by Wesley F. Buchele

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FARM MECHANIZATION OF THE SMALL HOLDINGS IN SURINAM

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The problems of the small farms in Surinam are of great importance to the country's economy: About 80 per cent of the total agricultural area is occupied by small holders; their contribution to the national income is, however, only 25 per cent.

The average income of the small farm family is about sf 1000. It is the sincere intention of the Surinam government to bring about improvement in this situation.

A wise and responsible introduction of new farm machinery and the improvement of indigenous agricultural implements can aid in attaining projected goals.

The problems facing the small holders can be divided into: technical, economical, educational, social-religious, and political. The most important ones in these groups are:

1. The small farms and their subdivision into numerous parcels.
2. The high initial costs of farm machines.
3. The low income of the farmers.
4. The high transportation costs of farm products.
5. The inadequate irrigation and drainage facilities.

It is true that farm mechanization can make unbelievable progress possible. It is, however, very important to

keep in mind that farm mechanization is not a cure-all, a panacea that can be applied under all conditions.

The improvement of indigenous hand and animal tools can, under certain circumstances, bring more progress than motorized farming. In a systematic way the problems have been analyzed and some suggestions toward the solution of them have been made.

In the discussion of the suggestions, emphasis has been put on a better cooperation with countries that have similar problems and where research toward the solutions of them has been conducted.

The weather in Surinam is unreliable. In order to cope with this problem some suggestions have been made to explore the field of deep well drilling. This can, especially in the direct vicinity of Paramaribo (the capital), eliminate the great price fluctuation of various agricultural products.

The educational side of any program is one that should not be neglected. In connection with this, attention has been paid to the teaching of a sound mechanization concept, to especially the young farmers. They, the future farmers, will determine, in a large measure, the fate of agricultural programs.

Testing of foreign agricultural machinery, as well as the indigenous implements, will enable the agricultural workers to advise the farmers better in the selection and maintenance of their machines. It is, therefore, of utmost importance that more and extensive applied research be done.

A good extension program is a very essential part of the overall program. With a sound extension service in farm machinery, the farm worker will be able to influence the farmers' attitude and make them mechanization-minded.

In this study the scientific method has been applied. This method consists of the following parts:

1. Determine the problems.
2. Analyze the problems.
3. Search for alternative solutions.
4. Make a choice among the solutions.
5. Test the solutions chosen.
6. In case the solutions are right, accept them, and bear the responsibilities.

Points 5 and 6 cannot be fulfilled in this study, but the author will be in the position in his home country to do so.

This study is far from complete; due to lack of more data, the author could not go into detail in certain matters. It must, however, be considered as a basis on which further work can be done.

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He further acknowledges his indebtedness to the United States' Operation Mission to Surinam and the Surinam government that made the study possible.

A word of thanks to the many agricultural workers and farmers in the state of Michigan, who familiarized him with the American agriculture and made valuable suggestions in relation to this study.

The author, finally, appreciated the cooperation which he received from his wife, Nita, during the study.

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Conversion Tables

1 HA (hectare) = 2.47 acres; 1 acre = 0.404 ha.

1 km (kilometer) = 0.621 miles; 1 mile = 1.609 km.

1 kg (kilogram) = 2.204 lbs.; 1 lb. = 0.454 kg.

1 g (gram) = 1000 mg (miligram) = 0.0353 avdp ounce

1 avdp ounce = 28.35 grams

1 metric ton = 1,000 kg. = 1.102 short or net tons

1 m (meter) = 3.28 ft.; 1 ft. = 0.304 m.

1 m = 39.4 inches.

1 m^3 = 35.3 $ft.^3$; 1 $ft.^3$ = 0.028 m^3.

1 l. (liter) = 0.264 U.S. gal.; 1 U.S. gal. = 3.785 liters.

1 kg/ha = 0.892 lb/ha.

1 lb/acre = 1.121 kg/ha.

Exchange Rate

1 Surinam guilder (Sf) = 53 U.S. cents

1.88 Surinam guilders = 1 U.S. dollar

INTRODUCTION

There was a time during the colonial period when Surinam (better known at that time as Dutch Guiana) was considered the most lucrative of all the Netherlands possessions. The colony had, in 1688, as many as 200 estates under cultivation. This number increased gradually and reached its peak in 1785 when there were 591 registered estates. Between 1750 and 1775 the country exported agricultural products worth 265 million guilders. Unfortunately this golden era could not be maintained. The number of estates declined rapidly after this period. Some of the causes of this decline were:

1. The abolition of slavery in 1863, through which the source of cheap labor disappeared.
2. The opening of the Suez Canal in 1869. The European entrepreneurs preferred Asia to South America, since this part of the world had an abundance of available cheap labor.

The government made several attempts to arrest the decrease of plantation agriculture. The most important one was the stimulation of immigrating agricultural laborers from India, China, and Indonesia (the former Netherlands East Indies). These measurements did not, however, halt the decline. In 1950, only thirty-one plantations could be found in the whole country. Most of them are in economic trouble.

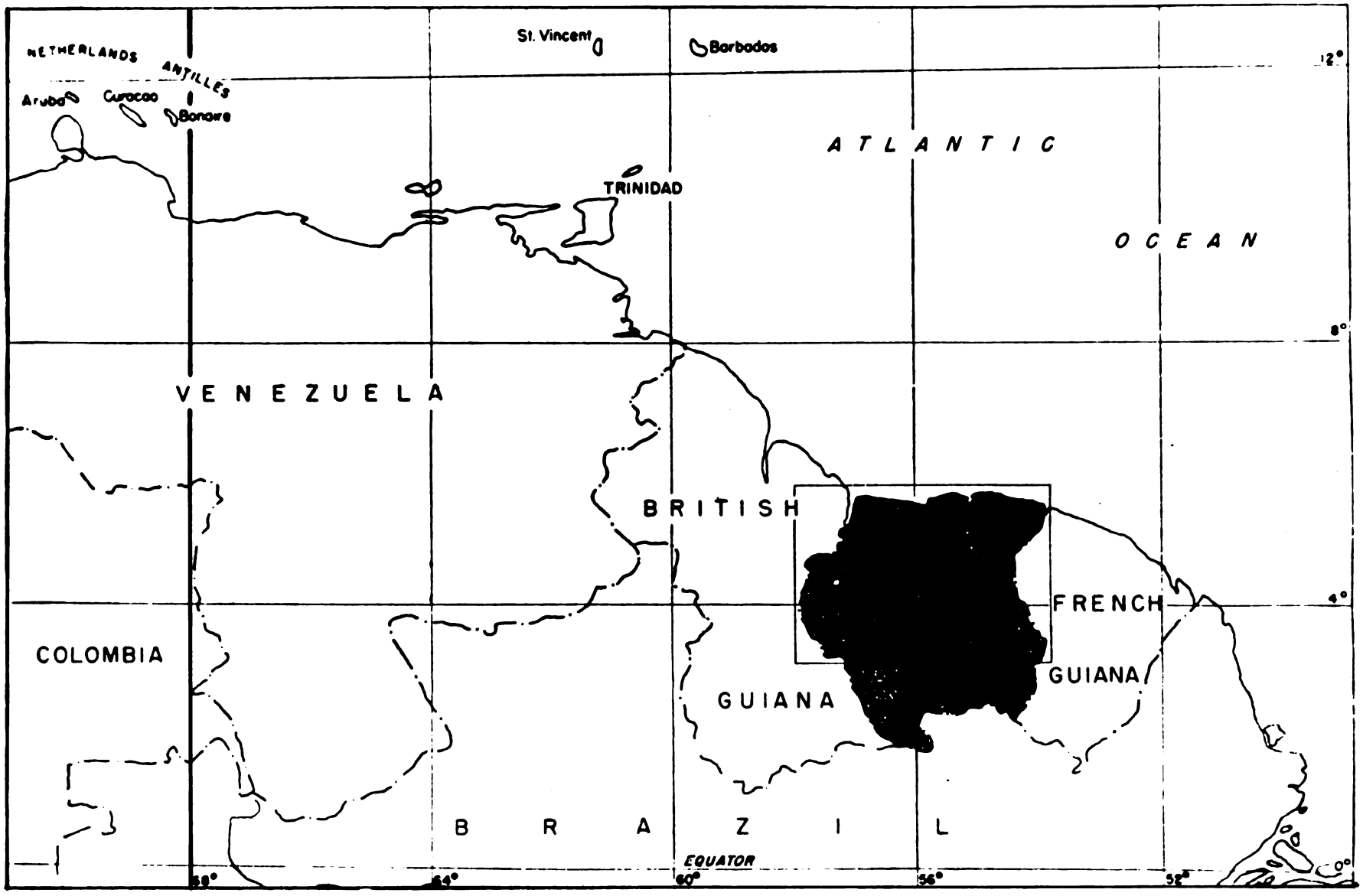


Figure 1. Location of Surinam on the South American continent.

Plantation agriculture was gradually replaced by another form of agriculture, namely, that of the small holdings. In 1950, 90 per cent of the total land under cultivation was in the hands of the small holders and 10 per cent remained in the hands of the plantation owners.

According to the 1960 census, Surinam has 16,239 holdings with a total area of 105,832 ha; the average area per holding is 3.91 ha. About 50 per cent of the holdings are smaller than two ha; about 25 per cent are between two and four ha; around 20 per cent has a size between four and twenty ha; and nearly 2-1/2 per cent are larger than twenty ha (Vox Guyanae, 1959).

It goes without saying that small scale farming is playing and will play a very important role in the Surinam agricultural program.

In spite of the importance of the bauxite industry, agriculture is important in the country's economy, since more than half of its population's livelihood comes from agriculture (Table 1). The government, aware of this fact, is strongly emphasizing the development of agriculture. The agricultural policy is based on these factors:

1. Increase the production of agricultural products in order that Surinam grown food will meet the needs of the increasing population.
2. Improve the composition of the menu of the population.
3. Increase the export of agricultural products in order to improve the export-import ratio.
4. Improve the income of the farmers (1958 = 1000 Surinam guilders).

5. Create work possibility for the growing agrarian labor population (Departement van Landbouw, 1958).

TABLE 1

EXPORT FROM SURINAM IN MILLIONS SURINAM GUILDERS

	1929	1938	1947	1948	1949	1950	1955	1956	1957
Bauxite	2.70	3.83	17.76	21.90	25.35	25.61	39.82	45.54	52.02
Wood	0.23	0.07	2.13	1.20	2.37	2.50	4.47	5.67	5.87
Rice	0.04	0.44	1.91	0.45	3.23	1.18	2.80	3.43	2.72
Balata	1.01	0.31	1.17	0.73	0.51	0.55	0.58	0.59	0.38
Fruits	0.02	0.01	1.00	1.20	1.49	1.07	0.36	0.82	0.75
Coffee	1.85	0.47	0.24	0.26	0.47	0.44	0.80	0.60	0.69
Sugar	1.36	0.55	--	--	--	--	--	0.18	0.35
Other items	0.74	0.93	0.30	1.70	0.80	0.05	0.85	1.04	1.00
Total	7.95	6.61	24.51	27.44	34.22	31.40	49.68	57.87	63.77

Total import in 1929 was 8.64 million; in 1950, 39.3, of which 5.7 million were for food stuffs; in 1957, sf. 73.1, of which food stuffs and drinks sf. 10.1.

Farm mechanization of the small holdings will help to the attainment of the above goals. In this thesis, the author will analyze the problems around the mechanization of the agriculture of this group and make some suggestions that can hopefully lead to the solution of them.

OBJECTIVES OF THE STUDY

The purpose of this study is to present information needed for understanding and solving the problems concerned with the mechanization of the small holdings in Surinam. The small holders are chosen because they urgently need aid and guidance in their farm practices. Specific objectives are as follows:

1. Analyze the technical as well as the social-economic problems that are playing an important role in the small holdings.

2. Determine ways to make more economical use of existing farm machinery.

3. Suggest procedures for establishing a stronger extension program in farm machinery and an educational plan to acquaint the farmers, especially the young ones, with the sound principles of farm mechanization.

4. Propose a program for importing and investigating farm implements from countries with similar conditions.

NATURAL, ECONOMIC, AND SOCIAL CONDITION OF SURINAM

History

Surinam, the former Dutch Guiana, occupied by the Spanish in 1529, has been thereafter under the English and Dutch flags. Since 1667, with a brief exception during the Napoleonic wars, the country has been under the Dutch flag. In 1949 a major degree of internal autonomy was granted to Surinam. The country came a step closer to complete autonomy in 1954 when the Realm Statute was established. At present it is an equal partner in the Kingdom of Netherlands. (The other two partners are the Netherlands and the Netherlands Antilles in the Caribbean.)

Geography

Surinam is situated on the northeast coast of South America. It lies roughly between the 2° and 6° parallels north and the 54° and 58° meridians west. The country is bounded on the east by French Guiana; on the south by Brazil; on the west by British Guiana; and on the north by the Atlantic Ocean. Excluding the disputed areas, it covers a territory of 142,882 square km (55,152 square miles).

Topographically, the land can be divided into two distinct natural regions: the low lying coastal area

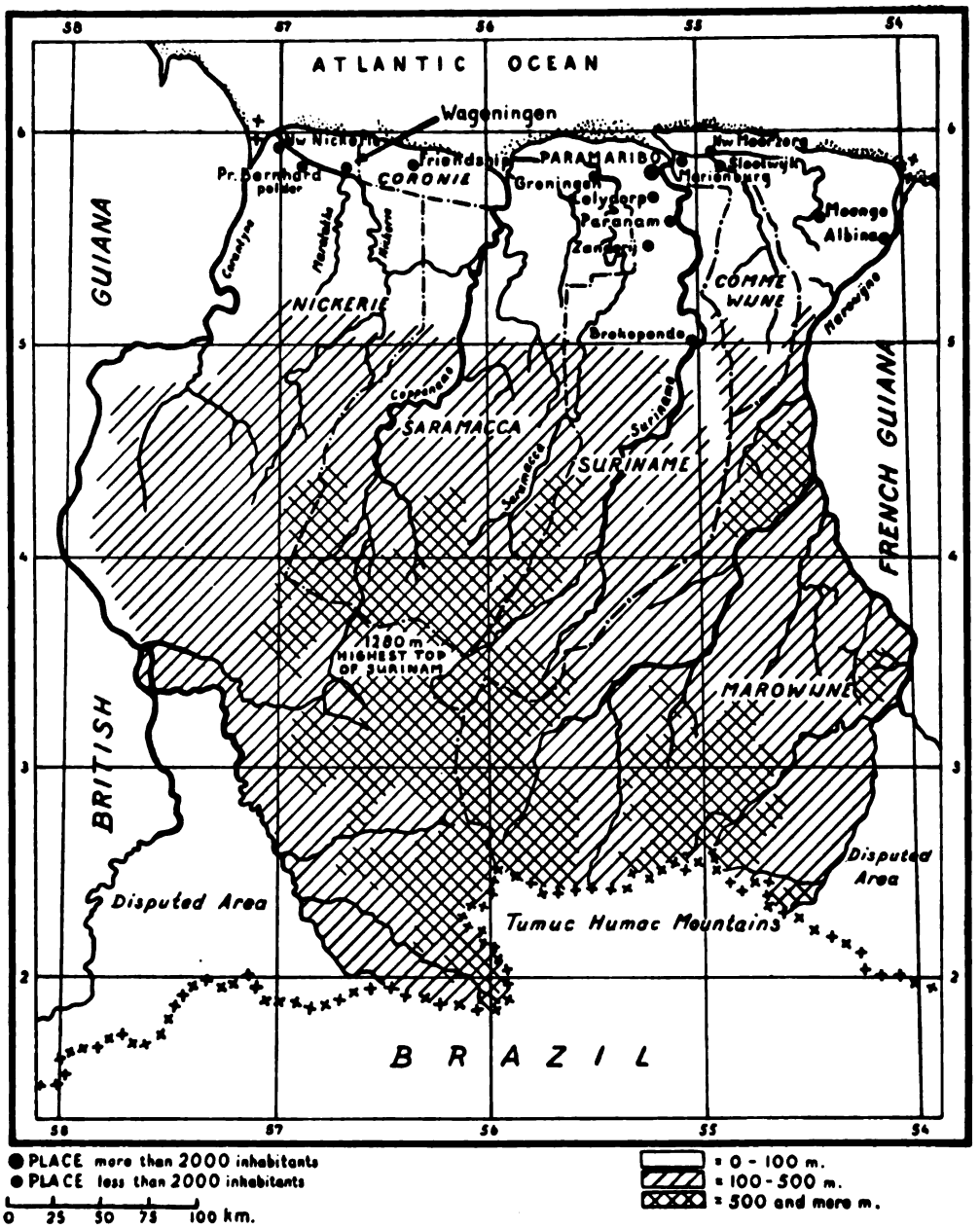


Figure 2. Map of Surinam.

(almost all of the population lives here) and the interior highland area which rises gradually to the Brazilian border. It is covered with forest and contains a number of low mountains and isolated peaks varying in height from 500 to over 1200 meters. Much of the interior is, as yet, unexplored. Surinam is traversed by numerous rivers, most of which run south to north. The rivers and interconnecting canals provide the chief means of internal transportation. Paramaribo, the capital, is located on the Surinam River, about twelve miles from the Atlantic Ocean.

Climate

Surinam has, according to the Koppen's classification, a tropical rain forest climate. The rainfall is less intensive on the coast than inland; it also decreases from east to west. The number of rainy days per year is 235. Precipitation-wise, the climate can be divided into four seasons:

1. The short rainy season (from mid-November to the beginning of February).
2. The short dry season (from the beginning of February to mid-March).
3. The long rainy reason (from mid-March to the end of July).
4. The long dry season (from the beginning of August to mid-November).

The long dry and rainy seasons occur every year; the short dry and rainy seasons can, however, vary in length from year to year. The average yearly precipitation of Paramaribo and Nickerie are 2284 and 1964 mm. respectively.

TABLE 2.

CLIMATIC DATA, 1959 (Meteorological Station, Paramaribo)

	Rainfall in mm.						Ave. Temp in °C.		Max. Temp. in °C.				Min. Temp. in °C.			
	1959	X	abs. min.	abs. max.	1959	X	1959	X	1959 Ave.	X	abs. max. 1959	abs. max.	1959 ave.	X	abs. min. 1959	abs. min.
Jan.	126.0	196.1	12.2	508.0	165	132	26.8	26.3	30.6	29.1	33.4	35.9	22.8	22.3	20.3	16.9
Feb.	63.3	138.8	4.9	552.0	177	150	26.8	26.4	30.3	29.8	33.1	35.2	22.6	22.2	19.8	17.0
Mar.	72.1	161.7	10.0	485.2	168	150	27.0	26.8	30.4	30.1	33.4	35.1	22.4	22.8	20.2	16.6
Apr.	276.1	222.2	26.3	584.0	135	131	26.8	26.7	29.6	30.4	32.0	35.3	23.4	22.9	21.5	16.9
May	275.5	314.5	76.6	611.1	177	129	27.2	26.8	30.1	30.1	32.5	34.8	23.4	23.7	21.9	17.9
June	321.3	302.8	139.8	491.2	147	134	26.6	26.6	28.9	29.7	31.1	34.7	23.6	22.7	22.0	17.8
July	194.9	236.1	75.3	450.0	171	180	26.5	26.9	30.0	29.8	31.7	34.7	23.2	22.5	21.8	16.7
Aug.	77.8	166.1	65.9	312.7	237	210	27.7	27.1	31.1	31.9	31.8	35.2	23.6	23.1	22.4	18.3
Sept.	101.7	84.1	8.9	203.0	252	231	28.3	27.8	32.0	32.8	33.6	35.9	23.7	23.7	22.3	18.5
Oct.	85.5	87.2	14.1	230.8	237	222	27.4	28.3	31.8	32.2	34.2	36.5	23.5	23.1	21.5	19.4
Nov.	146.7	102.6	2.3	399.0	135	180	27.1	27.8	30.7	32.1	32.9	37.4	22.7	22.5	18.0	18.9
Dec.	108.0	197.7	44.3	414.5	162	140	27.1	26.6	30.4	32.6	31.8	37.3	23.5	22.6	22.4	17.5

X = Multiple Year Average

Wind

There is a fairly constant northeast trade wind blowing throughout the year. The average wind velocity is 2.5 (Beaufort scale; corresponding to 7-10 mph). Unlike the Caribbean and Central American area, Surinam is not troubled with hurricanes.

Temperature and Air Humidity

The temperature in the coastal area varies on an average from 70° to 88° F. during the course of the day. The mean maximum is 86.9° F. and the mean minimum is 72.2° F. Surinam has a mean relative humidity of 80 per cent. The mean annual percentage of sunshine for Paramaribo and Nickerie is 57 per cent.

The Soil

From south to north Surinam can be distinguished in: the highland area (about 123.00 sq. km.), the old coastal plain or the Coropina formation (about 4000 to 5000 sq. km.), and the young coastal plain or the Demerara formation (Hendriks, 1953). The highland area is very scarcely populated and little information concerning the fertility of the soil is available. The old coastal plane consists primarily of silicate soils. They are generally less fertile.

The young coastal plane is primarily alluvial soil. The width of this formation varies from 10 to 20 km. in the east to 60 to 80 km. in the west. Within the young coastal plain are two landscapes: the ridge landscape, principally

in East Surinam; and the clay or Nickerie landscape. The clay of this landscape is very heavy and contains practically no lime. The soil in the newly cleared areas is covered with a layer of half decomposed organic matter ("pegasse"). The clay landscape is most important for the agriculture production. The majority of the arable land lies on this landscape (DeWit, 1960).

Economic and Social Conditions

Population

The population of Surinam is heterogeneous. The total registered population is 247,000 (1958) (Table 3). Besides this number there are about 40,000 Inland-Creoles and aboriginal Indians living in the interior.

TABLE 3

COMPOSITION OF THE POPULATION

Race	Number in 1958	Per Cent 1950	Per Cent 1922
Creoles[1]	100,000	41.0	53.5
Indians	85,000	35.0	27.0
Javanese	50,000	20.0	17.0
Europeans	3,500)		
Chinese	3,000)	4.0	2.5
Others (Jews, Syrians, Lebanese, etc.)	5,500)		
Total	247,000	100.0	100.0

[1]Primarily descendants of Negro slaves.

More than 100,000 people of the total population live in Paramaribo and 80 per cent live in a radius of 20 km (12.5 miles) around the capital. The population growth is rather high (almost 3 per cent; U.S., 1.9 per cent).

The Economic Base

As mentioned in the Introduction, the bauxite industry is at present very important in the country's economy. In 1950, it formed 80 per cent of the total export (International Bank, 1952).

The national annual per capita income in 1954 was more than U.S. $200 (Table 4). (It is now more than U.S. $300, according to 1962 data.)

Productive Resources

Surinam has three principal productive resources: agricultural land, tropical forests, and mineral deposits, primarily bauxite (International Bank, 1952).

Agricultural Land

The agricultural activities are confined primarily to the young coastal regions. In these regions large areas of clay soil of high fertility are found. The clay areas are interspersed with sandy ridges ("schelpen ritsen"). Table 5 gives the area and the yield of the principal crops.

Rice is the major crop in both area and value of the total production. Roughly 25 per cent of the population lives on farms devoted mainly to rice (International Bank, 1952). One of the most striking features of the rice

TABLE 4

NATIONAAL INKOMEN PER HOOFD VAN DE BEVOLKING
NATIONAL PER CAPITA INCOME

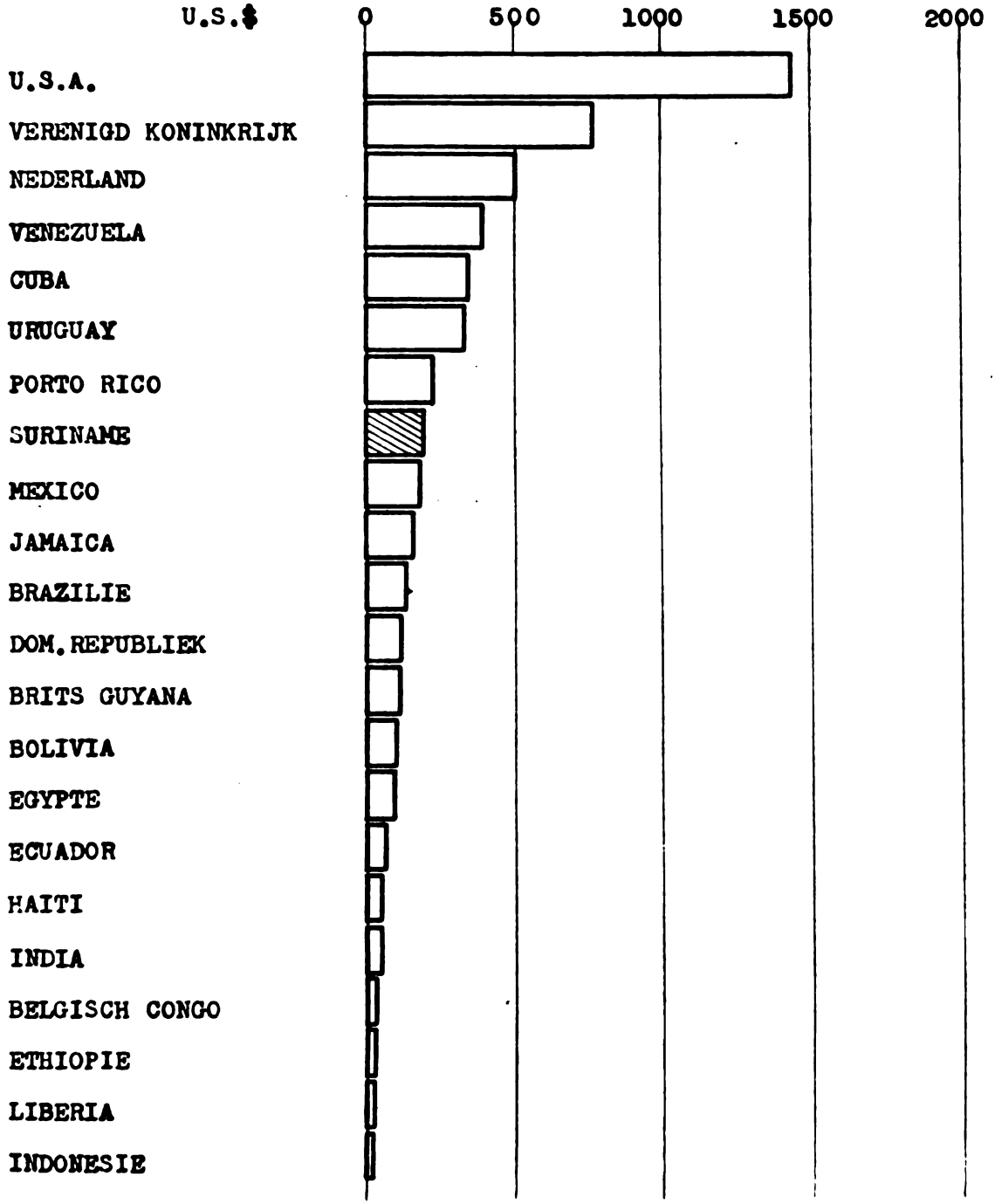


TABLE 5

AREA AND PRODUCTION OF THE IMPORTANT AGRICULTURAL PRODUCTS

Description	1954		1955		1956		1957		1958	
	Area ha	Prod. 1000 kg	Area ha	Prod. 1000 kg	Area ha	Prod. 1000 kg	Area ha	Prod. 1000 kg	Area ha	Prod. 1000 kg
Paddy	22368	66665	22257	64526	25021	71234	28233	55128	31211	85049
Corn	685	1225	360	739	573	1263	521	743	1024	1851
Tubers	419	1913	454	2341	522	3129	502	3044	396	2594
Peanuts	423	476	315	419	466	553	434	337	598	625
Soybeans	61	53	38	35	65	58	99	71	94	78
Other pulses	333	588	115	65	238	170	233	80	319	176
Vegetables	275	2310	258	2468	285	1395	452	1526	360	1477
Sugar	1170	5704	1488	7242	1312	7037	1443	8907	1708	9108
Cocoa	1365	87	1301	130	1563	135	1560	159	1580	132
Coffee	1782	450	2171	473	2158	272	2244	407	1881	144
	1000	bunches	1000	bunches	1000	bunches	1000	bunches	1000	bunches
Bananas	526	317	194	126	393	218	370	174	374	159
Plantains	673	558	366	311	571	306	610	212	743	308
	1000	pieces	1000	pieces	1000	pieces	1000	pieces	1000	pieces
Grapefruit	282	4931	310	6336	336	10551	312	5833	321	11555
Orange	1448	41244	1166	35886	1094	39656	1157	32132	1189	47727
Other Citrus	266	4538	196	4893	131	5565	165	4341	159	4827
Coconuts	2373	7793	1952	8697	2113	9530	2116	10549	2172	11834

cultivation in Surinam is the high yield, especially in some areas. Yields of this crop are much higher than anywhere in the tropics. (The next highest yield in the tropics comes from British Guiana with an average of 2.5 to 3 tons per hectare.)

A crop in which the farmers in Surinam have high hopes is the banana. Banana cultivation is not new in Surinam. In 1906, the Surinam government had a contract with the United Fruit Company to deliver a quantity of 20,000 bunches every week. The Panama Disease "Fusarium oxysporum f. cubense," was the cause of the collapse of this cultivation (Wardlaw, 1930). After this failure a number of attempts have been made to raise this crop on large commercial scales, but without success. Encouraged by technological developments and the favorable market conditions, the Surinam government is stimulating the banana cultivation again. The new approaches differ entirely from the previous ones in that they intend to involve large farming as well as small holdings in the growing of banana.

Tree crops like citrus, coffee, and cocoa are raised mainly on large estates. Coconuts can be found in the District of Coronie where, contrary to the other tree crops, it is raised by Creole small holders.

Livestock

There are in total 35,000 head of cattle on 7,725 holdings in Surinam. The increase in livestock has not kept

pace with the population growth. The government, therefore, has established different regulations to stimulate this increase. Great emphasis has been put on the improvement of the dairy herd. This will be primarily done by breeding programs and pasture improvement.

Forest

Aerial photographs indicate that 4.5 million of the 6 million ha. in the northern area are forests. To this can be added the unexplored 8 million ha. to the south.

Forests of commercial value can be divided into two groups: the swamp and the dry land forest.

The swamp forest, principally in the immense swamp areas of the coastal plain, yields Baboen (Banak) and Possentrie (Possum wood), both extremely valuable for the plywood industry, Grappa (Andiroba), Surinam mahogany; and other lumber wood. Some of the valuable timber of the dry land forests are: Basra Lucus (Angelique), cedar and Simaruba (Bitter wood). Seventy-five per cent of the logs are produced by Bush Negroes with primitive logging methods, according to the Forest Service. The remaining 25 per cent is done mechanically. The estimated value and volume of timber produced in 1950 was, respectively, SF. 4,021,967 and 40,094 m^3 (International Bank, 1952).

Mineral Resources

The bauxite mining industry is the most substantial industry in the country. The mining is done by the Surinam

Alluminum Company (a subsidiary of the Alcoa Mining Company) and the Billiton Mining Company. The importance of the bauxite industry to the country can be seen in Table 1 and Figure 3. Approximately 3,000 workers are employed by the companies.

Gold is also produced. In 1950 the total value of all gold mined was about SF. 300,000.

Surface investigations indicate that there are also deposits of diamonds, copper, cobalt, platinum, quarts, and low grade iron ore. It is, however, not yet known whether these deposits occur in commercially explorable quantities.

Education and Public Health

The elementary education in Surinam is good. This is primarily due to the establishment of compulsory education in 1876 for children between the ages of seven and twelve years. The literacy rate is more than 70 per cent.

There are, besides the elementary and secondary schools, one technical vocational school, one agricultural vocational school (the plan for a second one is underway), one law college, one college of medicine and pharmacy, and a few normal schools.

The health conditions are, compared to other tropical areas, good. The average birth rate is estimated at about 4.2 per cent and the death rate is about 1.3 per cent.

Industry

Due to the small size of the local market, the industry

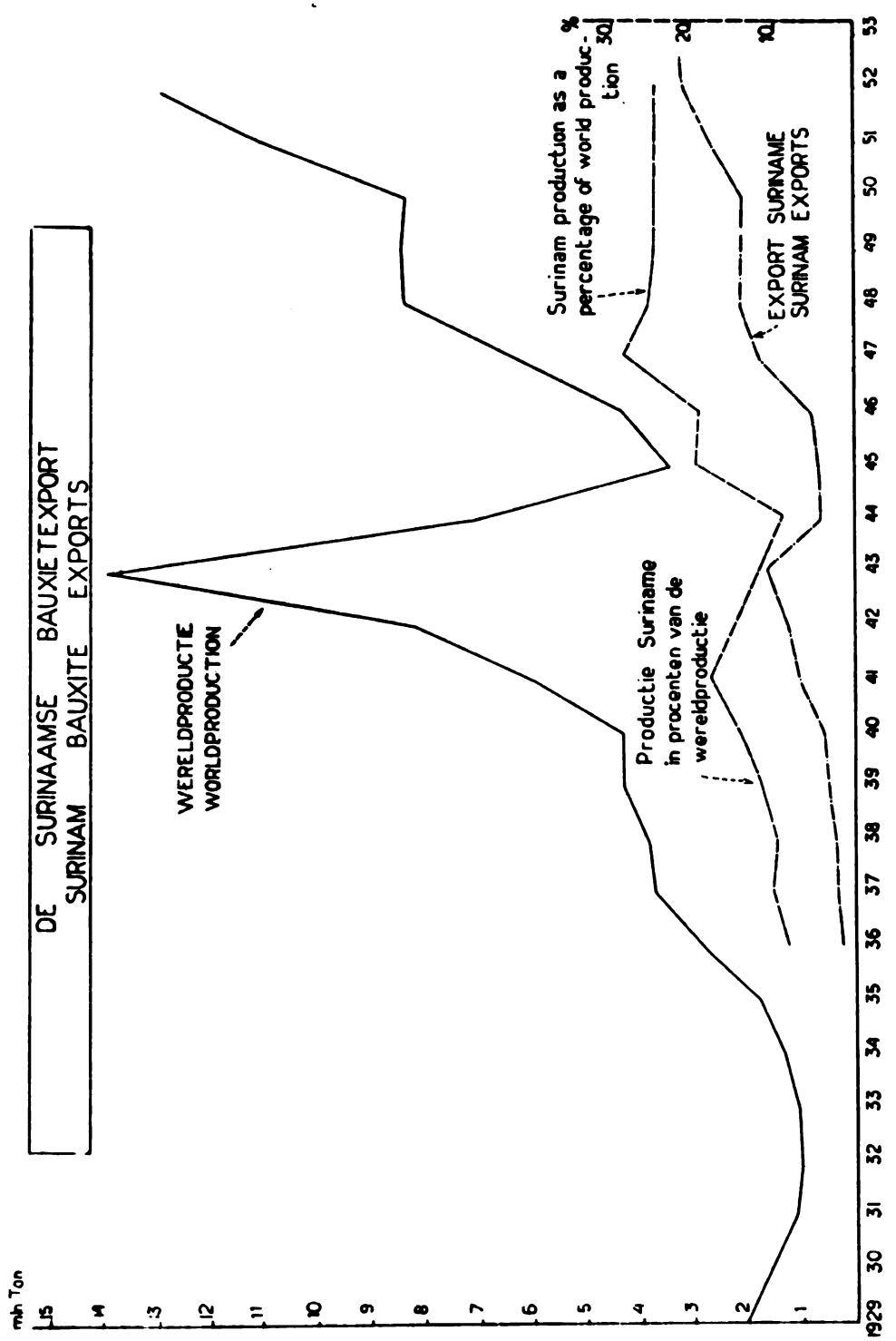


Figure 3. Surinam bauxite export.

has been confined either to small factories producing products for local consumption or to industries producing mainly for export.

Since wood is, besides bauxite, the principal resource, a great number of wood producing industries have been established. The Bruinzeel plywood factory, employing about 750 workers, is the most important one.

Other industries are: two sugar factories, a few cigarette-producing factories, shoe and garment factories, and rice processing industries.

Foreign Trade

Surinam is, unfortunately, not located on any of the main shipping routes. This fact and the small volume of foreign trade makes the freight rate rather high. The country is importing more goods than it is exporting. Over 80 per cent of all Surinam exports go to the United States; 40 per cent of its imports are from the European Continent, especially Holland.

LITERATURE REVIEW

The Ricardo-Malthusian Theory, which stated that the increase in agricultural products will not be able to keep pace with the growth of population, came true in the greatest part of the world. This is especially true in the less developed countries.

Morgan (1955) said in connection with this problem:

> In all underdeveloped areas, population is growing moderately or rapidly and will continue to grow unless war, pestilence or famine intervene to halt the rise.

Since this study will be about the economics of farm mechanization of the small holdings in Suriṇam, a study of a number of concepts will be conducted. Among the important concepts is the definition of economic progress.

Many writers defined economic progress as the increase in per capita income. Schultz (1953) stated that there are three different kinds of economic progress.

1. Increase in per capita income.
2. Increase in the national income and in the per capita income, so distributed that no segment of the population or community in the economy will be worse off than it was before the development occurred.
3. Increase in development in such a way that every segment of the population will be at least somewhat better off than it was prior to the particular development.

The small farming concept is not clearly defined because different people will emphasize different parts.

Should this be on the acreage, labor requirement, or capital turnover?

The Agricultural Machinery Subcommittee of the Organization for European Economic Cooperation (OEEC) arrived at the conclusion that it is impractical to connect the definition of a small farm (small holding) with the acreage. It is much more desirable to determine the size of the farm according to the labor requirements (Burer, 1955). The small holding is characterized by the fact that it is a family farm.

It is a fact not generally realized that, excluding Russia, three-fourths of the world's agriculture is carried out by small farmers, small holders, and market gardeners (World Crop, 1960). Most of the work on these farms is done by simple hand and animal tools. Studies have revealed that more than 80 per cent of the world's crops are cultivated and harvested with hand tools and animal-operated implements (FAO, no date).

In the past, little, if any, attention has been paid to mechanization problems of the small holders. The machinery manufacturers were, understandably, only interested in the larger farms where there was a ready market and where mechanization could be done much easier.

Mechanization of agriculture in developing countries is not an easy problem to solve. The main reasons are as follows:

1. The small size of the farm and/or the irregular layout of the fields.

2. Abundance of inexpensive farm labor which cannot find alternative employment.

3. Strong population pressure on the land.

4. Low cash income.

5. Lack of mechanical knowledge and skill (FAO, 1960).

Culpin (1959), when discussing the small farm mechanization difficulties in England, said:

> A field that has not received sufficient attention from the farmer is that of sharing the cost and use of equipment. One of the most frequent criticisms of equipment sharing schemes is the statement that all farmers need the equipment at the same time and, therefore, it is impossible for all to be satisfied. . . . [Culpin continues to say that] in practice results show that with good will, arrangements satisfactory to all participants can be made. The problem is, after all, no different in essentials from that which faces the user of a similar machine on a larger farm. It goes without saying that it is important to have a clear concept of mechanization. Very often people will only associate very complicated machinery with mechanization.

Mechanization can, however, be introduced and increased without the introduction of engines or motors (Grist, 1959). Farm mechanization can contribute a substantial part in the solution of the problems with which some part of the world is encountered. It must, however, not be considered as a panacea.

In order to introduce mechanization properly, the persons in charge of the program must have a clear understanding of what it really is. Mechanization embraces every form of farm equipment from the simplest to the most complex

ones (Acock, 1956). The mere introduction of implements from the more advanced countries does not solve the problem because the conditions in the countries of their origin may be quite different (Davis, 1959). Many failures and damages have been caused by the improper introduction of modern farm practices. "The pendulum that has been swung to far in one direction has to be set back again" (FAO, 1960). Most of the developing countries have small farms and an abundance of cheap labor. Mechanization in these areas should be carried out quite differently than in areas where these factors do not exist.

Efferson (1960) stated, "If China and Japan mechanize along the U. S. plan, one-fourth to one-tenth of their population would starve to death in less than two years." Any slavish copying of the west with average farms of around 100 acres without a full and careful study of the farm condition would spell disaster. In connection with this problem, Denker (1961), commenting on the mechanization in Europe, remarked:

> This short and compressed survey on the development of agricultural technology shows with a frightening clarity, that within the great process of transition, which European agriculture undergoes at present, and which is marked by the general change from muscle to heat transfer, we are still much closer to the beginning than to the end, especially in the sphere of small farms. Nothing would therefore be more dangerous than to press the presently applied techniques as soon as possible on the greatest possible number of farms. We must use patience in order to await the outcome of the fight for the shaping of new technical aids and new procedures which might result therefrom.

Gadhary (1957) stated some of the important factors on

which economy and feasibility of mechanical cultivation depends:

1. Whether there is a scarcity of labor for carrying out cultivation, not only over all but also during peak periods.
2. The size of the holdings and its fragmentation.
3. Whether mechanization is necessary on account of certain operations not capable of being carried out by human or animal labor.
4. Whether higher production can be had by resorting to mechanical cultivation.

Sometimes other factors than economy can lead to mechanization of a farm or activity. Some of these factors are: work becomes less tedious, mechanization relieves the farmer from the drudgery, and mechanization makes farm life more attractive.

The opinions are strongly divided as to how heavy the power of the prime mover should be. According to Taiwanese standards (1961) the most suitable type of tractor for use in Taiwan is the small power tillers (4-6 HP).

The early conception was that a small farm needed a small tractor. In relation to this, many garden tractors have been tried on small farming. The results were, however, negative (Coleman, 1953). Some of the reasons of failure are:

1. Many small tractors are not able to use the power developed by their engine.
2. The small tractors are very expensive per power unit.
3. Small tractors, especially two-wheeled, are very hard to handle under tropical conditions.

In the last few years there has been a considerable body of opinion in favor of providing the small farmer with replicas of the larger machines scaled down in proportion to the size of his holding. In fact, so strongly has this opinion been held that especially in Western Germany, a very excellent range, from the engineers' point of view, of small tractor of around eight to ten horsepower have been developed for this purpose. However, it has not been found possible to reduce the costs of production or indeed the running costs of these tractors in the same proportion as their output of power (Mitchell, 1961). Twenty-five to thirty horsepower is best suited for the condition (Mitchell, 1961).

It is generally agreeable that man as a power unit is very inefficient. He is limited to about 0.1 HP continuous output. It has been observed that twenty or more men with hand tools are required to till an acre a day; whereas, one man with a tractor can do the same activity in one hour (Cottrell, 1955).

Giles (1961) remarked: "When mechanizing we must not only be interested in the biological efficiency, that is, the number of bushels per acre, but also in the operational efficiency--the number of acres per man hour." The product of these two is known as the overall efficiency or system efficiency.

Losses of farm product, especially in the tropics, can run exceedingly high--sometimes 30 per cent or more of the crop is lost because of rodent damage, improper storage,

etc. It is important that due attention be paid to this problem in any mechanization program (Hall, 1961).

Very often one of the important incentives of farm mechanization will be the speed at which farming can be done. This is especially true in the tropics where the weather can be very unpredictable. Hadley (1961) reported that corn planted after the first of June and harvested the first of December gave a reduction of ten bushels or even twenty bushels per acre; in money this meant a reduction of $5-15 per acre for late planting and up to $10 per day for late harvesting.

Farm management principles are very important in the introduction and use of farm machinery. The highly mechanized farm is not the one with the most machinery, but rather one having a good balance between men and machines to insure the efficient operation of the farm as an economic unit. It is of great importance that the technicians who are going to introduce mechanization to a new area collect as much data as possible prior to the introduction. Bates (1957) stated that in planning many mechanization schemes in Africa, the cost of mechanical operation had been underestimated and machine performance overestimated.

The mechanization in the tropics acquires special attention. Surveys have shown that the annual repair costs in the U.S. is 1.28-3.98 per cent of the original cost, while in Malaya this cost can be as high as 10 per cent of the original cost. The tractors are depreciated in most of the

tropical countries in five years instead of ten years or more.

When farm acreage is limited, farm income can be increased by:

1. Increasing the yield per acre.
2. Changing the enterprise combination.
3. Reducing cost of production.
4. Or combining 1, 2, and 3 (Ray Corkhein, 1955).

In all our effort to mechanize we must not forget the human factor. Ogburn and Nimhoff (1952) remark:

> Mechanization is one of the most striking and pervasive phenomena of our times. Unfortunately, its study has been neglected by social sciences, which have not sufficiently recognized that while technology itself belongs to the field of the natural sciences, its far reaching effects on social life make it a vital subject for study by the social sciences.

Governor Nelson Rockefeller, in his message at the Conference on Automation, stated this concern also when he said:

> Rapid technological change brings shifts in employment and problems of social and economic adjustment which in our free society must be met with full consideration of human values. Encouragement of productive progress can go hand in hand with planned anticipation of its social impact. It is up to today's leaders in all fields to anticipate these new problems, to develop an agreed upon conceptual framework within which they can be solved, and to give direction and purpose to our free society's effort to cope with them.

Development is a concept that requires high discipline of the persons involved. Buehler's statement (1961) pictured the difficulties very clearly when he said:

A country that sets out on the road to development often does not realize the difficulties of the task ahead. When it becomes clear that development extracts a high price in terms of human suffering, social tensions, and the forced abandonment of traditional behavior and values, the desire for development may be lessened, bringing with it harmful economic tendencies which tend to slow down development, or eventually to halt it. If, on the other hand, the benefits of development are felt through an increase in individual income, this factor will outweigh the discomforts that may accompany it. In fact, it has been said that any policy which does not have as its objectives the raising of living standards cannot satisfy the needs of undeveloped countries.

SELECTION AND OPERATING COSTS OF FARM MACHINERY

The three most important incentives for farm mechanization are to:

1. Increase the production, both in terms of an increase in production per worker and an increase in production per acre.
2. Reduce the human drudgery.
3. Reduce the cost of production.

These incentives, however, can only economically be achieved if a wise selection is made in the machinery to be used and proper care and maintenance is given to them after they have been purchased.

Selecting farm machinery, simple as well as complicated ones, is a very difficult task. A rule of thumb cannot be given under any circumstances because there are numerous factors playing an important role in this matter. Some of these factors are:

The size and shape of the field.

The number of acres available.

The nature of the soil.

The locality of the farm.

The density of the population in the area.

The social and religious background of the farmer.

Last, but not least the economic feasibility.

It is readily understood that selecting the proper farm machinery in a developing country is much more difficult than in a highly developed one, where the farmers are used to many phases of farm mechanization and where managerial abilities are better developed.

Assume that the use of the machines in mind is technically and social-religiously feasible, then the prospective buyer should study the economic features of the machines to be purchased. The important questions he has to ask himself are:

1. Will the value of labor saved justify the purchase?
2. Will it be possible to harvest my crop in time (timeliness)?
3. Could the capital used for the purchase not be used more profitably on another part of the farm or business?
4. Would it not be cheaper if he had made use of custom service?

Larson (1955) stated as points influencing the cost of production the following:

1. Crop or products produced.
2. Operations involved in their production.
3. Season or period of time available for the various operations.
4. Acreage to be covered for each crop.
5. Capacity and performance of machine.
6. Adaptability of machine to soil conditions.
7. Power available.
8. Whether or not custom work is to be done with a combination of machines and power.

9. Relationship between labor and machinery costs.
10. Actual cost of the operation.

Cost Functions

It will certainly aid the adviser as well as the farmer if he knows the functions constituting the cost of farm machinery. These functions can be divided in the fixed or the ownership cost and the variable cost or operating cost.

Fixed Costs

The fixed costs are not influenced by the annual use of the machines. As fixed costs can be included: depreciation, interest on investment, insurance, taxes, and housing.

The variable costs are those which can be influenced by the annual use of the implements. They include such costs as repair, maintenance, lubrication, fuel and oil, and labor.

Depreciation

Fixed costs or ownership costs.--Bainer, et al. (1955) defined depreciation as the reduction in value of a machine caused by obsolescence, wear, weathering, accidental damage, etc. Depreciation is the highest single item of farm machinery costs. There are a number of methods to calculate depreciation. Some of these are: the straight-line, the constant-percentage, the compound or sinking fund, and the declined balance method. The three latter methods depreciate the machines more rapidly in the early years than the

straight-line method. Since the straight-line is the simplest and the most used method it will also be used in this study. The formula for this method is:

$$D = \frac{C - S}{L} \qquad (A)$$

Where: C = initial cost

D = depreciation in dollars (or guilders) per hour

L = estimated useful life in hours

S = salvage value (10% of C)

It is a well known fact that the tropical climate has greater deteriorating effects on farm implements than the temperate zone. A readjustment of the percentage used in the temperate zone will, therefore, give a better value of this cost. If a tractor is taken as an example: The useful life of this machine is about twelve to fifteen years in the temperate zone; in the tropics, however, experience has shown that the tractor can economically be used for only six to seven years. The author agrees that this short life cannot entirely be blamed on the climate; the skill of the operators, the care, and maintenance are undoubtedly factors influencing the useful life negatively. He feels, however, that for the time being the situation must be accepted as it exists. A re-evaluation can always be made later on when these factors dissipate.

Interest on Investment

Very often farmers in developing countries do not take

interest on investment into account when they used their own money (not borrowed) to purchase farm machinery. They must, however, realize that if this money had been used for other purposes they should have received interest on it. The method of calculation with the straight line method is:

$$I = \frac{(C + S)}{2N} \; i \qquad (B)$$

Where: C = purchase

i = rate of purchase

I = interest in dollars (or guilders) per hour

N = operating hours per year

S = salvage value

Insurance

The insurance of farm machinery is not a common practice, even in the U.S. The farmers must, on the other hand, bear in mind that they carry the risk themselves if the equipment is not insured (Fenton and Fairbank, 1955). The rates charged in the U. S. run from $.60 to $1.20 per $100 coverage. It is suggested, in cases where the exact charge is unknown to use 0.25 per cent of the original value. This is approximately the insurance rate in Surinam.

Taxes

The farmers in Surinam do not pay property taxes on farm machinery. He needs, however, a license to use the public roads. This costs Sf 75 for a period of twelve

months and Sf 37.50 for a period of six months. Most farmers are purchasing a six-month valid license, since the tractor and implements are not used on the roads during the whole year.

Housing

Housing has not been considered when calculating the cost of farm machinery. In some areas, there is no need to consider it since the houses are on stilts and the farm machinery can be stored under the houses. In the areas where this is not the case, it will definitely pay to take the cost of housing into account. The two methods of calculating this cost are:

1. A charge based on the cost per square foot of storage required for housing.
2. A certain percentage based on experience (normally 2% of the initial investment).

Under Surinam conditions, where local materials can be used for this purpose, a 1 per cent rate of the initial cost is reasonable.

Operating or Variable Costs

In these costs are included fuel, oil, lubrication, repairs and labor of operation. Experience shows that a thirty horsepower tractor consumes about two gallons of gasoline per hour. The result of the survey carried on at South Dakota State College suggested to use the following formula when no accurate figures are available for fuel and oil consumption:

Fuel and oil cost per day: Belt horsepower x 0.8 x Fuel price per gallon (C)

In this formula includes an allowance for the cost of grease.

Repair Costs

Repair costs are very high in the tropics compared to the temperate regions. There are a number of ways to calculate these costs. The method used by Richey (1962) whereby the total repair costs during the life of the machine is expressed in a certain percentage of the new cost (Figure 4) will be applied in calculations made in this study.

Labor for Operation

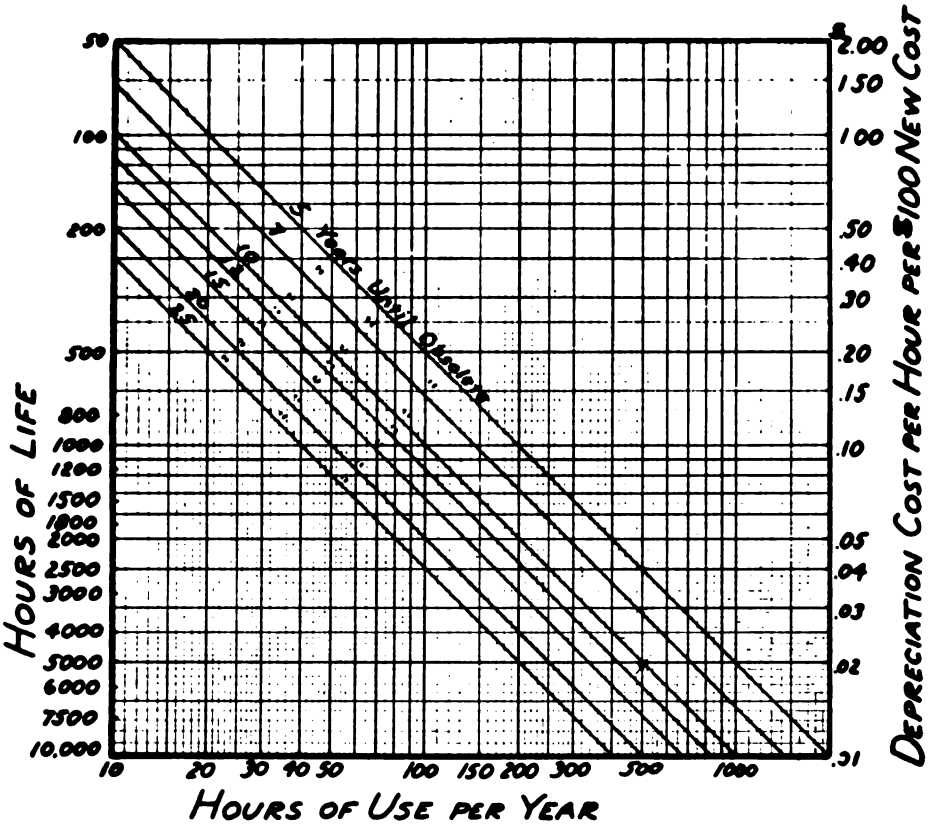
The wages normally paid for a skilled tractor drivers is Sf 7.50 per day.

The Costs of Owning Farm Machinery

On the basis of the foregoing discussion, cost calculations will be made of the more important farm machinery used in Surinam.

Tractor

Four-wheeled, thirty horsepower tractors costing Sf 4500 are widely used in Surinam. Most of them have gasoline engines, but there is a tendency to shift to diesel engines. The estimated useful life is seven years or 5,000 hours. (Until research is done in the field. this estimation must be used.) Price of gasoline - 52 cents (the exemption on tax


Hours of Life
50
100
200
500
800
1000
1200
1500
1800
2000
2500
3000
4000
5000
6000
7500
10,000
4 Years Usual Obsolete
1
2
3
4
5
10
15
20
25
10
20
30
40
50
100
150
200
300
500
1000
Hours of Use per Year
$
2.00
1.50
1.00
.50
.40
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.10
.05
.04
.03
.02
.01
Depreciation Cost per Hour per $100 New Cost

Fig. 4

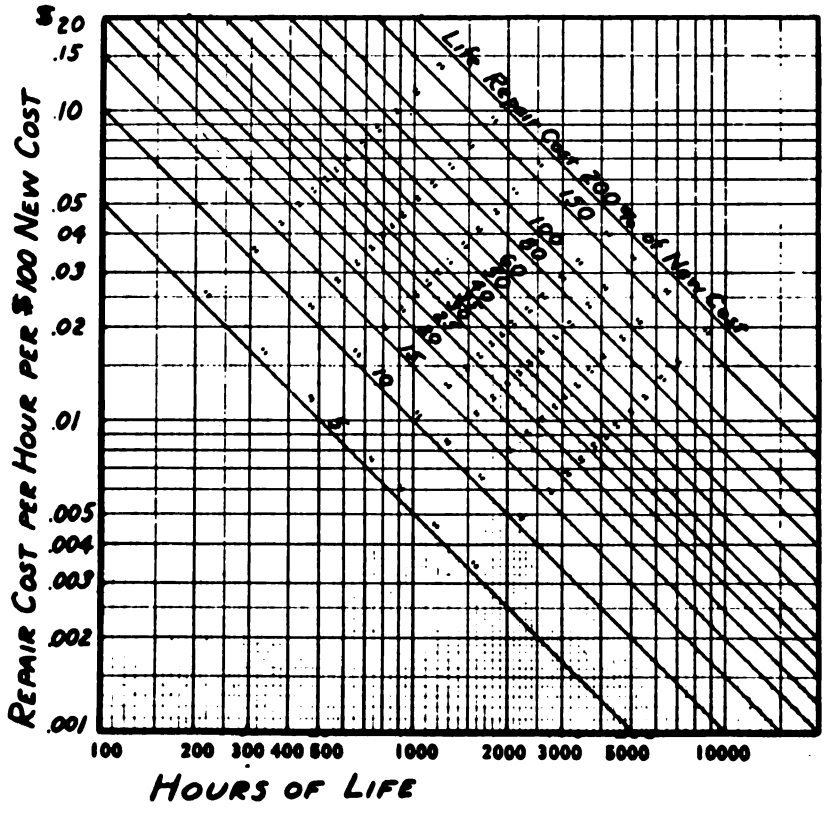
Repair Cost per Hour per $100 New Cost
$
.20
.15
.10
.05
.04
.03
.02
.01
.005
.004
.003
.002
.001
Life Repair Cost 200 % of New Cost
150
100
80
60
50
40
30
20
15
10
5
100
200
300
400
500
1000
2000
3000
5000
10000
Hours of Life

Fig. 5

of 50 per cent for gasoline used for agricultural purposes has been deducted.) Labor Sf 7.50 per day = 75 cents per hour, annual hours use - 500. The hourly costs for a tractor will be then as follows:

Fixed Costs

Depreciation.--From Figure 4 the depreciation costs can be read two ways:

1. As a function of annual hours of use and hours of life.
2. As a function of annual hours of use and number of years until obsolete.

The difference in depreciation costs between the first and second methods for the tractor on hand is Sf 0.45 (Sf 1.35 - Sf 0.90). To be safe, the higher figure will be used in this calculation.

Interest.--For the calculation use is made of Formula C: $I = \frac{C + S}{2N} i$

$= \frac{4500 + 450}{2.(500)} 6 = \text{Sf } 0.30$

Insurance.--0.25 per cent of the original value. Cost per hour is thus:

$\text{Sf } \frac{4500}{500} . 0.25 = \text{f } 0.02$

Taxes.--Since the tractor will make more use of the highways it seems more realistic to charge the license costs of a full year. The costs per hour will then be:

$$\text{Sf } \frac{75}{500} = \text{Sf } 0.15.$$

Housing.--One per cent of the original value. Cost per hour is thus:

$$\text{Sf } \frac{4500}{500} \times 1\% = \text{Sf } 0.09$$

Operating costs.--

Fuel. Use is made of Formula C:

Fuel and oil cost per day: Belt horsepower x 0.8 x fuel price.

$$\frac{30 \times 0.8 \times \text{Sf } 0.52}{5000} = \text{Sf } 0.45$$

Labor: Sf 7.50 per day; per hour = Sf 0.75.

The summation of the total costs is reported in Table 6.

The costs of other farm machinery can be calculated in a similar way.

TABLE 6

TRACTOR COSTS PER HOUR

Fixed Costs		
Depreciation	Sf 1.35	
Interest	0.30	
Insurance	0.02	
Taxes	0.15	
Housing	0.09	Sf 1.91
Operating Costs		
Fuel	Sf 1.25	
Repair	0.45	
Labor	0.75	Sf 2.45
Total		Sf 4.36

Some points that the prospective buyers have to take into consideration with regard to machines are:

1. Reliability of the manufacturers.
2. Design and workmanship.
3. Adaptability to his farming system.
4. The safety features.
5. Ease of operation.
6. Ease of service and adjustment.

Farm management is also of great importance in farm mechanization. A good farm manager uses the available scarce resources as economically as possible. A farmer who wants to mechanize his farm must investigate the following points very carefully:

1. Capital position.
2. Timeliness of operation.
3. The value of labor saved.

If these factors are unfavorable then he may consider one of the following factors to reduce the cost of mechanization:

1. Hiring custom operators.
2. Spreading the fixed costs over more acres.
3. Buying used machines at low cost.
4. Owning machines cooperatively with neighbors.
5. Increase annual use.
6. Prolong useful life by better service and maintenance.

Farmers are often reluctant to make use of custom service. Their main objections are:

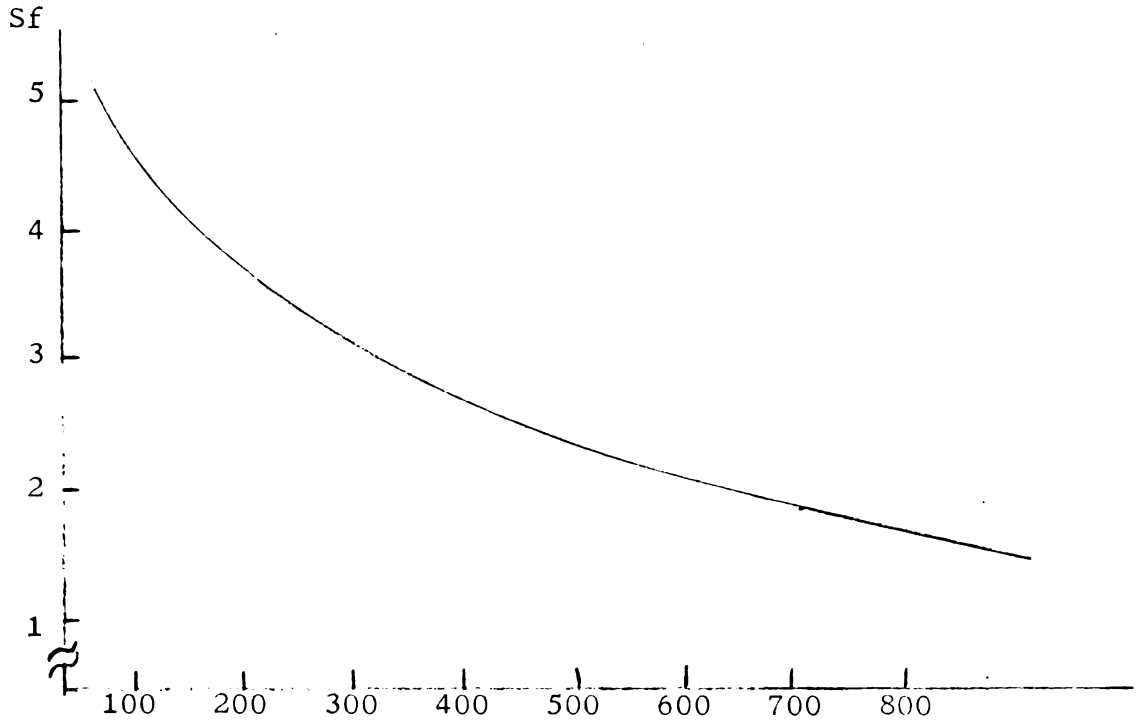

Fig. 6. Tractor cost per hour in relationship to the annual hour used.

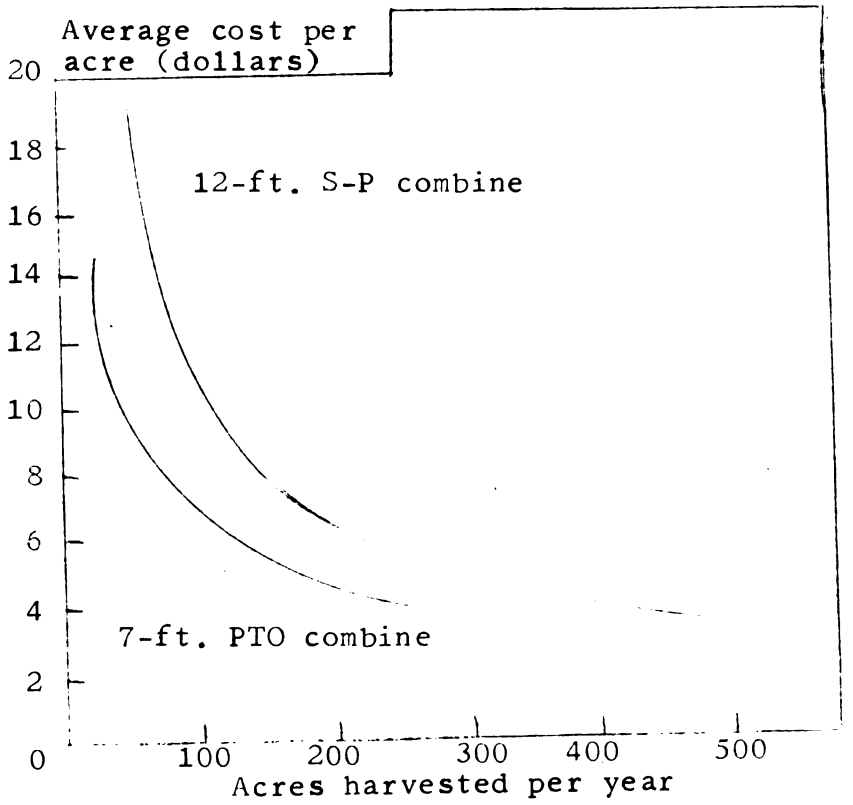

Fig. 7. Cost of combine harvesting in relationship

1. The custom worker is never available when he is needed.
2. The custom worker has the tendency to skip small farms or farms with odd sizes.

Experience, however, showed that with good arrangement and understanding, this system worked perfectly.

There are many more advantages than disadvantages involved in this service. Some of the advantages are:

1. The custom worker delivers better work.
2. Reduction on investment and costs.
3. Conveniences.
4. Greater flexibility for the farmers.

Sometimes farmers do not know whether it will be cheaper to buy a machine or to let the work be done by a custom worker. Decisions can be made easier by using the following formula:

$$B = \frac{F}{C - O - L} \qquad (D)$$

Where:

B = break even point in hours per year

C = custom charge in dollars per hour

F = fixed cost of machines in dollars per year

L = labor cost in dollars per hour

O = operating cost (includes fuel, oil, and grease per hour)

In Surinam the concept of custom work is relatively new. Very often the custom worker does not know the exact amount of money to be charged for a certain job. As a guide, the formula used by Mohsenin (1953) can be applied:

$$P = 1.25 \frac{(F + O + L)}{A} + (I) \qquad (E)$$

Where: A = rate of performance in acre per hour

F = fixed cost of machines in dollars per year

I = net income in dollars per acre

L = labor cost in dollars per hour

P = price of custom work in dollars per acre

The rate of performance in acre per hours can be calculated as follows:

$$C = \frac{SWEf}{S25} \qquad (F)$$ Bainer, et al (1955)

Where: C = effective field capacity, in acres per hour

S = speed of travel, in miles per hour

W = rated width of implement

Ef = field efficiency, in per cent

Selecting Between Diesel and Gasoline

A factor of great importance and difficulty is the choice of diesel or gasoline tractor. To make a comparison of a gasoline and a diesel tractor at least three important factors need to be considered:

1. The difference in price between gasoline and diesel tractors of the size under consideration.
2. The difference in price between gasoline and diesel fuels in that particular area.
3. The number of hours the tractor will be used per year (Fife, 1962).

By using Table 7, the prospective buyer can determine the number of years it will take for fuel savings to offset the higher initial cost of the disel tractor.

TABLE 7

ECONOMIC COMPARISON OF GASOLINE AND DIESEL TRACTORS

Tractor Price Difference (diesel minus gasoline)	$600			$750			$900		
Fuel Price Difference (gasoline minus diesel)	2¢	3¢	4¢	2¢	3¢	4¢	2¢	3¢	4¢
Years to Amortize	Number of Hours of Use Per Year								
2	1410	1210	1060	1780	1530	1340	2170	1850	1620
4	1250	1060	920	1600	1350	1170	1960	1860	1430
6	1130	950	820	1460	1220	1050	1820	1510	1290
8	1040	860	740	1370	1130	960	1740	1410	1190
10	980	800	680	1320	1060	890	1700	1350	1130

Source: Tractor Economics, Ethyl Corporation, Detroit, Michigan

PROBLEMS OF FARM MECHANIZATION IN THE SMALL HOLDINGS

This study will be mainly concerned with the small holdings, their problems, and how some of them can be solved. The reasons why the author is primarily interested in the small holdings are the following:

1. The Surinam agriculture consists of about 80 per cent of this type of farming. It stands to reason that they have definite influence on the economy of the country as a whole. If improvement is to be made in the standard of living, one should start with the group that has the lowest income. According to data of the Planbureau, the income of the average farmer is one-fifth of that of the skilled labor.

2. Due to the fact that this group does not have the capital, technique, and knowledge to make the needed improvements, it is the author's opinion that the government should pay more attention to their problems than those of the estates and larger agricultural enterprises, which generally have their own technicians to solve their problems.

In order to present the many complications of small farming in Surinam in a clear way and make some suggestions that, hopefully, will lead to their solution, the author has decided to make use of the so-called scientific method whereby the study on hand is divided in the following areas:

1. Determine the problems.
2. Analyze the problems.
3. Search for alternative solutions.
4. Make a choice among the solutions.

TABLE 8

TOTAL AREA OF SOME OF THE IMPORTANT CROPS DIVIDED IN SMALL SCALE AND LARGE SCALE FARMING

District	Paddy			Corn			Peanut			Pulses			Vegetables			Bananas		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Nickerie	15191	6953	8238	12	12	-	1	1	-	133	23	110	13	11	2	269	228	41
Coronie	296	296	-	12	12	-	-	-	-	2	2	-	3	3	-	41	41	-
Saramaca	2567	2567	-	203	203	-	201	201	-	158	158	-	76	76	-	286	265	21
Suriname	7672	7624	48	122	106	16	56	56	-	57	57	-	358	358	-	309	271	38
Commewijne	2767	2762	5	254	247	7	70	70	-	57	57	-	143	141	2	407	332	75
Total Country[4]	28546	20255	8291	610	587	23	328	328	-	444	334	110	606	602	4	1325	1150	175

[1]Total area in ha.
[2]Area small scale farming in ha.
[3]Area large scale farming in ha.
[4]The total area of the country does not equal the summation of the area of the district, since two districts have been omitted.

5. Test the method chosen.

6. In case the method chosen is right, accept it and bear the responsibility.

It is understandable that the author will not be able to carry out all the six above mentioned points in this paper. In this part of the study he will focus his attention more to the first four points. Since he will be in his home country on the occasion to work with the government on the mechanization of the small farming, he will then have ample time to carry out the last two points.

Determine and Analyze the Problems

Problems related to farm mechanization can be divided into:

A. Technical problems

B. Economic problems

C. Educational problems

D. Social and religious problems

E. Political problems

Some of the problems occur only in one section while others will be found in two or more sections.

Technical Problems

The technical problems can be divided into two groups, namely: those problems which deal with land, climate, topography, soil, and crops; and those dealing primarily with the farm machinery.

The most important technical problems that are not

directly related to the farm machinery are:

1. The small farms and their subdivision in many parcels.
2. The unreliability of the weather.
3. The poor conditions of the roads and the difficulties involved in reaching some agricultural areas.
4. The presence of bottomless soil in some areas.
5. The bad irrigation and drainage system.
6. The lodging of some types of rice.

It is not always possible to trace the causes of these situations. One of the reasons for the existence of the small farms is the crop itself. Rice, when cultivated manually, is a labor consuming crop. The acreage that a farmer can cultivate is determined by the available family labor force. Another factor is the way of life of the Asiatic farm population (the majority of the Surinam farmers are of Asiatic descent). The father will assign a specific part of his farm to his sons when they reach farming age. The original farm is thus subdivided and decreased in size with time. In short, the cultivation method of the rice grower leads to the subdivision of the farm in many parcels.

Rice is grown under wet conditions. To keep the rain water that provides the greatest supply needed, the farmer constructs a large number of bunds.

In the discussion of the climate (page 8) a scheme has been given. It sometimes happens that the long rainy season, of great importance to the rice, occurs later than anticipated. Under those circumstances, an irrigation system is needed.

Fig. 8. Plowing the fields with a pair of bullocks. Note the small plots in which this farm is divided.

Fig. 9. Experiment with a two-wheeled rice rotavator.

Two crops of rice are grown in many countries. This practice can, in Surinam, only be done on the larger estates, such as Wageningen, where irrigation is practiced.

The farm to market roads in the small holders area are poor, with the exception of the Paramaribo vicinity and part of the Nickerie district.

The small farmers may spend as much as one-half day taking their products to the market or purchasing food supplies. The rivers are important arteries for communication, but needless to say, that transportation via this means is slow.

The presence of bottomless soil, caused by physical conditions, is very often beyond the control of the farmer and his advisors.

The lodging of the rice is a serious problem confrontint the small holders. A considerable amount of grain is lost each year due to this factor. The Agricultural Experiment Station has bred some rice varieties with less, if any, lodging tendency. The acceptance of them is a slow process. The slow acceptance is more or less related to a conflict in their method of rice growing.

Problems Related to the Farm Machinery

Technical problems related to farm machinery are as follows:

1. The difficulties of using commercially available machines for the existing conditions.
2. The great variety of makes of farm machinery.

3. The vulnerability of machines used under tropical conditions to corrosion.

4. The insufficient service of the machinery dealers.

5. The improper use of the equipment.

Experience has shown that the concept, "Small farms need small machines," cannot be applied to the Surinam agriculture. This is especially true in the rice cultivation where the draft needed for the tillage cannot be supplied by small two-wheeled tractors with a capacity of nine horsepower. In motorized mechanization a four-wheeled tractor of at least thirty horsepower is the best prime mover.

Although the prime mover is, in many cases, too expensive for the farmer (will be discussed at length under the "Economical Problems"), they know at least that it will work under the Surinam conditions. This can, however, not be said of transplanting machines, sowing machines, harvesters, and driers, to mention a few. One main reason of the scarcity of proper machines is because the farm machinery manufacturers are manufacturing machinery principally suitable for larger farms. Great quantities of large farm machinery have been imported and sold to the farmers. It goes without saying that, on the long run, the small farmers will be the ones who will bear the consequences of this fact (unavailability of parts and service).

The tropical weather influences are factors that cannot be neglected when considering the introduction or development of farm machinery. Very often engineers are apt to judge

TABLE 9

EXPORT PRODUCTS OF SURINAM IN 1957

Agriculture	
Product	Sur. f.
Sugar and molasses	345.000
Rice	2.727.000
Grapefruit	334.000
Oranges	316.000
Cocoa	185.000
Coconut	103.000
Coffee	693.000
Total	5.006.000

Forestry	
Product	Sur. f.
Timber, Proc.	451.000
Timber, Round	446.000
Timber, Square	564.000
Sleepers	171.000
Balatum	377.000
Total	2.009.000

Mining	
Product	Sur. f.
Bauxite	52.022.000
Total	52.022.000

Other Industry	
Product	Sur. f.
Textile	499.000
Hides	24.000
Total	523.000

Grand Total	
Agriculture	5.006.000
Forestry	2.009.000
Mining	52.022.000
Other Industry	523.000
Total	63.768.000

farm machinery according to the same norm used in the temperate zone. Needless to say, that many failures have been caused by this negligence. An example of the influence of tropical condition is the following: A tractor in the temperate zone can easily be depreciated in twelve years or more than 10,000 hours; in the tropics, however, this machine will be depreciated in five years or 5,000 hours. The conditions under which the machines are used differ often entirely with that of the temperate zones. The tillage (puddling) of a paddy field, for instance, requires much more of the machines. The insufficient service and improper use of the equipment are other factors that also add to the unfavorable conditions of farm machinery.

Economical Problems

In this group a distinction can be made between the problems related to farm and management and problems related to the farm machinery. Problems in the first category are:

1. The small size and subdivision in parcel and plots.
2. Low income of the farmers.
3. The uneconomical use of labor.
4. The competition for labor with the industry in some areas of the country.
5. The high transportation costs of farm products.
6. The great fluctuation in prices of farm products.
7. Few possibilities to borrow needed money.

On a great many of these holdings the farmers have a subsistence livelihood. They supplement their income by

working in another branch of vocation. On large farms the labor requirement is the limiting factor; most of the labor is provided by the family. In peak periods (in the rice cultivation the peak occurs during the planting and harvesting season), the holders with a small family and a relatively large area have to hire outside labor.

The low income of the small holders has a considerable influence on the per capita income of the country. While 80 per cent of the total agricultural area is operated by the small holders, their contribution to the national income is only 25 per cent.

A close analysis of the labor requirement of the different agricultural activities reveals that the labor is not economically used. Part of the loss results from the use of inefficient, indigenous farm implements. Another factor is the ineffective managerial attitude of this group.

Labor costs in Surinam are relatively high, compared with other developing countries. This has its drawback, especially in areas where the rural labor population can easily find employment in industry. An example of this situation exists in the District of Surinam, where some farmers have the rice land available, but because of insufficient family labor they are unable to cultivate it as they are dependent on hired labor. The hired labor is expensive because the bauxite mining industry offers work opportunities.

Poor farm roads increases the farm to market

transportation cost of agricultural products. The central position of the important market (a large number of the farmers bring their products to the central market in Paramaribo, where, generally, they will receive a better price) is also a negative factor.

The great fluctuation in prices are caused by a number of factors in which the more important ones are: (1) The tendency of the farmers to grow the same products during the same period; (2) the market, not large in the first place, is easily saturated. This results in a considerable drop in prices received by the farmers. The opposite of this situation takes place during the dry season. Due to lack of water, the farmers drastically reduce the cultivated area. The prices of the products, especially vegetables and pulses, raises.

The few opportunities to borrow money for farm improvement is an economical obstacle. Very often the small holders, not able to obtain needed monetary aid via an official institution or bank, approach a local "financier." This individual loans money at very high interest rates.

Economical problems related to the farm machinery are as follows:

1. The high initial cost of equipment and the high cost of spare parts.
2. High depreciation, breakage, and repair expenses.
3. The few annual hours use of the farm machinery.

The high cost of farm machinery and spare parts is a problem common to most developing countries. They are

caused by high freight costs, high custom duty, and high commission for the implement dealers.

The influence of the tropical climate is one of the main factors for the high depreciation. Repair expenses are also high due to the scarcity of good mechanics.

A recent study has shown that the tractor is used approximately 300 hours per year. It is used only for tillage, hauling, and threshing.

Educational Problems

Education is a factor not only important to the introduction of farm machinery, but throughout the entire farm system. Important problems confronting the farm mechanization in Surinam is as follows:

1. The lack of general knowledge of the tractor and implement, especially by the farmers.
2. The misconception of mechanization.
3. Lack of enough personnel with knowledge of available machines and experience in the selection and maintenance.
4. The weak program in the testing of indigenous and foreign farm implements and the dissemination of the obtained results.
5. The lack of records kept by farmers.

The poor maintenance and care of farm implements is more or less a result of the misconception and lack of knowledge of farm mechanization. It is very strange to observe how the same Hindustanis, who are normally very thrifty, abuse and neglect their expensive farm machinery. The benefit that a shelter has on the useful life of farm implements

Fig.10. Harvesting paddy with the harvesting knife ("ani-ani").

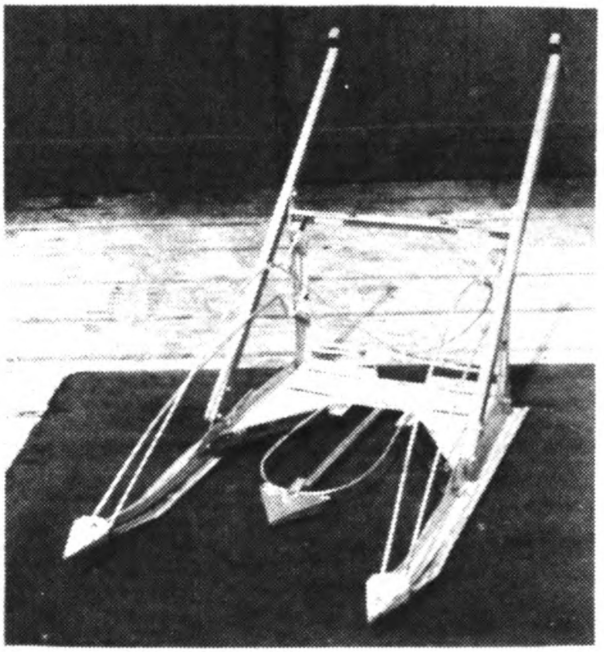

Fig. 11. A Japanese harvesting implement tried in the Surinam agriculture.

is, indeed, a strange concept to them.

The experimental program in farm machinery of the Department of Agriculture has not been strong in the past. The importing of foreign agricultural machinery, the testing and the dissemination of the results were far from perfect.

Most farmers do not keep records of the activities on their farms. It is hence impossible to study the economic value of farm mechanization. During the execution of his work in Surinam, the author worked with farm machinery owners who did custom work after finishing the activities on their farms. In the beginning, he found that nine out of ten machinery owners did not know what he did or where he worked two months ago.

Social and Religious Problems

Fortunately, these types of problems are not as serious in Surinam as they are in other developing countries; nevertheless, they do exist. Some important ones are:

1. Some farmers consider the ownership of farm machinery as a social standard.
2. The use of some farm tools and implements is attached to religious beliefs in certain groups.

Farmers, especially in the District of Nickerie, buy tractors and machinery totally unsuited to their farms. Their only incentive to buy them is because (in their opinion) the ownership of the machines will raise their social standard.

TABLE 10

NUMBER AND AREA OF THE FARMS ACCORDING TO RACE OF HOLDER, ABSOLUTE AND IN PERCENTAGES

Race	Holdings		Area (hectares)		Average Area per farm (hectares)
	Total	Per Cent	Total	Per Cent	
Creoles	1,779	10.9	15,284	14.4	8.59
Hindustani	8,047	49.6	47,876	45.2	5.95
Indonesian	6,175	38.0	13,599	12.9	2.20
Others	238	1.5	29,073	27.5	122.15
Total	16,239	100.0	105,832	100.0	6.52

A practice attached to the religious belief of the Indonesians is the use of a small harvesting knive (a metal blade about 5 cm. long, imbedded in a crescent-shaped wooden handle, shaped to fit the harvester's hand). Individual heads with 5-10 cm. of stems are clipped.

According to their belief, the spirit of the paddy will be offended by rough cutting and the result of this is that the yield will be far less the next year. Needless to say, this way of harvesting is time consuming.

Political Problems

The government of Surinam emphasizes strongly the development of a sound agriculture in its program. Problems in this category are, therefore, more indirect in character. The most important problem is the allowance to import a large number of different makes of farm machinery. This

influences the development of farm mechanization negatively since the many dealers are not able to give the implement owners the needed service. Another problem nearly related to the first one is the high commission made by the implement dealers.

Search for Alternative Solutions

It is realized that a great deal of time and effort will be required to develop solutions for the many problems just posed. In this discussion priority will be given to the problems more or less directly related to farm mechanization.

The development of mechanization in the different districts are not similar; some are advanced in the use of modern farm machinery, while in other districts, hand tools and animal implements predominate.

The rice crop, however, plays an important role in most of the districts. "Of the 16,239 holdings, 13,800 holdings (85%) with an area of 28,547 ha. grow rice. This area is 92 per cent of the total area of annual crops.)

To make the discussion more realistic, the problems of each district will be briefly described. (The problems in this stage will not be divided into technical, economical, etc. as has been done in the general determination section.) The next step will be the discussion of alternative solutions for said problems. Finally, the solutions most likely to succeed will be chosen.

TABLE 11

NUMBER OF TRACTORS IN SURINAM

	Total	One Axle	Two Axle	Track Layer	Gaso-line	Diesel
Paramaribo	8	5	3		5	3
Nickerie	409	26	307	76	190	219
Coronie	9	1	5	3	7	2
Saramacca	52	7	38	7	30	22
Suriname	115	11	100	4	25	90
Commewijne	27	6	13	8	11	16
Marowijne	2		2			2
Country	622	56	468	98	268	354

Nickerie District

(A division of the country in different districts is given on map 2.) This district is the most advanced in the use of modern farm machinery. Rice is the principal crop grown. About 50 per cent of the total rice area of the country is located here. Some of the reasons of the advancement in farm mechanization are the following:

1. The larger size of the farms. Two-thirds of the area has farms of average 4 ha and on one-third the average size is 7 ha. (Ubels, 1961).

2. Nickerie has the highest developed irrigation and drainage system. A great deal of irrigation water is supplied by the Nanni-swamp from which channels have been constructed to the rice polders.

3. The mechanization-mindedness of the small farmers. Their area is surrounded by the most modern large scale farms in Surinam (Wageningen project, Prins Bernhard experimental farm, and the Van Dijk estate).

They have been exposed thus to modern farming and they have been eager to improve their farm conditions. The

Fig. 12. Puddling a rice field with a four-wheeled tractor and harrow.

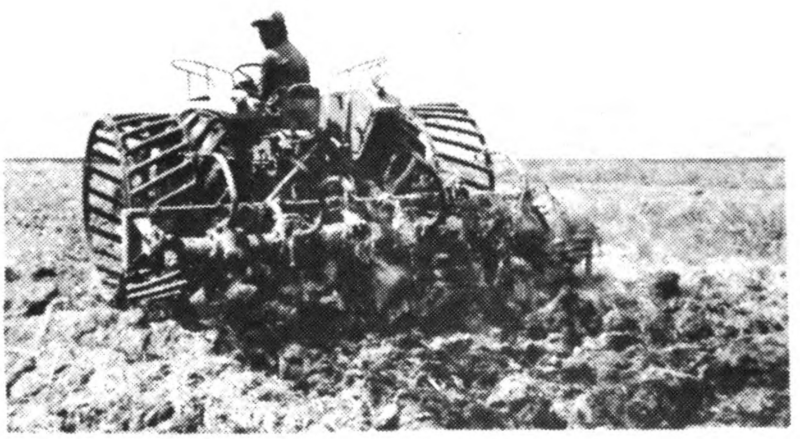

Fig. 13. A spade-like tillage implement that can be used on the heavy clay soils.

significance of farm mechanization in this district can be obtained from Table 11 in which is mentioned that 409 of the 622 agricultural tractors are located in Nickerie. This means that one tractor is available for every 30 ha. of arable land.

The most important farm mechanization problems are:

1. The few annual hours use of the farm machinery.
2. The high initial costs of equipment and the high costs of spare parts.
3. High depreciation, breakage, and repair expenses.
4. The unreliability of the weather.
5. The insufficient maintenance and care given to the machines.
6. The low income of the small holders.

The solution to the first problem (annual use of the machinery) is to increase the number of operations done by the tractor and other farm implements. At present the tractor, for instance, is used only for tillage, threshing, and transportation. Table 12 gives a typical labor and tractor hour requirement of 1 ha. of rice.

This means that the tractor is used for only about sixty hours a year on the average farm (according to Table 14 the size of the average farm in this district is 4 ha; 20 per cent time has been added for loss).

The tractor owners have also the function of custom service workers. It is believed that he will service about 20 ha. annually. This brings the total annual tractor use to 270 hours (210 custom work + 60 on own farm).

TABLE 12

TRACTOR AND LABOR REQUIREMENT TO GROW 1 HA OF RICE

Operation	Tractor Hours	Manual Hours
Weed control and dam repair		80
Tillage nursery	1	
Plowing and harrowing (puddling system)	8	
Sowing nursery		2
Pulling seedlings		48
Planting seedlings		200
Filling the gaps		100
Harvesting		200
Bundling of the paddy		64
Heaping up (with tractor)	4	40
Threshing	3	12
Winnowing		32
Baggings		16
Miscellaneous		100
Total	16	814

The activities which can be added on short range basis to the existing ones are:

1. The use of the tractor as a thresher.
2. The construction of a winnowing device, driven by the tractor.
3. The use of the tractor for plowing the rice land immediately after the harvesting of the paddy.
4. The more frequent use of the tractor as a means for product transportation as well as to transport persons.

The tractor has been used in many less developed countries for the threshing of paddy without any harmful consequences whatsoever to the implement. The factors to be taken into consideration are:

TABLE 13

METHOD OF TILLAGE AND THRESHING IN THE SURINAM RICE CULTIVATION

District	Hand		Animal Power		Mech. Power (owned)		Mech. Power (hired)		Not Tilled or Threshed	
	Tillage ha.	Thresh. ha.	Tillage ha.	Thresh. ha.	Tillage ha.	Thresh. ha.	Tillage ha.	Thresh. ha.	Tillage ha.	Thresh. ha.
Nickerie	13	182	92	25	10286	9298	4695	5683	105	3
Coronie	7	262	-	-	17	17	129	14	143	3
Saramacca	9	1790	9	58	261	271	928	442	1360	7
Suriname	276	1219	2604	4067	512	511	3581	1788	654	42
Commewijne	86	1734	256	599	66	74	761	343	1598	18
Total Country[1]	400	5265	2967	4753	11152	10180	10108	8276	3920	72

[1]The total area of the country is not equal to the summation of the area of the various districts, since two districts have been omitted.

1. A hard clean floor is necessary, a concrete floor should, however, be avoided.

2. At least 45 cm. of straw should be maintained.

3. High tire pressure must be avoided.

Rates of work as reported in Ceylon (FAO, 1960) are:

With two threshing floors - 640 kg (1,408 lbs.)

With three threshing floors - 960 kg (3,113 lbs.) per hour

With four threshing floors - 1,280 kg (2,816 lbs.) per hour

If the average Nickerie farmer uses two floors, he will be able to thresh his paddy in twenty-four hours (average yield is 3000 kg/ha).

A winnower, driven by tractor power, can be constructed easily. (The same principle used for the Japanese power driven winnower can be applied in the construction.) With a capacity of 1500 kg/hour, he can winnow his paddy (4 ha) in eight hours.

Experiments on the large scale farms and the agricultural mechanization division of the Department of Agriculture in Surinam have revealed that plowing of the field directly after the harvesting has beneficial action on the soil and the yield of the paddy (better aeration, etc.). It is very desirable that the farmer adopts this practice. By doing so he will use the tractor another twenty-four hours annually (plowing capacity - three acres per hour; the farm size is approximately eighteen acres).

The more frequent use of the tractor as a transportation

vehicle needs some consideration. Too often the farmers pay transportation charges to have their products transported by other persons (trucks, pick up, etc.).

A way to save travel expenditures for himself and his family is by constructing devices which will make the tractor suitable for traveling purposes. This problem was studied in a course, AE 840, "Advanced Power and Machinery, under the guidance of Dr. W. F. Buchele at Michigan State University. The class designed and built a device on the tractor so that it could temporarily be converted to an "automobile." It is the author's opinion that it is worthwhile to introduce this device to the Nickerian farmers.

The total hours that could be added this way are twenty for product transportation and twenty-five for using the tractor as an "automobile." These few added activities will enable the farmer to increase his annual tractor use on the farm from sixty hours to 180 hours.

He can also improve his income by custom work as follows:

1. Threshing.
2. Plowing after harvesting.
3. Winnowing of the threshed paddy.
4. Hauling.

The number of tractors available at present in the District of Nickerie is sufficient to handle the area of the small scale farmers. One of the important tasks, therefore, of the extension service in farm machinery is to bring this

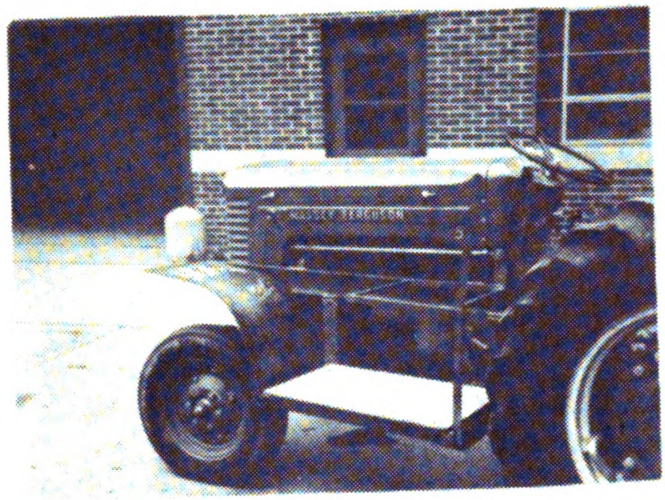

Fig. 14. First stage of converting a tractor to an "automobile."

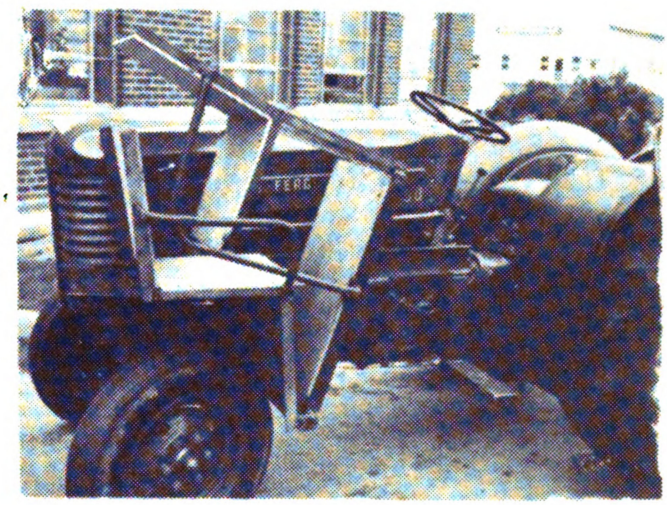

Fig. 15. Another view of the "automobile."

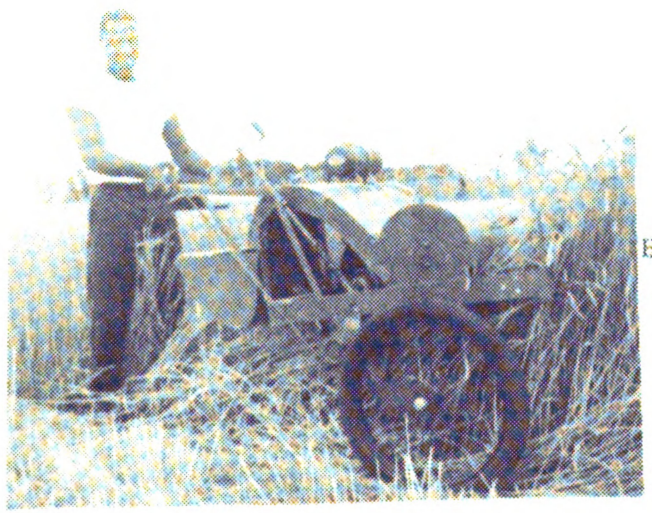

Fig. 16. Harvesting with the Poynter harvester.

fact to the attention of every prospective tractor buyer. There is, however, a fear that the purchase of farm machinery is beyond the control of the advisors and that farmers will continue to purchase tractors.

It is hence anticipated that the area serviced by the present tractor owners will decrease to 15 ha.

A summation of the annual custom service time will then be:

Puddling 15 ha -a 8 hours	120 hours
Dry plowing 15 -a 6 hours	90 hours
Threshing 15 x 6	90 hours
Winnowing 15 x 2	30 hours
Transportation of implements	50 hours
	380 hours

The total annual use of the tractor on his farm, as well as on that of the neighbors, will increase to 560 hours.

High Initial Costs of Machinery

As stated in the determination and analysis discussion, this problem is caused primarily by the high freight cost, the high commission of the dealers and in some cases the high prices of the market where the machine is purchased. The solutions, or at least part of the solutions, require governmental interference in the form of:

1. Establishing a certain percentage commission on farm machinery, especially spare parts.
2. Encouraging the import of farm machinery from markets with reasonable prices.

As to the first mentioned solution the writer realizes that a free enterprise system works best when there is the least interference from the government. If, yet there are

evidences that the free enterprise rules are applied in a way harmful to the development of the country, then it is the obligation of the government to attempt to improve these conditions.

As to the second solution, the persons involved in this decision must be very careful. Very often cheaper machines have a shorter useful life than the more expensive ones (use of less durable materials, etc.). There are markets, however, that can deliver durable machines at reasonable prices. In order to know if the cheaper machine will work as well as the more expensive one under the Surinam conditions, the government institutions involved with the testing of farm machinery should conduct extensive testing. If testing proves that the machine has a useful life, then those institutions can freely encourage the import or, even further, standardize the importation of farm machinery. These factors will be discussed at length in the long range goals of farm mechanization in Surinam.

High Initial Costs and Insufficient Care

Certain tropical climatic influences cannot be altered. It is true, however, that a proper care and maintenance program can extend the useful life of machines under all climatic conditions. Experience has shown that very often, and this is especially true in the wet paddy cultivation, machines have to be used under conditions for which they were not designed. Needless to say, depreciation, breakage

and repair expenses are higher. The only way to cope with this problem is by testing the machines and determining where weak points exist. If these can be corrected in a cheap way (for instance, the strengthening of a frame or the use of a water tight seal for the final-drive of the tractor), the experiment division should advise the local workshop, if there is any in that area, how these changes can be made. This solution is, it must be granted, not one that can be applied directly. It requires a thorough study of the machines on hand.

Other ways to decrease the costs related to this problem are:

1. The increase of the repair facilities.
2. Extension service courses in the maintenance and care of farm machinery.
3. Introduction of a vocational agriculture course in the last two classes of the elementary school and throughout high school.

The repair facilities are at present far from satisfactory. Most of them are located in Nieuw, Nickerie, the seat of the Nickerie district. For farmers in the Nanni Polder (the extreme southwestern part of the district), this means a travel of about forty km. Precious time will be lost, especially during tillage or harvesting seasons, if they have to drive that distance for repair work.

The government can aid in the solution of this problem by establishing a workshop in those areas where they are urgently needed. A start in this direction can be made by

the opening of two workshops: one in the western polders and one in the eastern polders. The execution of this plan can be done as follows: six months prior to the establishment of the workshops, the government chooses two local mechanics in the Nickerie district who are willing to manage the workshop after proper training. They are sent either to the Prins Berhard experimental farm (one of the large and highly mechanized rice estates in Nickerie) or to the agricultural mechanization division of the Department of Agriculture for further training. This training will not only include technical knowledge, but also simple bookkeeping and accounting that they will need later on in their own workshop. Finally, the government will establish a complete workshop for the trained workshop managers. It is desirable to let the managers have full charge and bear the responsibility of action taken. In other words, the government is loaning him the money needed for the establishment of the workshop on a long term and low interest basis. The only obligation to the government is to give the agricultural mechanization division access to their shops, books, and consider offered recommendations.

It is not advisable to establish workshops owned by the government. Experiences have shown that an ambitious private enterprise owner can work much cheaper than the government. (The government has higher overhead costs.) The building must be constructed in order that the following services can be accommodated:

1. Main overhaul area.
2. Welding and blacksmith area.
3. Carpentry and sheet metal area.
4. Machine shop.
5. Battery, tire, and fuel and ignition system shop.
6. Spare parts storage.

The teaching of the elementary concept of proper maintenance and the execution of simple repair has been fruitful in this district. There is yet a wide field to be covered in this area.

The District of Nickerie is of great importance to the further development of the small scale mechanization. It is, therefore, advisable that the Department of Agriculture place a full-time officer in charge of farm mechanization here. This officer can then teach said courses, conduct simple research and advise farmers on matters of farm mechanization.

Important items to be included in the extension service courses are the following:

1. Give operator a better understanding of the machine.

   Specific items to be covered are:

   a. The valve and valve service
   b. The importance of clean air
   c. Oil for engine and the hydraulic system
   d. The power transmission
   e. Ignition and cooling system

2. Show the proper care of the tractor and implements.

   Specific items to be covered are:

   a. Trouble shooting

   b. Machinery service and cost records

   c. The importance of a good shelter

   d. The safety of tractor and machines

3. Make him more familiar with the possibilities of the tractor and farm machines.

   Specific items to be covered:

   a. The hitch of the tractor to the plow and other farm implements

   b. Transmitting power by means of belt, chains and shafts

   c. The proper tools to use for different farm activities

The course can be taught during the period between the planting and the harvesting time (slack period). A duration of two months (three times a week) seems reasonable to obtain the above mentioned goals.

Many 4-H club projects have been highly successful in Surinam; a 4-H tractor project should be established. A translated American 4-H tractor program can serve the purpose.

With regard to vocational agriculture programs on the elementary school level, some work has already been done in this area. In the different districts, courses have been given to sixth graders and higher in the afternoon after they come from school (school terminates at 1:00 p.m. in Surinam). The total number of hours for said courses are 160. Of this

TABLE 14

AVERAGE FAMILY SIZE OF THE FARM FAMILY AND NUMBER OF FARM WORKERS PER HECTARE OF AGRICULTURAL LAND

District	Younger than 15 Years			15 Years and Older			Total			Farm workers per hectare
	male	fem.	total	male	fem.	total	male	fem.	total	
Paramaribo	1.5	1.6	3.1	1.5	1.3	2.8	3.0	2.9	5.9	4.4
Nickerie	1.4	1.4	2.8	1.4	1.3	2.7	2.8	2.7	5.5	0.4
Coronie	0.9	0.8	1.7	1.0	1.1	2.1	1.9	1.9	3.8	1.1
Saramacca	1.2	1.1	2.3	1.3	1.1	2.4	2.5	2.2	4.7	1.0
Surinam	1.3	1.3	2.6	1.3	1.2	2.5	2.6	2.5	5.1	1.2
Commewijne	0.9	0.9	1.8	1.2	1.1	2.3	2.1	2.0	4.1	1.7
Land	1.2	1.2	2.4	1.3	1.2	2.5	2.5	2.4	4.9	0.9

total, ten hours is appropriated to farm machinery. This number seems totally insufficient for a district such as Nickerie. A more realistic plan would call for twenty-five hours of training. Materials covered in this course must be simple; the teacher should give the students a general understanding of the tractor and farm machinery. He must further stress the importance of good maintenance, care, and safety. Finally, there must be an opportunity to teach the student to drive the tractor safely. (Many accidents have occurred on farms with youngsters who did not take safety precautions into consideration.)

The unreliability of the weather, although less than in the other districts, interferes with farm work. The inconveniences occur either in the late start of the rainy season, through which the farmers are forced to plant their paddy later than anticipated. (The irrigation system does not supply all the water needed for the paddy cultivation) or some heavy rain showers during the harvesting period which results in a soft condition of the field, making the harvesting with machines very difficult. It is obvious that this problems is nearly related to a poor irrigation and drainage system. If the rice cultivation is to be mechanized completely, it will be essential to improve the water control. Attempts are made to solve this problem. At present, however, the farmer, unfortunately, will have to live with it.

TABLE 15

DESIRED PRODUCTION AND LAND EXPANSION

Product	1958	Desired in 1965	Area 1958	Necessary Expansion 1958-1965				
				Area Necessary in 1965	Large Holdings	Small Holdings		Total
						By Rearrangement	By Clearance	
	tons	tons	ha	ha				
Rice (paddy)	18,049	131,400	28,800	36,400	6,000		1,600	7,600
Sugar	8,361	11,000	1,700	2,500	800	--	--	800
Banana and Plantain	4,660	92,000	600	7,400	2,000	400	4,400	6,800
Cocoanuts	5,673	6,500	1,600	2,100			500	500
Orange	9,545	11,500	1,100	1,400	300			
Pulse	878	2,000	700	1,900	--	400	800	1,200
Vegetables	1,477	4,300	400	1,100		200	500	700
Milk and Cheese	7,100	18,300	5,700	7,800				2,100

The insufficient maintenance and care is, fortunately, a problem that can be solved through education and advice. A few ways have been suggested to decrease repair costs (page 71). To these can be added a system of personal inspection of the machinery by an officer of the extension service as follows: Once a year (preferably between the planting and harvesting period) an extension officer of the mechanization division visits the individual machinery owner. Together they will check the tractor, plows, mower, thresher, and other machines. While checking the officer will point to parts needing special care or repair. This method may seem elaborate, but it can be very fruitful, especially with farmers who do not attend the offered courses.

Another source of help in educating the farmer to a better understanding of machinery is the implement dealer. The dealers, with the exception of a few, consider their responsibility to be limited to the selling and delivery of the farm machinery. The extension service should convince them that it is also part of the business to see that the machine sold is handled in a proper way and that a mistreated tractor can harm the reputation of that brand on hand.

The low income of the small holders is the most difficult problem and it is not easy to solve because it consists of technical, social, as well as economical factors.

The net income of one ha. rice land is around Sf 200.00. Table 16 shows a specification of the income and expenditures.

TABLE 16

NET INCOME OF 1 HA. RICE LAND

Income	Expenditures	
3000 kg. of paddy a Sf. 0.10 = Sf. 300.00	Seed 50 kg a Sf. 0.12	Sf. 6.00
	Tillage (puddling)	60.00
	Weed and insect control	8.00
	Threshing	20.00
	Ground rights	2.00
		96.00
	Transport product	10.00
		Sf. 106.00
Net income = Sf. 194.00		

This means that a farmer with four ha. rice land will have an annual income of about Sf. 800.00. This amount is insufficient to support him and his family. In areas with industries, he will work at a part-time job in order to increase his income.

The above specification applies to a non-mechanized farm. The situation is better on a partly mechanized farm (animal implements or power machinery) inasmuch as the costs of tillage and threshing will be lower.

There are many ways in which the income can be raised. Some of these are as follows:

1. Increase the yield per acre.
2. Enlarge the acreage under cultivation.
3. Switch to other crops.
4. Raising more than one crop on the farm.
5. A combination of these points.

The solution in Surinam will be reached by an increase in the acreage and by raising more than one crop on the farms.

There is a general tendency to develop farms of about eight ha. in the new cleared area. This, with the improvement of some of the used practice, will enable the farmer to increase his income from Sf. 800 to 1500. Table 17 shows some of the changes that can be done in the rice cultivation in order to decrease the number of hours needed per ha. and by doing so increase the annual income. Most of the changes are not drastic and can easily be accomplished. The extension service will play, though, an important role in this matter.

TABLE 17

SUGGESTED TRACTOR AND LABOR HOURS ON 1 HA. RICE LAND

Operations	Tractor Hours	Manual Hours
Plowing (after harvest)	6	6
Making bunds and weed control	5	10
Tillage of nursery	1	2
Puddling	6	6
Sowing seeds		2
Pulling seedlings, etc.	6	20
Planting		150
Filling the gaps and weed control		100
Harvesting		150
Heaping up paddy	4	40
Threshing	3	12
Winnowing	2	4
Bagging	1	10
Transportation and miscellaneous	5	50
Total	39	662

A family consisting of four persons will now (without hired help) be able to raise eight ha. of paddy. They would not be able to farm this area with the conventional methods now used.

If the assumption is made that the eight ha. just described is owned by a farmer with a tractor and the needed farm machinery (plows, harrows, wagon, and winnower), his income will then be as follows:

TABLE 18

NET INCOME OF 8 HA. RICE LAND

Income	Expenditures	
24000 kg a Sf. 0.10 = Sf. 2400	Seed 400 kg a Sf. 0.12	Sf. 48.00
	Farm machinery [1]312 hours a Sf. 3.50	1092.00
Net income farm = Sf. 1180 (Sf. 2400 - Sf. 1220.00. [2]Income as custom worker = 360 hours a Sf. 0.75 = Sf. 270. Total net income for farmer thus is Sf. 1450.	Weed and insect control	64.00
	Ground rights	16.00

[1]In the Sf. 3.50 is included tractor and machinery cost minus labor.
[2]The 360 hours is the total hours made on 15 ha. a 24 hours. Only his labor has been taken into consideration since the other items in the machinery cost calculation cannot be considered as income.

The other way to improve the income of the farmer is for him to raise more than one crop. Experiments in this regard in the Groot-Henar polder (southeastern part of the district) are very hopeful. The farm in this polder are

about eight ha; banana and rice are the main crops grown. According to plans of the Bureau of Rural Development, the farmers will be able, in the long run, to have an annual net income of more than Sf. 2400.

The suggestions made in this discussion are those which in the author's opinion can be made in a reasonably short time. The long range program to increase the income can be accomplished by further mechanization of the rice cultivation and other crops. These changes, however, depend on many factors that need investigating.

Suriname District

The Suriname district is the second in importance and grows a great variety of agricultural crops, and contains 115 farm tractors (Table). Rice is, however, still the most important one. The total area of paddy is 7672 ha (27 per cent of the country's paddy area).

The most important problems mechanization-wise are the following:

1. The high initial cost of farm machinery.
2. The competition for labor with the industry.
3. The division of the farms in many parcels.
4. Poor irrigation and drainage.
5. The unreliability of the weather.
6. The inadequate care and maintenance of farm machinery, hand and animal tools.
7. The uneconomical use of farm labor.
8. The low income of the farmers.

Fig. 17. Threshing paddy with bullocks. This practice is still widely used in the Surinam District.

Fig. 18. Threshing with a portable threshing machine (Turner Economy).

Suggested solutions to the problems. The same solutions suggested in the district of Nickerie can also be used in this district, with regard to the high initial cost of farm machinery. In order to keep the cost of mechanization as low as possible, it will be advisable to study the indigenous hand and animal tools used in this district. The use of the bullock, unlike the district of Nickerie, is very common here. Its use is, however, confined to the paddy cultivation. Nothing has been done in the past to adapt this animal to dry farming. It is, therefore, advisable to do some testing with bullocks as prime mover in dry farming.

The normal practice is to use a pair of oxen for the pulling of the various farm implements. Tests in many countries have shown that especially constructed harnesses enable one bullock to do the same work of a pair of bullocks. Work done in India and Pakistan can aid the testing institute in Surinam in constructing a harness that will fulfill the local requirements. Another method of decreasing the cost of mechanization is to make an extensive study of the so-called Japanese rice cultivation system. A few Japanese rice implements have been ordered and tested rather superficially in the past. One of the reasons for the unfavorable result was the fact that the paddy was not planted in rows as it is the case in Japan. To try the feasibility and economics of said machines, a suggestion will be made to order a few sets and conduct tests according to the methods

used in Japan. If they are adaptable to the conditions, a program can then be established to introduce this system to the small farms that are totally not suitable for tractor and other more advanced farm machinery.

The competition for labor with industry is felt especially in areas around Paramaribo and the bauxite industry. For the farmers with a small area of available land, the presence of these industries is beneficial. They can, indeed, increase their annual income by working part time in the industry. For those in larger areas who must hire labor, this is less fortunate. During the planting and harvesting season they normally cannot get the labor needed; and if they can get it, they have to pay higher wages.

Solutions to this problem can be:

1. Introduce the custom service method in this area.
2. Recommend cooperative use of farm machinery on farms not large enough to have their own set of implements. The tractor owner, who does not have enough land to economically justify the purchase of farm machinery, will, after completing his work will work for the neighbor.

In spite of this there are still areas that cannot be cultivated. The method of custom service can be of help under those circumstances.

The agricultural mechanization division can assist individual interested in initiating a custom service by providing him the information needed for such a service. The cooperative idea does not have such a good name in Surinam. This is the result of corruption that took place in some

cooperatives a few years ago. The cooperative division is, however, working hard to improve their public image and teach the farmers the fundamentals of a sound cooperative system. Many persons are very skeptical about farm machinery coops. With education and proper advice, this form of machinery ownership will certainly be adaptable in Surinam.

In order to develop this idea the agricultural mechanization division should stimulate a group of farmers to start a farm machinery coop. The division can help these farmers by providing an experienced officer who will teach them how to set up work schedules, how to maintain the machinery. The cooperative division's assistance can also be included in this service. It is advisable not to start the first machinery coop on a large scale. If it becomes economically solvent, additional machines can be purchased.

The division of the farm in many parcels is a result of the crops grown. The rice farmers, due to the poor irrigation and drainage system, are entirely dependent on the rainfall. They should collect as much of this water by constructing numerous bunds on the fields as possible.

An improvement of the irrigation and drainage would, obviously, eliminate this problem. Since this improvement will take considerable time, it seems more feasible at this time to find machines for rapidly constructing bunds. The farmer can break the bunds every year during the tillage system and then reconstruct them. This will enable him to work faster on the paddies and make use of larger implements.

Two systems are suggested:

1. The use of a bund maker (animal as well as tractor).

2. The use of levees.

The construction of a bund maker is simple. Plastic levees have been used extensively in the rice cultivation in the U. S. One of the important factors that will determine the adaptability of this product will be whether it can be done economically.

Irrigation and drainage problems are being studies at the Department of Public Works and the Water Works Division of the Department of Agriculture. The mechanization division will not actually work on the solution, but will assist as needed at the institutions. This solution of this so important problem not only to the rice cultivation, but also for the dry land cultivation.

The unreliability of the weather has been discussed in the general section. The fluctuation caused by the weather and inadequate irrigation and drainage, especially in the vegetable area, can possibly be solved by the use of deep wells. Unfortunately, a detailed discussion is impossible due to the absence of essential data. The first step to be taken by the testing institute is the purchasing of a well drilling machine (4-8" diameter) and conduct tests in the area needing water. If the results are successful, the next step will be to conduct economic studies and work out a plan to drill wells for the farmers.

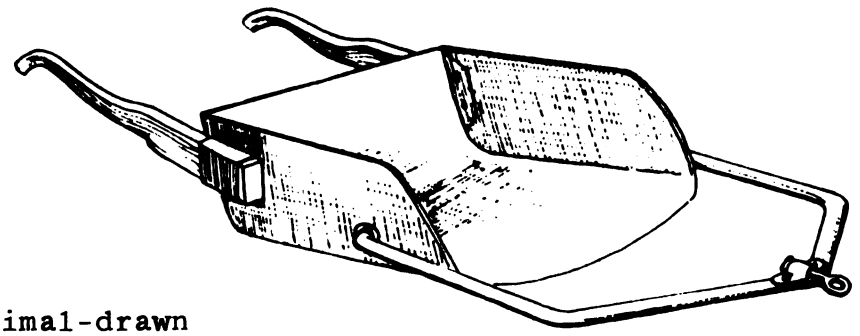

Fig. 18a. Animal-drawn earth scoop.

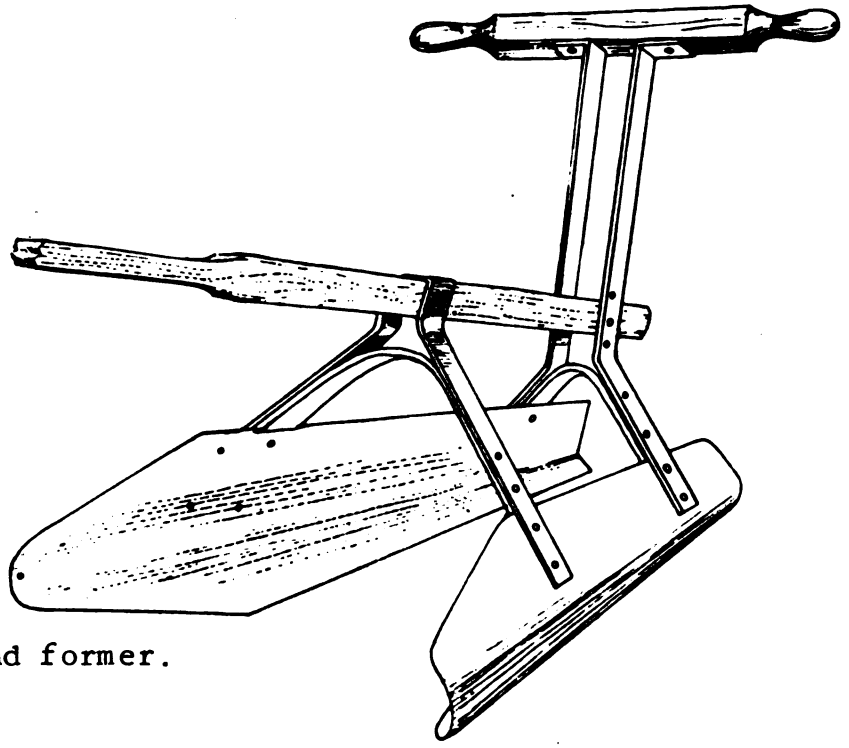

Fig. 18b. Bund former.

The uneconomical use of farm labor manifests itself in the use of time-consuming devices and practices. An example is the method of transporting of the paddy seedlings used by most of the farmers. He carries two bundles of the seedlings over a considerable distance. A more economical way should be the use of a sled or a carrier. The principles of farm work simplification could be used to change these practices. The problem of inadequate maintenance can be solved along the same line suggested in the Nickerie district. Since the number of tractors in this district is less than Nickerie and the farmers are closer to Paramaribo, one shop in the Santo-boma polder will be sufficient. The same procedure as suggested in Nickerie can also be applied to the establishment of this workshop.

There are a large number of bullocks and animal-drawn implements in this district. Many of these implements have a low field efficiency. Testing will be done in order to increase the features of the implements so that they can be used more economically.

Low Income of the Farmers

The farms in the Surinam district are smaller than in Nickerie and ways to expand the area of those farms are not feasible. The government has, however, constructed a number of new polders in this district with larger farms. A way to increase the income of the farmers on the "old land" is by consolidating the smaller farms into larger ones. Part of

Fig. 19. Clearance of the land for dry farming.

Fig. 20. Experiments with a machine to control the aquatic weeds in the many ditches in the surinam agriculture.

the farmers can transmigrate to the new polders. This will also make the use of farm machinery better adaptable to the condition.

The problems and suggested solutions of the districts Nickerie and Surinam have been discussed extensively. Since most of the solutions can, to a great extent, be applied to the other districts, the author will not follow the same approach. He will confine himself to the suggested programs that can lead to the solution of the problem. He will often refer to condition, discussion in the first two districts.

Saramacca District

The problems of this district are more or less the same as in the Surinam district. The peanut cultivation plays an important role in the life of the farmers of Indonesian origin. The rice area is 2567 ha. The greatest majority of the rice farmers use hand and animal tools (see Table 13).

Suggested programs to solve current problems.

1. Introduce more advanced mechanical tools in the peanut cultivation.
2. Test the feasibility of a small two-wheeled tractor and implements in the cultivation of pulses.
3. Introduce a set of Japanese implements on farms suitable for their use.
4. Extension courses in farm machinery maintenance in Groningen, the district seat.
5. Use of farm simplication methods to improve labor efficiency on the farm.

Commewijne District

Most of the large scale farms are located in this district. The principal crops grown on these farms are: citrus, coffee, cocoa, and sugar cane. Commewijne has 2762 ha. rice land (Table 8). The raising of vegetables and bananas is also of importance. Conditions are nearly the same as in the Surinam district.

Suggested programs are the following:

1. Introduce farm machinery in the northern part of the district where most of the rice land is located.
2. Teach farmers from Indonesian origin to accept more economical ways of harvesting the paddy.
3. Improve labor efficiency on the farms through farm work simplification.
4. Introduce simple and improved hand tools in the vegetable cultivation.
5. Establish extension courses in the maintenance and care of simple tools and implements in Amsterdam.

Coronie District

This district is mechanization-wise at present less important. Most of the agricultural land is planted with coconut trees. The activities in this crop confine themselves to the sporadic cleaning of the surface around the trees and the harvesting of the fruits.

In the new rice polders, some mechanization can be found. Coronie has nine tractors and suitable tillage implements. Animal implements are not used in this area. The available bullocks provide tractive power for carts and other

Fig. 21. A scythe is very rarely found in the Surinam agriculture. Experiments in other countries have proved that this implement can be used successfully in small farming.

Fig. 22. A Danish selfbinder at work in a paddy field. The results with this machine were excellent. A drawback, however, is the high initial cost.

Fig. 23. Manual peanut cultivation in the Saramacca District. The hoe is used here for earthen up and weed control.

Fig. 24. Experiment with mechanical cultivation of the peanut crop.

means of transportation. Hand tools are utilized for preparation of the small plots of dry land farming.

Suggested program:

1. Improvement of the indigenous hand tool and method of cultivation.
2. Instruct tractor owner to use tractors and implements cooperatively.
3. Instruct the small coconut-grove owner to make cooperative use of spraying equipment and the like.

Experiment to be Conducted

In the foregoing pages the problems of the small scale farmer have been discussed and suggested solutions presented.

Some of the solutions are based on experiences gained in other countries with similar conditions as in Surinam, other on hypotheses. In order to prove that they will certainly work in the country's agriculture, there is need for well equipped testing facilities. There has undoubtedly work been done in this field in the past, but a lack of the proper instruments, fields for the testing of equipment, and cooperation were factors that hindered the development of such an important institution.

Ubels (1956) mentioned, in connection with this, that in the past many results in testing were lost due to:

1. Insufficient diagnosis.
2. Inadequate preparation.
3. Few possibilities to chose and establish an experimental field on a responsible manner.
4. The dependability on private individuals for experimental fields.

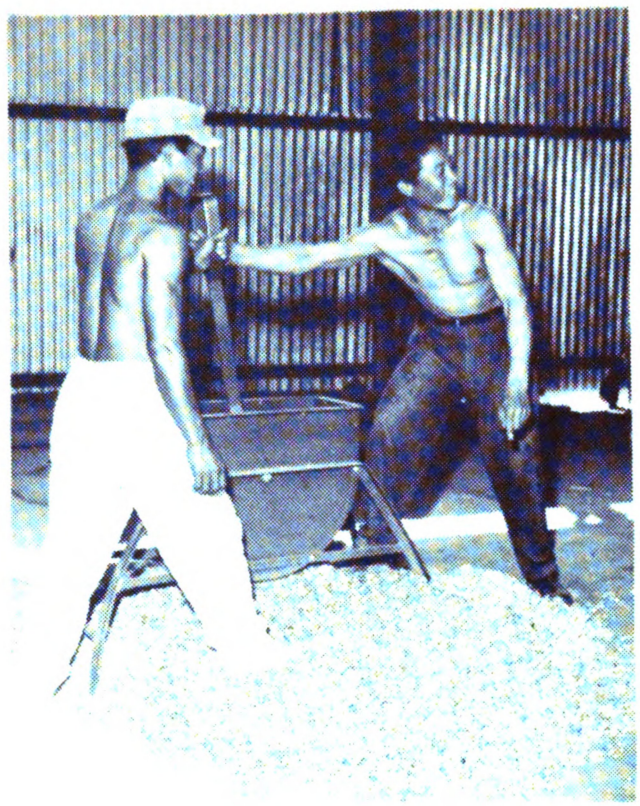

Fig. 25. Husking peanuts with a simple Japanese Husker.

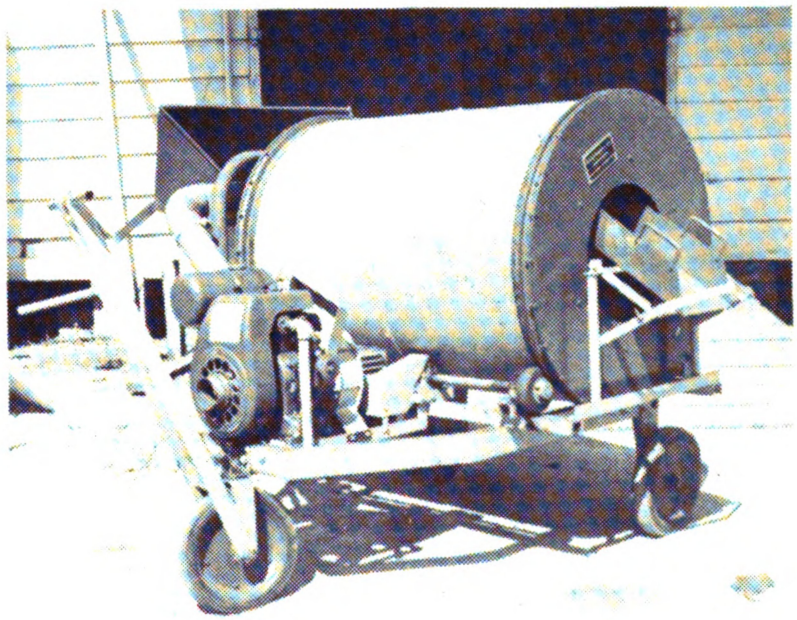

Fig. 26. Drying of the agricultural products is very important. In the photograph a dryer tested for use on small farms.

5. Poor maintenance as a result of inadequate control possibilities.

Fortunately, there have been changes in this condition.

Some of the suggested solutions can be executed within a short period, while others require a longer time of testing before they can be released as adaptable under the conditions at hand.

It seems, therefore, very proper to establish a short term and a long range program. A short term program can be defined as a result of testing or change in present agricultural practices that can be applied within a period of two years. Long term programs are those which will require a time beyond the above mentioned period.

Taking the suggested solutions into consideration, the following can be specified as short term goals:

Rice

1. Test a complete set of the Japanese rice system implements.
2. Construct devices for bund making (the use of plastic can also be included).
3. Test the scythe for the harvesting of rice.
4. Construct harness for bullocks.
5. Construct simple transportation devices for farmers with hand and animal power.
6. Conduct experiments with the Poynter harvester.
7. Test implements to be used in the establishment of pasture.
8. Conduct research on irrigation and drainage of the banana fields.

Tractor

9. Construct devices which will make it possible to use tractors as a means of transportation.

10. Construct and test lug wheels with better floating abilities.

The long range goals are the following:

Rice

1. Construct and test mowing device attachable to the tractor (front mower).

2. Test and modify some of the transplanting machines on the market.

3. Construct and test simple threshing machines.

4. Test apparatus for the drying of the rice products.

5. Use of rice straw in the rope and construction industry.

6. Location of small combine suitable for Surinam.

Other Crops

7. Conduct experiments with mole drainage.

8. Conduct further experiments with irrigation and drainage of the banana fields.

9. Test implements to be used in the vegetable and pulse crops.

10. Conduct experiments with deep wells and their economical use, especially in the vegetable region of the district of Surinam.

11. Conduct experiments to find an economical method of clearing the newly developed area.

12. Work toward the solution of the mechanical harvesting of paddy.

13. Standardize the import of farm machinery.

The author realizes that this schedule does not give

a complete picture of the activities to be conducted in the future. It does, nonetheless, give the important points that need direct attention of a testing institute.

A matter of great importance to the development of the farm mechanization in the small scale farms is to have a very close contact with other countries where research is also done on similar problems. An exchange of ideas and implements will not only accelerate said development, but it will also enable the involved institutions to do more with less funds.

It is not the intention to discuss the points mentioned in the short and long range goals in detail, but some explanation is needed. With standardization of the implements, the author means the testing of a great number of implements that seem promising and the accepting of a few that worked best under given conditions. The government will then issue import quotas only for these machines. The purpose of this regulation is twofold: (1) Protecting the small farmer in the purchase of farm machinery, and (2) with only a few makes, the dealers are in a better position to give the needed service and to have the required parts on hand. These regulations have been practiced successfully in Israel and Pakistan (Hetstroni, 1962, and Drew, 1960).

TABLE 19

CROP HARVEST CALENDAR FOR SURINAM

Crop	Harvest Period	Bulk of Harvest
Corn	October-March	January-March
Rice	March-April August-November	March-April[1] September-October
Sugar cane	Whole year around	August-January
Sweet potatoes, yams, and cassava	Whole year around	August-January
Vegetables	Whole year around	January-May and December
Pulses	January-February and July-August	January-May and December
Oranges	July-November	July-September
Grapefruit	June-November	June-September
Bananas and plantains	Whole year around	September-February
Coconuts	Whole year around	September-February
Peanuts	February-April and September-November	October-November
Soy Beans	January-June	March-May
Coffee	January-February and October-December	January and October-December
Cocoa	Nearly whole year round	May-August

[1]For acreage with mechanical cultivation and good water control only.

EDUCATION AND EXTENSION SERVICE IN FARM MECHANIZATION

In the discussion of suggested solutions to the problems in various districts, some attention has already been paid to this side of a farm mechanization program. An import place must be assigned to demonstration and the actual involvement of the farmers in the various activities.

The teacher and extension worker must keep the words of Dr. Knapp, the founder of the U. S. extension service, in mind. He once stated: "What a man hears he may doubt; what he sees he may possibly doubt, but what he does himself he cannot doubt."

The extension service worker must also realize that he is not assigned to solve the problems of the individuals. His job is more to help the people to help themselves.

Besides the suggestions made in the previous chapter, the following points will need the attention in the fulfillment of a mechanization program:

1. Have the tractor and implement manual translated into the Dutch language so that the farmer will be able to understand it better.

2. Suggest the use of a plate similar to that of Figure 27. The farmer will, in this way, get more familiar with the maintenance and care rules of the farm machinery.

3. Teach personnel of the distrct extension service the essentials of farm mechanization. They can then help in the fulfillment of the farm mechanization goals.

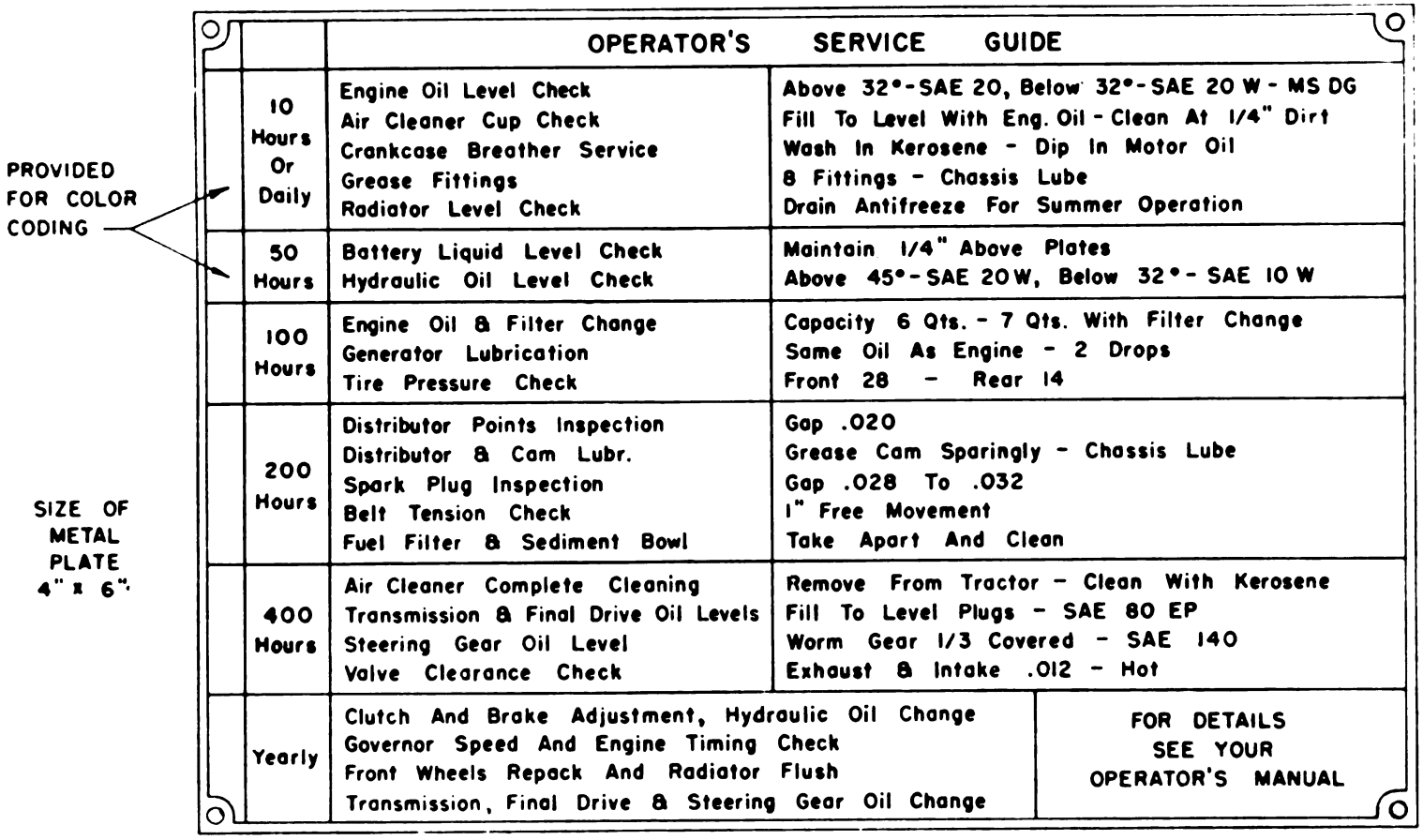

Figure 27. Example of plate to be used on tractor.

4. Establish a demonstration farm in each district. On this farm the interested farmers can acquaint themselves with the progress made and the possibilities of farm mechanization.

The agricultural vocational school at Alliance (district of Commewijne) will be of great importance in the establishment of middle class farming in Surinam. As stated in the study, there are only small scale and large scale farmings.

The program of this school has, however, not appropriated enough time to farm mechanization (farm mechanics). Only 40 of the 4,230 hours is available for the teaching of farm mechanics. This is insufficient. A better understanding of farm mechanics principles will not only enable the young farmer to manage his farm better, but he can also use it as a demonstrator.

Farm mechanics deal with the unspecialized mechanical activities carried on in daily farm operations and the performing of those activities with tools, equipment, and abilities which a proficient farmer could reasonably be expected to possess. Farm mechanics instruction is focused on better selection of equipment, more effective use of mechanical and labor-saving devices, preventive maintenance, and simple building.

It stands to reason that the planning of a farm mechanics course is influenced extensively by the level of training of the students in mind and the existing need for training in the area where the school is to be located. The following plan was developed to teach activities of practical

interest and value to the agriculture of the specific area where the student originated. The purpose of this plan is to guide the teacher of farm mechanics. Since most of the students have not been exposed to such a program in the past, it is recommended that the teacher proceed at a slow pace during the first few months. The development of a skill or activity chart is valuable in that it shows the accomplishment of the student and serves as a guide to both the student and the teacher. The table suggests an allotment of time for the various enterprises during the complete three year course.

TABLE 20

EXAMPLE OF A TIME BUDGET FOR A SUGGESTED PLAN OF A THREE-YEAR FARM MECHANICS COURSE

Enterprise	Time Allotted at Each Grade Level 1	2	3	Total
Drawing and sketching	10	5	--	15
Farm carpentry	25	25	25	75
Cold-metal work	5	5	5	15
Forge work	15	15	25	45
Rope work	4	4	--	8
Soldering and sheet metal work	--	10	10	30
Farm electricity and motors	--	--	10	10
Concrete and masonry construction	--	--	10	10
Plumbing and water supply	--	10	15	25
Sewage disposal	--	2	4	6
Power transmission	--	10	15	25
Tractors and engines	25	20	20	65
Farm structures	--	10	10	20
Farm machinery	30	20	30	80
Fencing	--	5	6	11
Irrigation	10	10	20	40
Farm tool fitting	10	5	5	20
Total	134	156	220	510

PATTERN OF AN ANNUAL PLAN FOR FARM MECHANICS--1ST YEAR

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
Drawing and Sketching	Demonstrate Lettering Scale drawing Freehand sketching Preparing a bill of material	Lettering exercises Construct farm signs Scale drawing of simple farm building Prepare bill of materials	10
Farm Carpentry	Demonstrate Use of common woodworking tools Selecting building materials Types of nails, screws, other fasteners and their uses	Construct Workbench Nail box Saw horse Tool cabinet or panel Simple wooden animal implements	25
Cold Metal Work	Demonstrate Cutting cold metal Drilling metal Filling metal	Construct Gate hinge Foot scraper	5

PATTERN OF AN ANNUAL PLAN FOR FARM MECHANICS--1ST YEAR (continued)

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
Forge Work	Demonstrate Starting and maintaining a forge fire Squaring, rounding, tapering, punching, riveting hot metal Tempering metal	Fabricate Cold chisel Punch Hoe	15
Rope Work	Demonstrate Whipping rope ends Making a crown splice Making an eye splice Making long and short splices Tying square and bowline knots	Make Rope halter Long splice Short splice Eye splice Crown splice	4
Tractor and Engines	Included in Farm Power and Machinery		25
Farm Power and Machinery	Demonstrate Making simple repairs on machinery, such as re-	Recondition simple farm implements Locate trouble on tractor	30

PATTERN OF AN ANNUAL PLAN FOR FARM MECHANICS--1ST YEAR (continued)

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
	placing plowshares. Lubricating machinery Protecting machinery from elements Preventive maintenance on tractors and machines	Perform preventive maintenance on a tractor Safety exercise with farm implements	30
Irrigation and Drainage	Discuss the use of irrigation water and the maintenance of an irrigation system Discuss drainage practices	Construct simple drainage and irrigation systems, such as open ditches and culverts	10
Farm Tool Fitting	Demonstrate Dressing emery wheels Sharpening, reconditioning, and maintaining common hand tools	True up emery grinder Sharpen Wooden chisel Plane iron ax, hatchet, and hoes Tin snips or scissors Knife Condition screwdriver	10

PATTERN OF AN ANNUAL PLAN FOR FARM MECHANICS--2ND YEAR

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
Drawing and Sketching	Review Sketching and lettering Simple blueprint reading Preparing bill of material	Sketch simple project to be made Prepare bill of material for project	5
Farm Carpentry	Review and discuss Selecting building materials Estimating material costs Demonstrate Other tools	Construct Poultry feeder Chick brooder Workbench Grain box Gate Bullock yoke	25
Cold Metal Work	Demonstrate and review Using cold metal working tools Using power drill	Construct Poultry-picking hanger Gate hinge Sackholder Twine and string cutter	5
Forge Work	Demonstrate Temper and sharpen a pick Demonstrate	Sharpen and temper pick Construct Nail puller Pinch bar	15

PATTERN FOR AN ANNUAL PLAN FOR FARM MECHANICS--2ND YEAR (continued)

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
	Reconditioning hand and animal tools	Tractor clevis and pin Construct bullock plow	
Rope Work	Demonstrate the use of local materials (rice straw) for rope making Continue on work of 1st year	Construct Simple device for rope making	4
Soldering and Sheet Metal Work	Demonstrate Operating a blow torch Cleaning, tinning, and using a soldering copper Soldering small holes Sweating patches Soldering a seam Fastening with rivets or metal screws	Construct Metal feed scoop Chick feeder	10
Plumbing and Water Supply	Demonstrate the principle of simple water pumps, their care, and maintenance	Construct Simple water reservoir Dismount and mount water pumps	10

PATTERN FOR AN ANNUAL PLAN FOR FARM MECHANICS--2ND YEAR (continued)

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
Sewage Disposal	Discuss the principle of sanitation on the farm	Construct Simple privy	2
Power Transmission	Demonstrate Using belts, chains, and pulleys properly Using power take-offs properly	Select proper size pulley for a given job Belt up to a job Provide safety on power take-off	15
Tractors and Engines	Discuss and demonstrate Operating principles Oiling and lubricating Cooling system care Daily operational care Safety in tractor operation	Prepare tractor for use Fuel checking and adding Coolant checking and adding Lubrication Checking tires, inflating and adding liquid (weight) Checking for worn or loose parts Study safe tractor operation	20
Farm structures	Remodeling old structures Demonstrate laying out and and squaring a foundation	Lay out a foundation for a small building Correct building failures	10

PATTERN FOR AN ANNUAL PLAN FOR FARM MECHANICS--2ND YEAR (continued)

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
Farm Machinery Repair and Care	Demonstrate Replacing mower knife Replacing sections and ledger plates Repairing farm machines Painting farm machinery Preserving plows after use Storing farm machinery	Recondition and repair Plow Harrow Cultivator Disc Farm wagon	20
Irrigation	Continue and extension of 1st year material	Construct bunds and simple water works	10
Farm Tool Fitting	Review Reconditioning and maintaining Plane iron Cold chisel Auger bit Hoes Demonstrate Reconditioning and maintaining saws	Recondition Screwdriver Auger bit Cold chisel Plane iron Knife Hatchet or ax Hoe Hammer	5

PATTERN OF AN ANNUAL PLAN FOR FARM MECHANICS--3RD YEAR

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
Farm Carpentry	Demonstrate Laying out rafters Laying out stringers for steps Selecting and using hardware	Construct Farm workshop bench Farm gate Implement trailer Feed rack	25
Cold Metal Work	Continue material from 2nd Year	Continue material from 2nd Year	15
Forge Work	Demonstrate Construction of hand and animal tools	Construct Hand and animal tools	25
Farm Electrification	Discuss electricity terminology Safety in the use of electricity on the farm Demonstrate Selection of electrical wires, etc. Simple wiring	Make an extension cord Inspecting home wiring for hazards Reading meters Compute electric bill	10

PATTERN OF AN ANNUAL PLAN FOR FARM MECHANICS--3RD YEAR (continued)

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
Concrete and Masonry	Discuss Materials--cement, water, aggregates Proportioning of materials for types of jobs and conditions Water-cement ratio Watertight construction Reinforcing concrete Estimating quantities of materials Demonstrate Testing for silt Mixing concrete Constructing forms Placing, finishing, and curing concrete	Perform silt test Construct forms Mix materials Lay concrete walk Build section of wall Make concrete fence posts Lay block foundation for a building	8
Plumbing and Water Supply	Discuss How to protect wells and springs from surface water and possible pollution	Install a simple water system Build a watertrough for livestock Repair leaky valves and faucets	4

PATTERN FOR AN ANNUAL PLAN FOR FARM MECHANICS--3RD YEAR (continued)

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
Sewage Disposal and Sanitation	Discuss Types of sewage disposal for farms Laying sewage drains The septic tank Ways of making the farm more sanitary Proper storage of manure and facilities for handling	Construct septic tank Lay a sewage drain Construct shed for manure Construct pit for manure	4
Power Transmission	Demonstrate Using belts, chains, and pulleys properly Using power takeoffs properly Using hydraulic systems properly	Check rpm of a pulley Select proper size pulley for a given job Belt up to a job Provide safety on power takeoff Perform maintenance on hydraulic unit	15
Farm Structures	Discuss Remodeling old structures Causes of failure in farm buildings	Brace a farm building Lay out a foundation for a small building Correct building failures	10

PATTERN FOR AN ANNUAL PLAN FOR FARM MECHANICS--3RD YEAR (continued)

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
	Requirements for farm buildings, foundations, and footings Demonstrate Laying out and squaring a foundation		
Farm Machinery	Discuss Recent improvement in farm machinery Selection of farm machinery for the job How to prolong the usefulness of farm machinery Use of service manual Demonstrate Replacing worn parts	Perform preventive maintenance on farm machines Repair Plows Harrows Animal implements	30
Fencing	Principle of good fencing Construction and maintenance	Construct Fence on school farm	6
Irrigation	Discuss Irrigation of rice field	Construct Simple irrigation system for rice land	20

PATTERN OF AN ANNUAL PLAN FOR FARM MECHANICS--3RD YEAR (continued)

Enterprise	Teacher Activities	Student Activities	Time Allotment (Single Periods)
Farm Tool Fitting	Demonstrate Reconditioning and Sharpening of ensilage cutter blades Discs Cultivator shovel Rolling coulter	Sharpen Disc Ensilage cutter blades Rolling coulter	5
Tractors and Engines	Demonstrate Cleaning and replacing oil filter Cleaning and adjusting spark plugs Carburetor adjustment Discuss Fuel system Ignition system Cooling system	Clean or replace an oil filter Adjust a carburetor Clean and adjust spark plugs	20

SUMMARY AND CONCLUSION

Developing countries are eager to improve their economical position. Most of them hope to do this through an improvement of their agriculture consisting primarily of small farms. The majority of the farms have an abundance of labor and the use of hand and animal tools (80 per cent of the total world farmers still practice farming with hand and animal tools).

The mechanization of the small scale farming is an universal problem, not easily solved. Other factors besides the size and abundance of inexpensive labor, which hinder the rapid development of mechanization are: the strong population pressure on the land, the low cash income, and the lack of mechanical knowledge and skill.

In Surinam, agriculture is and will play a very important role in the country's economy. Since about 80 per cent of the agricultural land is in the hands of the small holders and their contribution toward the national income is low (25 per cent), the government is trying to find ways and means to improve this condition.

Mechanization can aid the achievement of the desired goals. It must, however, be introduced and developed carefully. The different districts are not equally advanced in the use of farm machinery; it is thus impossible to make one

master plan suitable for all conditions.

Because of this, every district has been considered separately. Their main problems have been discussed and solutions suggested. The important problems in the mechanization of the small farms follow:

1. High initial costs of farm machinery.
2. Low hours of annual use of the tractor and farm implements.
3. Low income of the farmers.
4. Poor irrigation and drainage facilities.

The following suggestions were studied to reduce the high initial cost of farm machinery: (a) test machines to be imported, (b) choose the machines which work best under given conditions and let the government restrict the importantion of farm machinery to this brand, (c) financially aid farmers owning land suitable for mechanization, and (d) search for less expensive machinery with similar durability qualities as the more expensive machines and stimulate the purchase of said implements.

Some suggestions for increasing the annual use of the tractors are:

1. Increasing the number of activities performed by the tractor (threshing, winnowing, transportation).
2. Using the tractor cooperatively or for custom service.

The low income of the farmers is the most complicated problem, because it is interwoven with technical, social, economical, and political problems. The most obvious

solution would be an increase of their farms. This is, however, not feasible. The government is now approaching this problem by opening larger farms and trans-migrating some farmers in urgent need of land to this area.

Another solution is the cultivation of other crops besides the rice. (Rice has a low return per ha. compared to other crops.) Planting of more than one crop on the land spread also the risk. This solution can only be followed on land where the condition is suitable to grow dry land products.

One normally connects farm-mechanization with the use of tractor and other modern farm machinery. Simple hand tools and animal implements are, however, also mechanization tools. Great success can often be achieved with these tools than with the introduction of large equipment.

Besides the use of tractor and farm machinery, proper attention will also be given to hand and animal tools where most of the bullocks and animal drawn implements are found. A complete set of the implements used in the so-called Japanese system will be imported and tested for adaptability under Surinam conditions.

To eliminate the great fluctuation in the prices of some farm products, which are caused by unreliability of the weather and poor drainage and irrigation, suggestions have been made to test the feasibility of deep wells. Education will play a very important role in the achievement of the

goals. The program on the vocational agricultural school has, in the opinion of the writer, an inadequate number of hours dedicated to farm mechanization. Of a total number of 4,230 hours, only 40 are appropriated to farm mechanization. A program has been suggested whereby 510 hours are appropriated to farm mechanics during the three-year period. The inadequate maintenance of the farm machines, hand and animal tools are partly caused by a lack of knowledge on the part of the farmers. In order to cope with this problem, courses will be given to the adult as well as to the young farmers. The advisory work will also receive a great deal of attention.

The study conducted in this thesis is by no means a complete picture of the very complex problems surrounding the mechanization of small farmers. There are so many facets involved which make it impossible to arrive at complete solutions. The study gives, however, a basis on which further work can be accomplished.

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APPENDIX

APPENDIX I

ACCEPTED AND RECOMMENDED INTERNATIONAL RICE TERMINOLOGY

There is a great deal of confusion about the nomenclature of the rice cultivation. This is primarily due to lack of uniformity in nomenclature. The International Rice Commission outlined an International Rice Terminology at its first session held in Bangkok, Thialand (March, 1949). References concerning rice made in this thesis are in accordance with said outline. The following are frequently used terms.

Common Terms	Definitions	Accepted and Recommended Terms (I.R.C.)
Stalk paddy	Unthreshed rice in the husk, harvested with part of the stalk.	Stalk paddy
Paddy; unhusked rice; rough rice	Rice in the husk after threshing.	Paddy
Husked rice; shelled rice; hulled rice; brown rice; silver skin rice; cargo rice whole rice	Rice from which the husk has been removed; it still retains the bran layers and most of the germ.	Husked rice
Home pounded rice; Hand pounded rice	Rice from which the husk, germ and bran layers have been partially removed without use of power machinery.	Home pounded rice

Common Terms	Definitions	Accepted and Recommended Terms (I.R.C.)
Undermilled rice; lightly milled rice; unpolished rice	Rice from which the husk, germ and bran layers have been partially removed by power machinery.	Home pounded rice
Milled rice; machine milled rice; highly milled rice; white rice; clean rice	Rice from which the husk, germ and bran layers have been substantially removed by power machinery.	Milled rice
Polished rice; coated rice	Rice milled to a high degree and then coated with a foreign substance such as glucose or talcum. Called polished rice in Europe, whereas in the United States of America the term refers to rice that has been milled to a high degree and which has gone through the brush. In other countries the same term is used for highly milled rice treated with polishing powders. The term "polished" therefore causes some confusion.	Coated rice
Parboiled rice; converted rice; malekised rice	Rice obtained by pounding or milling from paddy which has been steeped in water, steamed or heated, and subsequently dried.	Parboiled rice
Whole grain rice; whole rice	Rice which does not contain broken grains, smaller than three-quarters of the whole grain.	Parboiled rice
Broken rice	Rice consisting of broken grains, smaller than three-quarters of the whole grain.	Broken rice

Common Terms	Definitions	Accepted and Recommended Terms (I.R.C.)
Brewers' rice	Very small broken rice generally used for industrial and feeding purposes	Brewers' rice
Rice polishing	A by-product from the milling of rice consiting of the inner bran layers of the kernel with part of the germ and a small percentage of the starchy interior.	Rice polishing
Husks, hulls; chaffs	A by-prduct consisting of the outermost covering of the paddy grain.	Husks
Bran; cargo meal	A by-product consisting of the outer bran layers of the kernel with part of the germ.	Bran

APPENDIX II

QUESTIONNAIRE
LABOR REQUIREMENT AND COST OF RICE CULTIVATION IN THE SURINAM SMALL HOLDING

Operations	Surinam District		Nickerie District		Saramacca District		Commewijne District	
	Sf./ha.	Hr./ha.	Sf./ha.	Hr./ha.	Sf./ha.	Hr./ha.	Sf./ha.	Hr./ha.
Repairing the buds	7.50-25	20-80	18.50-40	50-110	3	8	25-50	50-125
Cleaning ditches	25-50	42-160	7.50-20	15-45	10-15	15-35	12-15	40-48
Preparing seedbeds	4-10	12-30	8-12.50	7-15	10-15	16-35	18-50-50	30-50
Weed control (mech.)	40-50	130-160	25	40	50-100	150-200	40-80	150-200
Plowing (oxen)	35-45	40-65	30	40	75	80	37.50-50	40-60
Harrowing(oxen)	16	10	15-30	36-40	--	--	15-30	16-25
Pulling seedlings	7.50-10	25-40	11.50-25	50-80	10-25	32-60	15-25	40-65
Transplanting	40-50	150-200	25-50	85-110	37.50-50	100-125	50-70	150-200
Filling the gaps	10-15	35-70	7.50-15	12-30	12.50-25	25-40	10-12.50	24-50
Maintenance	10-25	40-80	12.50-25	30-50	12.50-30	24-80	10-25	30-60
Harvesting	40-50	150-200	20-37.50	50-130	37.50-50	80-130	32.50-50	80-150
Binding	10-12.50	32-40	10-15	32-50	12.50-15	32-50	10-25	20-25
Heaping up	10-12.50	32-40	10-15	10-25	15-25	30-50	15-20	30-45
Threshing (Manual or oxen)	35-40	64-80	25-50	30-80	25-50	50-125	25-50	40-90
Winnowing	8-12	32-40	6-10	12-20	7.50-13	25-40	10-15	25-45
Transporting paddy	7.50-15	25-40	7.50-10	10-30	10-15	24-40	10-17.50	15-30
Storage	5-7.50	16-20	--	--	--	--	2.50-5	5-10

APPENDIX III

DRAFT AND POWER REQUIREMENTS OF CROP MACHINES

Machine	Normal Range
Tillage:	
Plow	5-12 psi of furrow section
Lister	400-750 lbs. per row
One-way disk	150-350 lbs. per ft. width
Single-disk harrow	40-130 lbs. per ft. width
Tandem-disk harrow	80-160 lbs. per ft. width
Tandem-disk harrow, 22-in. diameter, 9-in. spacing	170-225 lbs. per ft. width, or 90 per cent of weight
Spike-tooth harrow	30-60 lbs. per ft. width
Spring-tooth harrow	75-150 lbs. per ft. width
Duck-foot field cultivator	90-160 lbs. per ft. width
Roller	30-60 lbs. per ft. width
Subsoiler	80-160 lbs. per inch of depth
In certain Southern and Far Western soils, draft figures ranging up to a maximum of approximately double the above have been recorded.	
Planting:	
Grain drill	30-80 lbs. per ft. width
Corn planter	80-120 lbs. per row
Cultivating:	
Rotary hoe	30-60 lbs. per ft. width
Corn cultivator	22-95 lbs. per shovel
Spring-tooth weeder	25-35 lbs. per ft. width
Rod weeder	80-110 lbs. per ft. width
Harvesting:	
Mower	60-100 lbs. per ft. width
Grain binder	65-150 lbs. per ft. width
Thresher	0.8-1.2 hp per in cylinder width
Combine, 5 and 6-ft.	2-4-1/2 (pto) hp per ft. of cutter bar
Combine, 8-12 ft.	Engine with 2-3 net hp per ft. of cutter bar
Corn picker, 2-row	2-5 (pto) hp per row
Stationary silage cutter	0.761-1.60 hp-hr. per ton
Husker-shredder	0.25-0.35 hp-hr. per bu.
Pickup baler	Engine with 15-25 net hp
Forage harvester	1-3 (pto) hp-hr. per ton of grass silage at 1/2-in. cut

From: Agricultural Engineering Yearbook, 1962, p. 226.

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