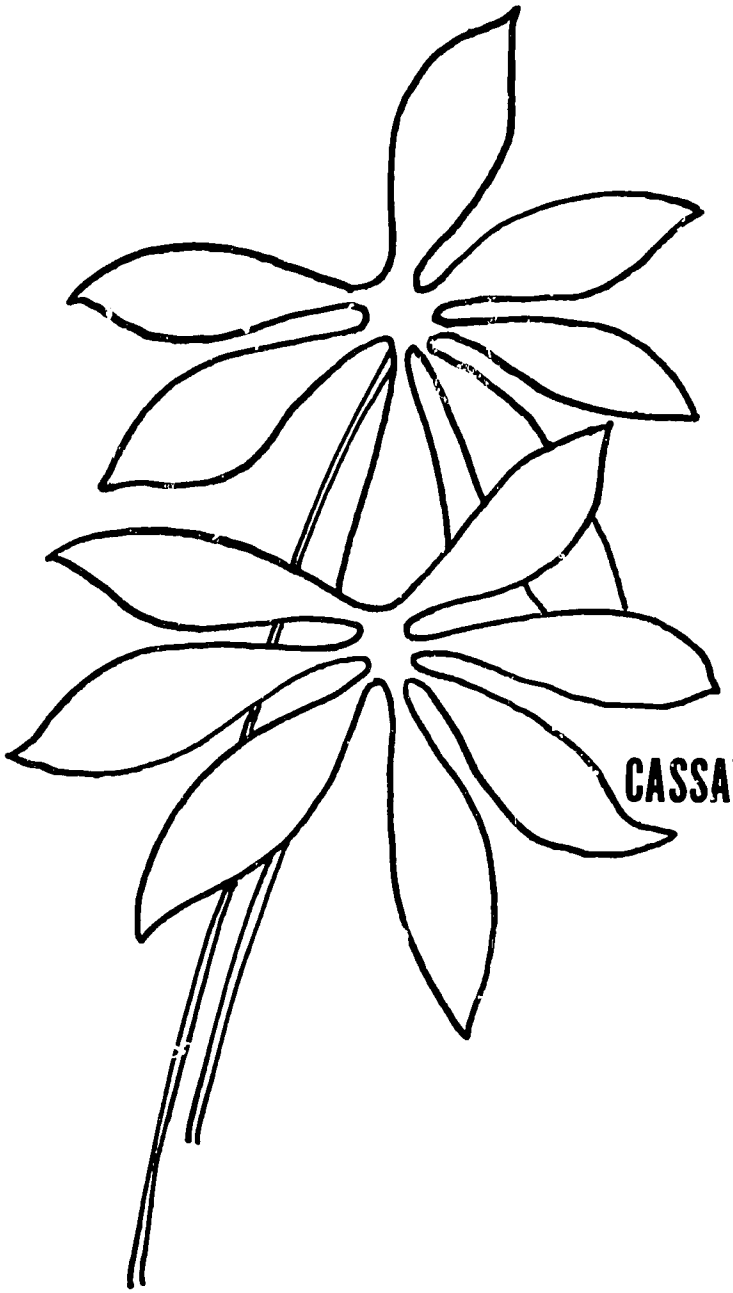
PN-AAK-912



DEVELOPING THE POTENTIAL FOR CASSAVA AS A COMMERCIAL LIVESTOCK FEED IN SOUTH VIETNAM

Prepared by

Anne R. McClelland
Economist

U.S. Agency for International Development
Office of Associate Director for Food and Agriculture
Agricultural Economics Division
Saigon, Republic of Vietnam

January 1975

DEVELOPING THE POTENTIAL FOR CASSAVA AS A COMMERCIAL LIVESTOCK FEED IN SOUTH VIETNAM

Prepared by

Anne R. McClelland
Economist

U.S. Agency for International Development
Office of Associate Director for Food and Agriculture
Division of Agricultural Economics and Support
Saigon, Republic of Vietnam

January 1975

PREFACE

Until recently, cassava was considered in South Vietnam, as in most cassava-growing countries, primarily as a crop for subsistence agriculture. In 1973, apparently stimulated by reports of high prices being paid in Western Europe for Thai cassava pellets for livestock feed -- against the background of an already spectacular growth in Thailand's cassava export market -- there was an awakening of interest on the part of both the Vietnamese Government and the private sector in developing a cassava-processing industry for export. During 1974, optimism as to Vietnam's cassava export prospects appears to have waned. At the same time, the rising price of corn has again brought cassava to the fore, this time as a possible product for domestic use as a livestock feed.

The Vietnamese prospects for exporting either dried cassava or cassava starch, as assessed in a December 1973 paper and briefly reviewed again in the light of more recent data, do not indeed seem at all favorable for the relatively near future. On the other hand, another earlier paper (April 1974), dealing with the nutritional aspects of cassava as a livestock feed, concluded that cassava can be satisfactorily substituted for at least half, or even more, of the grain in animal diets. Despite the dim outlook for foreign markets, therefore, cassava, an excellent source of carbohydrates and available indigenously without the added import costs borne by Western Europe, seemed a natural candidate as a domestic livestock feed.

The present paper is addressed both to examining the potential for developing cassava for domestic use as a commercial feedstuff in Vietnam, and to helping further the realization of the potential. The potential appears to be good. Large livestock producers are interested, and sufficient supplies of the fresh root can be expected to be forthcoming. Cassava as a commercial feedstuff would in effect be a new commodity in the Vietnamese economy, however, and the study foresees that informed interest and guidance -- over and above the normal market forces -- will be needed if the potential is to be realized rapidly in any substantial degree. By highlighting what seem to be the probable problem areas, and bringing together in-

formation both on cassava in Vietnam and the processing of cassava for livestock feed, it is hoped that at least some of the obstacles may be more easily overcome.

The advantages of a cassava-feedstuff industry, together with the anticipated problems and suggested remedial measures in getting it under way, are summarized in section V, Recapitulation, pages 25 through 28.

The two earlier papers (the latter modified somewhat) are included here as Annexes VI and V. Annexes I through III cover general background material on Vietnamese use, production and prices of cassava, as well as material relating specifically to cassava as a feedstuff; and annex IV, general background material on the processing of cassava chips, as well as material relating specifically to Vietnam.

Anne R. McClelland

Saigon, Vietnam
January 1975

CONTENTS

Page

PREFACE iii

MAP - Cassava production in South Vietnam xi

DEVELOPING THE POTENTIAL FOR CASSAVA AS A COMMERCIAL LIVESTOCK FEED IN SOUTH VIETNAM

I. THE SETTING

The commercial market for cassava in South Vietnam 1

High levels of cassava production in 1973 and 1974 2

The awakening interest in cassava by commercial-scale pig-producers 3

Unlikelihood of an export market for cassava in the near future 3

Required processing of cassava for use as a livestock feed . . 6

II. THE POTENTIAL FOR A DOMESTIC CASSAVA-FEEDSTUFF INDUSTRY

As an agricultural crop 7

As a livestock feed 7

As an agri-business 9

III. LIKELY IMPEDIMENTS TO THE RAPID DEVELOPMENT OF A CASSAVA-FEEDSTUFF MARKET

Tendency toward underutilization of cassava in animal rations 10

Difficulties in developing a cassava-processing industry . . . 11

Need for a more mechanized cutting/drying operation . . . 11

Lack of attraction to the average investor 12

Likely types of investors 13

Deterrents to likely investors 14

Poorly developed marketing system 14

IV. THE PROBLEMS AND SUGGESTED WAYS OF HELPING TO RESOLVE THEM

Inadequate information on cassava as a feed ingredient 16

Absence of a traditional base for the use of cassava . . 16

Attitudes of livestock producers 17

Activities of the Ministry of Agriculture 18

Potential role of the Government in providing the necessary information 19

Page

IV. THE PROBLEMS AND SUGGESTED WAYS OF HELPING TO RESOLVE THEM - continued

Needed information on the cutting/drying operation 21

Developing a market for dried cassava 22

Experience of livestock producers in obtaining dried cassava 22

Suggested action 24

V. RECAPITULATION

The desirability of promoting cassava as a feedstuff 25

The potential problems 26

Suggested remedial measures 27

Possible agents 28

ANNEXES

Annex page

I. USES AND MARKETING OF CASSAVA IN SOUTH VIETNAM

A. Uses of cassava 1

Types of use 1
Relative importance of the various uses 2
Extent and usage of dried cassava slices 3
Note on conversion factors for dried slices and starch . . 4

B. Marketing of cassava 4

Text table: Distribution of cassava use, 1971 2

II. CASSAVA PRODUCTION IN SOUTH VIETNAM

Movement in overall production and hectarage, 1956-73 . . . 6
The cassava-producing centers 7
Trends in regional distribution 7
Yields 10
Origin of cassava expansion in 1973 and indications for the future 10
Disposition of 1973 production 13
Potential level of production 13
Note on cassava varieties used in Vietnam 13
Supplemental note on 1974 production 16

Tables:

1 Hectarage, production and yield of cassava in Vietnam, by province, 1968, 1970-73 8

2 Changes in hectarage and production of cassava in Vietnam, by province, 1972-73 11

3 Peak hectarage and production of cassava in Vietnam, by province 14

3-A Hectarage, production and yield of cassava in Vietnam, 1974, compared with 1973 . . . . . 16b

III. PRICES OF CASSAVA IN SOUTH VIETNAM AND COST AS FEEDSTUFF

A. Prices of cassava 17

Retail prices of fresh cassava 17
Prices of fresh cassava in truckload lots 18
Prices of sliced dried cassava 23

Annex page

III. PRICES OF CASSAVA IN SOUTH VIETNAM AND COST AS FEEDSTUFF - continued

B. Comparative costs of using cassava vs corn in livestock feed in Vietnam 23

Tables:

4 Average retail prices of fresh cassava in Saigon and selected provincial markets, 1964-74 19

5 Retail prices of fresh cassava in Saigon and selected provincial markets, monthly averages, 1970-74 20

6 Comparison of retail prices of fresh cassava in selected markets with those in Tay Ninh, 1964-74 . . . 22

7 Comparative costs of balanced pig rations utilizing varying proportions of cassava 26

7-A Summary comparison of costs of pig rations utilizing varying proportions of cassava 28

Text table: Prices of sliced dried cassava 23

IV. THE PROCESSING OF CASSAVA CHIPS

A. Introduction 29

B. Thailand's dried-cassava production and marketing systems . 29

C. The cutting-drying operation 31

D. The cutting machine 33

Thai machines 33
Cassava-cutters in South Vietnam 40
A sophisticated chipping operation 41

E. The drying floor 41

Size of the floor 41
Type of construction 42
Estimated cost of construction in Vietnam 43

F. Relative costs of open-air and artificial drying 43

G. Note on cassava production in the Thai province of Supan Buri 47

References pertaining to Annex IV 49

Annex page

IV. THE PROCESSING OF CASSAVA CHIPS - continued

Illustrations

Cassava chipper commonly used in Thailand 35-37
Cassava drying in Thailand 37
Thai-manufactured Winster cassava-cutting machine available for export 38-39

Text tables:

Prices of Thai cutting machines 40
Size requirements for drying floor 42
Estimated cost of materials for drying floor in Vietnam . . . 43
Relative costs of open-air and artificial drying in Thailand 46
Costs and returns reported for fresh cassava root production in Supan Buri province 47

Work table: Estimated cost of raw materials for drying field . 44

V. THE ACCEPTABILITY OF CASSAVA AS A FEEDSTUFF

A. Introduction 51

B. Common forms of cassava for use as a livestock feed 51

C. Basis for the level of use estimated 52

Protein and energy values 52
Utilization of cassava in compound feeds in West Germany and the Netherlands 53
Experience of Malaysian feed producers 54
Performance of cassava in animal-feeding trials 54

D. The importance of balanced rations 56

E. The importance of unspoiled cassava 57

F. Added note on cassava substitutability and ration balance . . 57

Tables:

8 Recapitulation of cassava utilization as a feedstuff . . 59

9 Summary analysis of sample diets for pigs, using local Vietnamese ingredients 62

VI. PROSPECTS FOR VIETNAMESE EXPORTS OF CASSAVA PRODUCTS*

I. Introduction 63

Annex page

VI. PROSPECTS FOR VIETNAMESE EXPORTS OF CASSAVA PRODUCTS - continued

II. The international market situation 63

Cassava starch 64

Dried cassava for livestock feed 64

Thai productive capacity in a position to respond to demand 64

Expansion of current markets not anticipated 65

Thai institutional and physical framework well-developed 65

Corrective measures for poor quality 66

III. Competitive prices 69

Thai-EEC prices 69

Recent Hamburg quotations 69

Recent Thai quotations 69

Trend in prices 70

Can Vietnamese prices compete? 71

IV. Summary 72

V. Supplemental note on Thai and Vietnamese cassava prices in late 1974 73

Tables:

1 Thai chips and pellets: Wholesale price quotations in Bangkok, and resellers' quotations in West Germany, Aug 72 - Nov 73 74

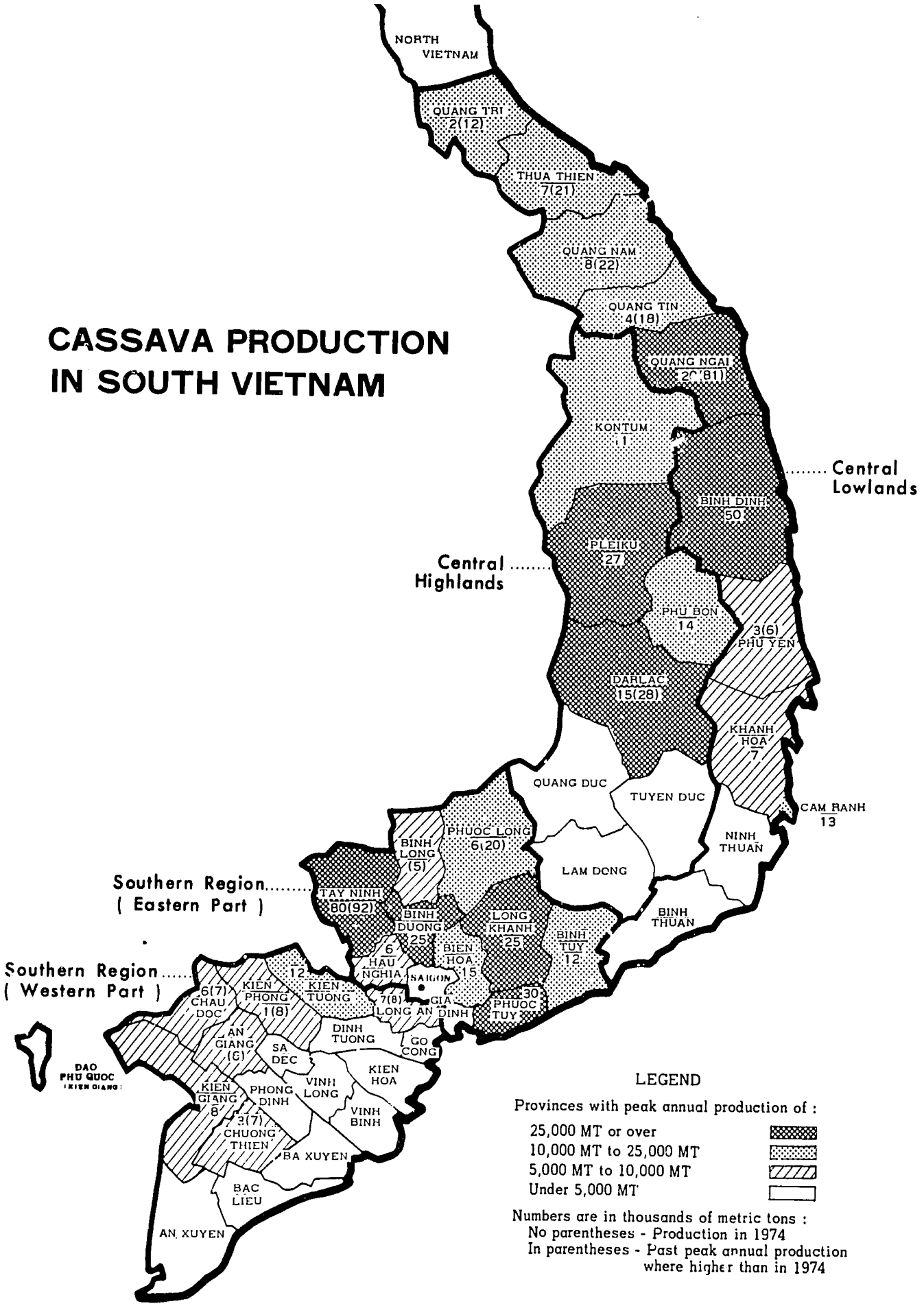
2 Dried cassava products: Average value of Thai exports and of West German imports, 1962-73 75

Text Comparison of Thai prices for fresh roots, chips and pellets, Oct 72 - Nov 73 70

Text Average and peak prices for Thai roots, chips and pellets, 1972-73, in U.S. dollars and Vietnamese piasters 71

*Sections I through IV of annex VI were written in December 1973. Section V is an updating of the material in section III, B.

CASSAVA PRODUCTION IN SOUTH VIETNAM



DEVELOPING THE POTENTIAL FOR CASSAVA* AS A COMMERCIAL LIVESTOCK FEED IN SOUTH VIETNAM

I. THE SETTING

1. The commercial market for cassava in South Vietnam. Used traditionally both as a low-cost food and a backyard livestock feed in the Vietnamese countryside, cassava first entered the "commercial" market in South Vietnam in the early 1960's with the establishment of small cassava-starch home industries in Tay Ninh province, in the eastern part of the Southern Region (MR-3). Until very recently, starch (or flour, as it is sometimes called) has been its only commercial use. The larger livestock producers, with access to PL 480 corn at highly subsidized prices, were understandably uninterested in cassava as a feedstuff.

Cassava root production appears to have been highly responsive to the starch market it did have. Statistics by use are not available, but the impetus given cassava plantings by the new starch industry shows up clearly in the spurt in fresh root output in the Southern Region (where other provinces followed Tay Ninh's lead, though on a much smaller scale). At 52,000 tons annually in 1958-60, cassava production in the Southern Region had more than doubled to 127,000 tons by 1962, reaching 175,000 tons in 1963. In the Central Lowlands, the country's traditional cassava-growing area, tonnage also increased (from an average 128,000 annually in 1958-60 to 201,000 in 1963), apparently also spurred by expectations of a local starch market; but when earlier plans for cassava-starch plants were abandoned, reportedly because of the poor quality of the product, production dropped sharply. Production in the Southern Region also dropped after 1963, but has stayed well above its pre-1960 levels: for most years between 1964 and 1972, output has ranged between 127,000 and 155,000 tons.

---

*Known also as "manioc" and, in Thailand, as "tapioca."

2. High levels of cassava production in 1973 and 1974. In 1973, cassava tonnage in the Southern Region reached a new high of 251,000 tons. In the Central Highlands, with a highly erratic record in the past, tonnage also peaked to 54,000 tons, up from 10,000 in 1971 and 20,000 in 1972. For the country as a whole, despite the low of 74,000 tons for the Central Lowlands, cassava production came to 380,000 tons -- only slightly below 1963's peak of 390,000 a jump of 50 percent over 1972. Area planted to cassava increased by close to 16,000 hectares over the year, reaching almost 48,000 hectares.

Much of the new plantings in 1973, possibly as high as 4,000 hectares, seems clearly attributable to emphasis on cassava in war victims resettlement projects. Collective projects of military and ex-military personnel reportedly account for another 2,500 hectares (about half in the Central Highland Region) planted primarily to cassava, at least some of it apparently in anticipation of a sharply rising market for starch and livestock feed, for both domestic use and export. Greater stabilization in the nomadic economies in the Highlands, and the ban on logging in Tay Ninh (where plantings increased by 3,200 hectares) may also have contributed significantly.

Beyond this, it is difficult to identify the probable factors for what seems to have been a spontaneous expansion. (Aside from the planting of two hectares of the high-yielding H.34 variety, for both free distribution and sale of seedlings, the Ministry of Agriculture reports no organized promotion of cassava production.) There have been some sizable plantings by large starch-manufacturers newly coming into operation; and the starch market appears to have been the target in MR-3 as well. In the western part of the Southern Region (MR-4), with a 2,300-hectare increase, all of the provinces with significant new plantings either are themselves, or neighbor upon, large suppliers of hogs for the Saigon market. Undoubtedly also of importance as an underlying factor is cassava's easy cultivation, and the relatively little attention needed, which has apparently made it a favorite crop for the military to meet the cultivation requirements for land deeded under the Diem or Land-to-Tiller programs.

A large part of the expanded plantings, it should be noted, was on newly cleared lands.

Preliminary estimates indicate significant further expansion in 1974, with production up by 18 percent over 1973 and area planted up by 14 percent, reaching all-time highs of almost 450,000 tons and 54,300 hectares. About 70 percent of the increase took place in the Central Lowlands, probably to be accounted for in large part by newly cleared sites in war victims resettlement projects. The remaining gains were divided roughly evenly between the Central Highlands and the Southern Region, which, for the latter, represented only a relatively small percentage increase.[1]

3. The awakening interest in cassava by commercial-scale pig-producers. In the absence of any organized information on cassava usage in South Vietnam, there is little guidance as to the extent to which cassava has been used as a livestock feed. Given, however, the low prices at which U.S. corn was available to the large livestock producers, the feedmills, and -- through cooperative organizations -- even to relatively small pig and poultry farmers, it seems safe to assume that little cassava was being utilized by the commercial livestock industry in the past (aside from some use of cassava waste meal available as a by-product from nearby starch-manufacturing plants).

In August 1973, with the market for animal products already considerably dampened by the generally reduced purchasing power in the country, the livestock industry was further faced with a price of VN$110/kg for imported corn, up from VN$68 in June. By early 1974, the price had risen to VN$130. The industry retrenched -- reportedly by 50 percent, or even more -- and many of the pig farmers, including large-scale operations, appear to have begun to turn naturally to cassava as a partial substitute for corn.

4. Unlikelihood of an export market for cassava in the near future. Considerable Vietnamese interest was generated in 1973 and early 1974 in the manufacture of cassava pellets and starch, presumably in response to rumored possibilities for highly profitable export to Western Europe and Japan.

1/ Further detail on recent and past cassava production is given in annex II.

Since then, plans for building capacity to export pellets seem to have been dropped; and, while new starch plants have been coming into production during the past year, output so far appears to be directed to domestic consumption.

As detailed in annex VI (written in December 1973), the Vietnamese prospects for cassava exports do not, indeed, seem promising for the foreseeable future.[2] The Thai cassava industry (whose exports of cassava products in 1974 are expected to reach nearly 2 million tons, with over 1½ million tons in pellets alone) presents extremely difficult competition to a newcomer. The channels of trade with the Dutch and German markets are firmly established, with important West European participation at all stages, from pellet production in Thailand, through exporting and ocean ship-charter, to membership on the Hamburg Bourse; and the industry has been selling pellets to France and Belgium, and starch to Japan as well. The productive capacity, both of the fresh root and the finished product, seems capable of responding to any likely increases in demand; and the extensive physical plant and production experience, geared to the rapid and steady flow of the product from grower to ocean-going vessel, permits it to provide a continuous, high-level output, an exceedingly important consideration to the foreign compound-feed industry. There has been dissatisfaction with the quality of the Thai pellet; but Thailand's price competitiveness still permits it to dominate the market.[3]

The high prices paid for pellets in Western Europe, moreover, include high speculative margins as well as transportation and other costs, and bear little relation

---

2/ There has, however, been no investigation of the prospects for the export of products utilizing cassava-starch as a raw material, such as monosodium glutamate (MSG), now being produced in South Vietnam; and the comments on the export market for cassava starch and animal feed are not intended to apply.

3/ Thai cassava accounted for 94 percent of Dutch imports in 1972, and for 87 percent of West German imports in the first 8 months of 1973. Indonesia, also with long-standing trade connections, made up most of the balance. Mainland China and some African countries enjoy a limited market made possible by the supply of a premium-quality product, for which South Vietnam as yet has neither the tradition nor the institutional framework.

to what the local seller receives. Making the more relevant comparison of Vietnamese prices with those in Thailand, the analysis made of 1973 prices showed quite clearly that Vietnam could not compete.[4]

A quick look at more recent prices indicates that, despite the slackening in Vietnamese cassava prices during 1974, the more favorable piaster exchange rate of 685:1, and the recent highs in Thai prices (which may be only seasonal), the gap is still too large to bridge. To compete with the late-1974 Thai prices (the equivalent of US$20 a ton for fresh roots, and $68 a ton for chips), Vietnam, at a conservative estimate, would have to be able to sell at VN$10 a kilo for fresh roots at the cutting factory, and VN$36 a kilo for chips at Saigon. Fresh roots in truckload lots at the Tay Ninh farm were reported at VN$25 to VN$27 per kilo in March-April 1974. At the lowpoint for the year -- lasting no more than a month -- they appear to have been down to about VN$16. Prices of dried cassava (in Vietnam the cassava is cut by hand, and the prices may not be indicative of a machine-operation) were reported at about VN$80 to VN$85 earlier in the year, and at VN$70 in September.[5]

No analysis has been made of comparative starch prices, but conversations with starch producers who have had contacts with the Japanese market have indicated that, here also, Vietnam is not now close to being competitive.[6]

4/ Allowing for the unfavorable freight differential between conference rates from Saigon to North European ports, and the charter rates available from Bangkok, it was estimated that Vietnam would have to be able to sell its fresh roots at no more than VN$8½ to VN$9 per kilo (in terms of the late-1973 price level) to meet what appeared to have been an all-time high for Thai roots (the equivalent of US$20/MT, delivered at the cutting/drying factory at Chonburi, Thailand's primary cassava-center). South Vietnam's low in 1973 -- for truckload lots in Tay Ninh during August, at the height of the harvest season -- was VN$14-15 a kilo, at the farm.

5/ Details are given in the supplemental note to annex VI, page A-73.

6/ No price analysis was undertaken in December 1973, since the latest available data showed a markedly downward long-term trend in the inter-

-- footnote continued

5. Required processing of cassava for use as a livestock feed. Beginning in 1967, Thailand has been shipping its dried cassava to Western Europe in the form of pressed pellets, essentially to reduce transportation and handling costs. In the aftermath of the Vietnamese interest in exporting dried cassava, some confusion seems to have remained on the need for pelletization even for domestic use as a feedstuff. Pelletizing requires considerable outlay (one pelletizing machine was quoted at $12,000); is a more complicated and costly process, requiring dried chips or slices as a raw material in any case; and offers little if any advantage over slices or chips, for the domestic market.

Since, however, the fresh root degenerates rapidly once it is harvested, it is essential that it be well dried -- in turn requiring prior cutting or breaking, given its 65 to 70 percent moisture-content -- if it is to be stored. (For a product suitable for animal feed, cutting/drying should be initiated within 24 to 48 hours after the root is lifted.)

The dried root can also be used in the manufacture of cassava-starch. From the farmer's point of view, drying permits the holding of the crop for a more favorable market.

As far as can be determined, only a minor -- and variable -- amount of cassava is now being dried in Vietnam and, to the extent it is being dried, the cutting operation is entirely by hand and the moisture content often uneven.

Footnote 6 continued:

national cassava starch market. (Imports by the U.S., the largest single buyer in the past, have been declining steadily from 150,000-180,000 MT in the early 1960s, to below 100,000 MT in 1968, 70,000 in FY 72 and 46,000 in FY 73. Thailand's exports in 1972, including 40,000 MT to the U.S. and 43,000 MT to Japan, came to 124,000 MT -- down from a high of 208,000 MT in 1967.) In 1973, however, Thai starch exports rose to 184,000 tons, and in the first seven months of July 1974 reached over 150,000 tons, with Japan now Thailand's largest starch-customer. Without further analysis, it is not clear whether this represents a lasting upturn: exports to Japan have fluctuated fairly widely in the past; and cassava-starch imports are restricted by quota as well as by high tariffs.

II. THE POTENTIAL FOR A DOMESTIC CASSAVA-FEEDSTUFF INDUSTRY

While the outlook for early exports is not promising, the potential for developing the use of cassava as a commercial livestock feed for domestic consumption appears to be good, and, in turn, the development of the potential can be expected to make a significant contribution to the economy.[7]

1. As an agricultural crop. Without going into the complex question of the relative merits of growing cassava versus alternative crops -- though its ability to grow on poor soils, its need of relatively little attention, and its high yields are worthy of note -- it would seem pragmatically to be attractive to the Vietnamese farmer, as evidenced by the past responsiveness to commercial demand by the cassava-starch industry and the high level of 1973 production, at least in part without foreknowledge of a sure market. Based on the 1973 experience, expanded production to meet livestock needs can be expected in general to be additive to, rather than in substitution of, other crop production.

2. As a livestock feed.[8] While dried cassava has been able to compete with feedgrains in Western Europe primarily because of protectionist agricultural policies, its use in Europe must absorb two costs not applicable to Vietnamese domestic use: (1) the high cost of ocean transportation (even at chartered rates, costs in 1968-72, before the rates were increased by the oil crisis, were running between $15 and $23 a metric ton); and (2) the pelletization of cassava, which added $5½ a ton, on the average, to Bangkok wholesale prices in 1973.

In specific terms of the Vietnamese scene, the use of cassava in place of imported (or exportable) corn not only saves foreign exchange but, at current prices, seems

---

7/ Limiting the discussion to cassava as a livestock feed is not intended as a slight to the possibilities for developing cassava-starch and its products for domestic use. Rather, as far as starch is concerned, the market mechanisms seem already to have been set in motion.

8/ The nutritive value of cassava and its suitability as a feed for poultry, as well as pigs, are discussed in annex V.

unquestionably more economical, even after taking into account its lower protein value. Using as the measuring stick three sets of sample diets for pigs, each set with equivalent amino-acid content (prepared by Dr. B. G. Harmon of the University of Illinois, with indigenous fish meal and rice bran as the source of the compensatory protein needed), rations relying on dried cassava in lieu of corn were cheaper than the corn-based rations as follows:[9]

Prices used	Percentage by which the cassava rations were cheaper		
	Weanlings	Growing pigs	Finishing pigs
As of April 1974 (cassava @ VN$82½/kg)	9½%	11½%	14%
As of June 1974 (cassava @ VN$82½)	8½	10½	12
As of Sept 1974 (cassava @ VN$70)	14½	15	13½
Lowest price for corn during Apr-Sept 1974 (VN$130), and the highest for fish meal (VN$170) and rice bran (VN$115), with cassava arbitrarily raised to VN$90*	7	8½	10
Same as above, but with cassava arbitrarily raised to VN$100*	4½	6	8½

*I.e., giving the utilization of cassava a significantly lesser advantage than it actually enjoyed in 1974.

The sample diets, moreover, were addressed to the greater utilization of locally available Vietnamese ingredients, and do not include any rations relying primarily on corn as the carbohydrate source. Illustrative diets specifically designed for a cassava/corn cost comparison would show even greater differentials.[10] Again pragmatically, commer-

9/ While the rations for each type of pig were equated on the basis of amino-acid content, their caloric values (which were shown for the weanling and the growing-pig rations) vary somewhat within each set. To provide comparability of caloric value as well, the comparisons within the weanling and growing-pig sets have been made on the basis of cost per calorie. The rations for finishing pigs, for which caloric values were not available, have been compared on the basis of cost per kilogram.

10/ Details on the composition of the diets, the estimated prices used, and the relative costs of the various diets are provided in annex III, pages A-23 through A-28, and annex V, pages A-57, 58, 62 and 62-a.

cial livestock producers have indeed been shifting to cassava at these prices, with indications as of April 1974 that a price of VN$100, or even higher, would also be acceptable (see footnote 22)

At this point in time, cassava also seems to have the greatest potential among the domestically grown crops for being developed as a primary energy-supplying feedstuff on a commercial scale. Too little, unfortunately, is known of either production or consumption patterns to predict how much additional cassava production might be forthcoming at prices acceptable to both the farmer and the commercial purchaser. (It would take about 250,000 to 300,000 tons of fresh cassava roots annually to meet the roughly 100,000 tons of corn imported per year for animal feed during 1970-72, before the livestock-production cutback.) However, given the recent upsurge in cassava production, much of it apparently on formerly uncultivated lands, and the fact that in some cassava-producing areas 1974 production still fell considerably short of past peak levels, further considerable increases -- if there were a market for the product -- would seem entirely within the realm of possibility.[11]

Dried sweet potato might be another good potential domestic carbohydrate feed; but its development as a commercial feedstuff would probably encounter even greater problems than cassava (see footnote 17). The prospects for using it as a commercial feed ingredient have not been explored here, however, and it is possible that they are more favorable than visualized. Sufficient production of sorghum for wide-scale animal use does not seem likely in the near future and, again, some similar problems are foreseeable.

3. As an agri-business. Given the uncertainties on what is, or would be, involved in a cassava cutting and drying operation in Vietnam -- in terms of the likely entrepreneurs as well as the costs involved -- there is little to guide us on precisely how profitable such an operation might be.

11/ Aggregating past annual peaks reported for the individual provinces yields a total of 76,000 hectares or, even with no increase in yield, as much as 630,000 tons of cassava production. (See annex II, pages A-14, 15 and 16a.)

To the extent that cassava is now being sliced and dried here, it is presumed that it is bringing in compensatory returns either in the form of agri-business wages, or as a means by which the farmer can sell his crop most profitably. What the costs might be under a more mechanized operation -- if, as seems likely, the present hand-operation is inadequate to meet large-scale commercial demand -- is not known. However, even if the more mechanized operation were to prove more costly than the present hand-operation, which does not seem particularly likely, there would still seem to be enough leeway in the prices acceptable to the livestock producer, and perhaps even to the farmer (if given a new market thereby) to absorb the difference.

On the whole, therefore, it seems fair to presume that an expanded processing operation to meet expanded domestic demand for dried cassava would indeed prove profitable. The new agri-business income would, of course, be additive to the economy.

III. LIKELY IMPEDIMENTS TO THE RAPID DEVELOPMENT OF A CASSAVA-FEEDSTUFF MARKET

In sum, the potential for dried cassava as an animal feed in Vietnam looks promising. Sufficient supplies of fresh cassava can be expected to be forthcoming. Commercial livestock producers have already been turning to dried cassava as a partial substitute for grain, buying at prices that have apparently been satisfactory to both the cassava farmer and the livestock producer, and increasing usage can be expected. Cassava as a commercial feedstuff would, however, represent in many ways an entirely new commodity in South Vietnam, in processing and distribution as well as in usage; and serious impediments to the fuller development of a real commercial market are foreseeable:

1. Tendency toward underutilization of cassava in animal rations. There is a widespread lack of information in South Vietnam on the nutritive potential of cassava which, combined with an uninformed fear of its toxicity, tends to make commercial livestock producers

reluctant to utilize as much cassava as they might and, in the case of the Directorate of Animal Husbandry, has resulted in the dissemination of guidelines that unduly encourage limiting the use of cassava in animal rations. Imperfect comprehension of the economics of alternative feed ingredients may also contribute to a failure to fully appreciate and exploit the advantages of cassava.

2. Difficulties in developing a cassava-processing industry. Extensive use of cassava as a commercial feedstuff will probably entail the development of an entirely new processing industry, requiring an investment too large for a home operation and, at the same time, of a type that is not likely to be attractive to the average Vietnamese entrepreneur. Unfamiliarity with the process and the equipment is further apt to discourage entrepreneurial initiative.

Need for a more mechanized cutting/drying operation. It may be that once the demand for dried cassava is effectively registered, it can be met merely through an expansion of the current hand operation, with perhaps some artificial after-drying; but it seems more likely that adequate supplies of the dried root would require mechanical cutting capacity and an attendant larger-scale open-air drying capacity.[12] As envisaged, this

---

12/ Open-air drying is still postul ed here, even for a large operation, since artificial drying down to the needed 14-15 percent (from a moisture-content in the fresh root of 65 percent, or even higher) would seem both prohibitively and needlessly expensive. Thailand, even with its 1½ million tons of dried product this year, has relied solely on sun-drying; and, as noted in annex IV, pages A-43 and A-46, an experiment conducted there with diesel-oil heating indicated the cost of artificial drying to be three times that for sun-drying (before the sharp increase in oil prices. it might be noted), and concluded it was not feasible. What was suggested as a possibility was the sun-drying of the root down to 20% moisture, and using artificial after-drying for the rest. (This was estimated as increasing drying cost by only 6½ percent -- again at early-1972 oil prices -- if the cassava were cut into fine strips. No estimate was given for the after-drying of the regular Thai chip.)

-- footnote continued

would be effected through relatively small-scale operations located near the cassava-growing areas,[13] but would entail a certain amount of capital expenditure and, probably, working capital for financing inventories as well. Capital requirements would be a cutting machine (probably about US$700 to US$1,000, though it might be more or less); the construction of a concrete or cement drying floor (probably about US$1,200 and up, exclusive of land costs, depending on size); a shed for storage in rainy weather; plus, possibly, a truck.[14]

Lack of attraction to the average investor. The processing procedures are simple, requiring no complicated skills, and the outlays needed are not large. Paradoxically, however, the operation is not likely to be of general appeal. While the type of work involved would

---

Footnote 12 continued:

On the other hand, controlled open-air drying does require a drying floor large enough not only to hold the chips in thin layers but also to permit them to be turned over frequently in organized fashion. /As best as can be ascertained, the small, farmer-operated Thai drying floor is at least 0.4 acres (1600 square meters) in area; and that of commercial collector-operations, at least an acre. Floors of large operations run 4 to 8 acres in area. (See annex IV, pages A-41,42.)/

13/ Where the livestock-producing areas are relatively distant from the cassava-growing areas, locating the cutting/drying operation near the growing area would probably have the advantages of (a) lower land-values for the drying field; (b) facilitating the early initiation of the drying process; (c) lower costs of transporting the dried, rather than the fresh, root; and, perhaps, (d) permitting the sharing of cutting machines by two or more operators.

14/ A Thai cassava-cutting machine, available for export, was quoted in November 1974 at $1200 f.o.b. Bangkok, exclusive of the 5-H.P. motor it uses. With transportation, fees, value added tax, and a motor (Japanese-made 5-H.P. diesel engines were quoted in Saigon, also in November, at the equivalent of $390, including the 10% VAT), the total unit, delivered, would come -- at a guess -- to something over $2,000. However, the Thai operators use a less-finished machine made in the Chonburi workshops, available locally at about $325, again

-- footnote continued

be very suitable for home industries, there is enough money involved to put it beyond their range. On the other hand, the need for fixed investment makes it an unlikely venture for the ordinary Vietnamese middleman (now operating, for example, in the cassava-starch industry, where his capital outlay is confined to trucks, divertible to other use if desired); and the relatively small scale of the individual operational unit, combined with the geographical dispersion of a multi-unit operation, makes it of limited interest to the ordinary large investor.

Likely types of investors. The most likely candidates for taking the lead in getting a cutting-and-drying operation under way are the livestock producers themselves -- those with their own milling operations -- several of whom have already expressed interest in such investment.[15] (Feedmillers as such may be interested at a later stage, but, at the moment, cassava in commercial feeds seems to be taboo.) The large cassava-starch plants, now coming on the scene in Vietnam, might also find it a profitable sideline as well as a means of keeping inventory on hand for their own operations. Other possibilities, once the market becomes firmer, are collectively-financed operations,

---

Footnote 14 continued:

exclusive of the 5-H.P. motor it uses. While the less-finished machine is apparently not available for export, it would seem possible for the Vietnamese machine shops to duplicate it at not too much higher cost. The export model is described as having a cutting capacity of 10 tons of fresh roots an hour; the latter, as about 2½ to 4 tons an hour, depending on the skill of the operator. (The machines would appear to be essentially similar, and the difference in capacities has not been confirmed.) Additionally, the Vietnamese Agricultural Machinery Directorate, with USAID/Vietnam assistance, has constructed a prototype cutter (capacity not formally tested, but estimated at 300 kg an hour) at an estimated cost, for labor and materials only, of $75. With overhead, value added tax, and a ½-H.P. motor, this might come to about $220.

The cost of materials for the drying floor is estimated roughly at about $1,100 per 1,600 square meters (0.4 acres).

See annex IV, pages A-33 through A-45, for further details.

15/ One livestock producer has already purchased what appears to be the export model of the Thai cassava-cutting machine referred to in footnote 14. At last report, it had not yet been delivered.

perhaps by groups such as the Cao Dai who were leaders in the cassava-starch industry (though Tay Ninh province, the base of their cassava operations, is probably not suitable for a chip industry since the need there to harvest the root during the rainy season, when its soil is more pliable, may seriously interfere with open-air drying); and it would seem a natural undertaking in war victim resettlement projects, where cassava as a crop is already being fostered, if funding could be found. Evidence of good returns might also attract owners of relatively large plantations now growing, or suitable for growing, cassava.

Deterrents to likely investors. There is danger, however, that the potential for developing a cassava-feedstuff industry will be stifled by a lack of initiative in the face of the lack of information on both the market and the operational requirements. The livestock producer is of course aware of the market, but he is generally unfamiliar with both the equipment and the process, simple as they are, and there has not been a ready source of information and technical advice he can turn to for getting started. He has neither been able to procure a cassava-cutting machine locally;[16] nor has he ready access to the advertising matter and operational blueprints and literature usually available in connection with more complicated processing techniques and more expensive equipment offered for export. Even though interested in investing in the operation, he seems stymied on how to proceed. For the other types of possible investors, there are the additional deterrents of only a minimal awareness that a potential market exists and, probably in the case of a shared effort of smallholders -- with or without government participation -- of difficulties in organization and funding as well.

3. Poorly developed marketing system. The lack of awareness of the market is part of the larger problem of an imperfect buyer-seller communication not uncommon in Vietnamese enterprises involving large centralized consumers and scattered small suppliers, even in activities already under way. In a market that is still in

---

16/ The export model of the Thai machine has apparently become available only recently; and its availability does not seem as yet to have been generally publicized.

an incipient, tentative stage, it might well inhibit the development of demand as well as supply.

While the buying and selling of dried cassava as a commercial feedstuff has been begun, there is no established market place or regularized distribution channel. While some livestock producers have been able to meet their current demands, others have been experiencing difficulties, even with reliance on intermediaries, and reduced utilization of cassava because of the difficulties in obtaining supplies has been reported. At the same time, demand has not been organized, and it is doubtful that the present cassava grower or cutter-drier is really aware of even the present market for dried cassava as a feed.

Once a processing industry aimed at the general livestock market emerges, the individual operations would probably be sufficiently large-scale to provide the needed concentration points. /This would not necessarily be true of undertakings by livestock producers, who might well limit their operations to supplying their own individual requirements (except, perhaps, insofar as they are also sellers of commercial feed, and use of cassava in prepared feeds becomes acceptable)./

Until then, it may be that enough demand will filter through to elicit increased supply of hand-sliced cassava; but it seems unlikely that a cassava-feedstuff industry will get really under way until there is more tangible evidence of demand.[17]

17/ As suggested earlier, while there has been no investigation of the prospects for developing sweet potato as a commercial animal feed, it seems quite likely both that it would face the same types of problems, and that the problems would be aggravated. Imperfect as it is, there is already, in the case of cassava, a commercial pattern of production in some areas of the country geared toward the cassava-starch market; and there are also at least some channels for commercial trade. Additionally, whether due to this, the greater familiarity with cassava through using the waste of the cassava-starch mills, or the publicity given to the European use of cassava as a feedstuff, the sweet potato tuber is probably even less familiar to the commercial livestock producers than is cassava.

IV. THE PROBLEMS AND SUGGESTED WAYS OF HELPING TO RESOLVE THEM

To the extent that both the general outlook and the diagnosis of the probable problems are correct -- and it should be recognized that some of it might more accurately be termed conjecture or subjective judgment based on meager samplings taken some months ago[18] -- most of the ingredients needed to get a cassava-feedstuff industry under way are there. No great amounts of either technical or financial inputs are involved. Essentially, what seems to be needed is a middleman, or middlemen, to get the necessary information into the hands of those to whom it would be useful.

1. Inadequate information on cassava as a feed ingredient

Absence of a traditional base for the use of cassava. Until recently, as already noted, the use of cassava as a livestock feed has been pretty well limited to nearby cassava waste meal and small-farm use in the rural areas. With subsidized corn prices -- and the recommended prescription of corn as the carbohydrate base of the animal diet -- there had, understandably, been little interest in cassava as a feed in commercial animal production. Now, with the cutback in foreign exchange

---

18/ In addition to DAE statistics, published sources on cassava in Vietnam have been Le Xuan Hoa, "Measures to Develop the Cassava Planting in Vietnam," (Joint Development Group, Working Paper No. 44, 1969) and the National Council for Export Development's "Cassava - Production Development and Export Market," 1973, both of limited scope.

Additionally, conversations were held in April-July 1974 with Mme. Le (president of the Vietnam Livestock Development Association and a pig producer, with 4000 pigs); Miss Phuong (on the staff of TAPHUNOCO, a cassava-starch plant in the process of being established); and Messrs. Tich (a pig producer with 1500 pigs); Can (owner of the VITAGA feed mill and a pig-farmer with 2500 head); Nguyen Thanh-Xa (president of the National Federation of Livestock Cooperatives with 19 member cooperatives ranging in size from 70-80 members to some with 1000-2000 members, dealing in poultry, fish and pigs; himself with a farm of 1300 pigs and also in the process of setting up a cassava-starch plant, SATICO); Tung (Dong-A farm with 3000-4000 pigs); and Hoang (owner of the DUTAFAC feed mill); as well as staff in the MOA Agriculture Statistics and Crop and Animal Production Services and the National Livestock Training Center.

assistance and the increasing price of corn, the interest is there, on the part of the government as well as the large livestock operations. Both are rather handicapped in following through, however, since the more or less "turn-key" manner in which the livestock industry was developed, and the easy access to externally prescribed "optimal" rations using imported ingredients, have failed to generate either the store of knowledge on domestic raw materials normally found in an indigenously evolved activity, or a full appreciation of cost-price relationships. To the extent that clarifying information and guidelines are not forthcoming, the usage of cassava on a commercial scale is -- and can be expected to continue to be -- rather tentative.

Attitudes of livestock producers. All five of the large pig-farmers visited had indeed begun incorporating cassava in their feeds to some extent -- one at least as far back as early 1973. There is, however, a wide range in the amount reported as utilized, from 30 and even 40 percent of the total ration, down to a token replacement of 10 percent of the corn component; and it seems clear that at least some were uncertain as to how much cassava could satisfactorily be used, and that they were not necessarily capable of drawing up rations that were properly balanced and/or most economic.[19] The five, moreover, all

---

19/ The amounts of cassava used were reported as follows:

(1) 30% cassava and 10% corn, even in young pig rations, and 40% for the older pigs /it was not reported whether corn also was used here/;

(2) 20% cassava and 40% corn /producer expressed intention to increase this to a 50% replacement of corn on a trial basis, after being shown materials indicating this to be a satisfactory level/;

(3) 10% cassava, 30% corn, 47% rice and wheat brans /also reporting an experiment using 30% cassava and 56% rice and wheat brans as unsuccessful/;

(4) cassava as 10% of the ration /reporting a reluctance to use more because of unfamiliarity with its qualities, and that using even this small amount had required overcoming his animal husbandryman's unwillingness to use any at all; but indicating his receptiveness to Harmon's sample diets (see later) providing for significantly greater cassava utilization/; and

(5) cassava substituting for 10% of the corn ingredient /here the limiting factor was given as difficulty in obtaining supplies/.

prepare their own feed. According to reports received, cassava was not being used in commercially prepared feeds /the reports may of course reflect a reluctance to admit its usage/, since customers were unwilling to accept it because of their not being accustomed to its use and their adverse reaction to the lack of color. Poultry-farmers were not queried, but it seems likely -- as reported by one source -- that there is not much, if any, cassava utilization in the larger poultry-operations.

Activities of the Ministry of Agriculture. A significant start in fostering cassava use, probably instrumental in getting some utilization started, has been made by the Ministry of Agriculture. Information materials have been disseminated, and a joint MOA/USAID seminar for pig-producers was held in February 1974 on the use of indigenous feedstuffs in pig rations. The impact has, however, been limited. The audience reached has been small; and the materials themselves fall short both in setting forth the full potential and advantages of cassava as a feedstuff, and in providing adequate guidance on its usage: while cassava is recognized to be a good source of carbohydrate, it is at the same time -- along with carbohydrate itself -- rather disparaged, at least in part unwittingly; specific guidance with providing balanced diets incorporating cassava has been limited; and the economics of utilizing the lowest-cost combination of ingredients providing a given nutritional value has not been fully understood or adequately expounded.[20]

20/ Action to date through June 1974 covered:

(a) Distribution to the Province Agriculture Chiefs, for dissemination to the field extension services, of the Directorate of Animal Husbandry (DAH) information sheet, Advice on the Use of Local Agricultural Products (Cassava and Sweet Potato) in Animal Feed, dated 1973, which notes that

> "... cassava and sweet potato cannot replace corn, sorghum or rice bran because they contain less protein, minerals and vitamins. They have high quantities of carbohydrates, however. This type of feed should be used therefore only as supplementary feed in order to reduce the cost of animal feed because of its lower price...In general, one should

-- footnote continued

Potential role of the Government in providing the necessary information. The swine industry -- if one can project from the pig-farmers visited -- seems entirely receptive to guidance in using higher proportions of cassava in the rations. There is already a core of the more venturesome who have in fact experimented on their own by trial and error. What would seem to be of great value in overcoming resistance to greater use and at the same time helping to ensure proper usage is for someone who (1) is interested in promoting the utilization of cassava as a domestic feedstuff, (2) can speak with authority on its nutritional aspects and limitations, and (3) can set forth the economics of alternative feedstuffs, to take the initiative in developing the needed informational materials and in getting the information to the livestock producers.

The Feeds Analysis Laboratory of the National Livestock Training Center, which can provide the technical competence for designing proper rations as well as analyzing

---

Footnote 20 continued:

> not use more than 30% of cassava or sweet potato in pig rations, or more than 20% in poultry rations..."

adding that animal feed rations should generally be made up of 60-80% carbohydrate, 15-37% protein and 3-5% vitamin and mineral premix.

(b) The "seminar" or, more accurately, the lecture by Dr. B. G. Harmon, professor of animal nutrition at the University of Illinois in February 1974, which unfortunately was not well publicized in advance (two of the five pig-farmers visited expressed regret at not attending, one because he had received notice only after the session, the other because he was not aware of it at all). Moreover, while sample balanced diets for pigs, providing for varying proportions of the ingredients and including diets with up to 40% cassava in the ration, were distributed at the session, the talk itself was not addressed to cassava use as such (it was given only passing reference among a goodly number of other possible feedstuffs as part of a broad treatment of animal nutrition in general); nor was the economics of selecting among alternative rations touched upon. /The sample diets were, however, later distributed to the Agriculture Province Chiefs, along with the materials in (c) below./

(c) A paper prepared by Mr. Le Quang Thong, Chief, Feeds Analysis Laboratory of the National Livestock Training Center under DAH, Use of

-- footnote continued

the composition of specific feed samples,[21] would appear to be the natural focal point for carrying out the indicated activities. Mr. Thong, chief of the Laboratory, with whom discussions have been held on the present shortcomings, has indicated his interest and willingness to undertake the needed revision of the written materials; to set up further seminars for livestock producers, including poultry-farmers, with emphasis on a limited number of feedstuffs, among them cassava; and to publicize the availability of individual consultations which, it is believed, might be more conducive to freer inter-communication.

Footnote 20 continued:

Domestic Products for Livestock Production, presented in March, and again in April or May 1974 at a seminar for Agriculture Province Chiefs, which states:

> "The cassava root is very high in caloric value, with a carbohydrate content of more than 80 percent...Because cassava can be used only as a source of energy, its use as an animal feedstuff is limited. Usually a basic feed ingredient such as corn, sorghum or rice bran must provide half the protein in the nutritional requirements... since the basic feed ingredients cost less than the protein concentrates..."

/Not only does the statement fail to recognize that the most economical among a set of nutritionally equivalent rations depends on the price interrelationships of the alternative ingredients prevailing at the time; but it is actually misleading since, at prevailing prices, it is definitely less economical to use corn in combination with cassava to provide the additional protein needed, than it is to use cassava as the carbohydrate base supplemented by fish meal in combination with rice bran./ There is attached to the paper only one sample ration for each type/age of animal, using relatively low proportions of cassava in relation to sorghum. Dr. Harmon's sample diets were, however, also distributed to the Agriculture Province Chiefs. Copies of the paper and attachments were also made available to the agricultural extension headquarters in Saigon, but the extent to which further distribution of the materials was made was not known.

(d) A listing of the Principal Nutritive Elements of Agricultural Products and By-Products Used as Animal Feedstuffs, also prepared by Mr. Thong, covering percentages of dry matter, protein, calcium, phosphorus and crude fiber, but neither the percentages of carbohydrates or fat nor the caloric value.

21/ The laboratory is, however, not equipped to conduct the more complex analyses such as ascertaining amino-acid composition; nor, at

-- footnote continued

The prospects for a sound educational program appear promising. The Center is, however, a new institution, and its relations with the livestock industry are not as yet firmly established; its channels for dissemination are dependent on other services within the Ministry; and its staff is limited. While the need for further attention may not arise, it would seem both useful and worthwhile, especially given the sizeable investment already made in developing the Vietnamese livestock industry and the small additional input that would be involved, for the Government authorities to monitor the progress made and ensure that needed support is provided.

2. Needed information on the cutting/drying operation. Of the five pig-farmers visited, three specifically expressed interest in undertaking a cassava-chipping operation, in order to ensure a steady supply of well-dried chips. A fourth, with whom a mechanical cutting-operation was not discussed, had already started construction on a brick kiln (to be heated by fuel oil), for drying cassava and sweet-potato chips for feed, and was apparently thinking of using dried cassava chips for his starch plant as well. Those who were interested had, however, little or no knowledge on what the operation might entail.

Information available in Vietnam on the operation was, at best, fragmentary; and a visit by the writer to the Thai Trade Center in Saigon elicited only the information that there had already been several earlier requests for information on the Thai cassava-cutting machines, which they were unable to supply. The problem was compounded by the fact that, insofar as could be ascertained, the machine shops producing the Thai chippers were not geared to export sales, and were prepared to sell only ex factory.

To provide at least the rough outlines of what is involved, annex IV, "The Processing of Cassava Chips," presents information collected, some of it on a brief visit to the Chonburi cassava-producing center in Thailand, covering the cutting and drying procedures as well as details on the Thai-cutting machines, one model of which has now, as noted above, become available for export.

Footnote 21 continued:

last report, were there yet available at the Center facilities for conducting animal trials.

As far as is known, the livestock industry, generally, is not as yet familiar with even the preliminary information that is at hand (the pig-farmer who has imported the Thai chipper had personal connections in Thailand); and a first step might well be to publicize the information that is available among the larger livestock producers -- and perhaps starch processors as well -- in the hope that they might be stimulated individually to action. To the extent that the information is not sufficiently definitive for proceeding with investment, however, it is likely that individual action would involve duplication of effort and cost. It would seem preferable -- and again worthwhile -- to canvass likely investors to ascertain whether they are prepared to go ahead, and if several are interested, for one or two agri-business experts to collect, and make available, the needed details.

Additionally, with regard to a cassava cutting-machine, it would not only save foreign exchange and simplify the procurement process, but would also undoubtedly reduce costs, if the machine were to be produced locally. As noted in annex IV (page A-41), there is a possibility that a local Saigon firm may be manufacturing a cassava-slicer under franchise with a foreign firm. Formal testing of the Agricultural Machinery Directorate's prototype model (also a "slicer," rather than a "chipper") under simulated work conditions would also seem to be in order, and comparison made with the Thai chipper, allowing for any differing requirements. It might also be possible that the pig-farmer who has acquired the Thai machine might make it available for observation by interested machine-shops and/or persons interested in investing in a cassava cutting-and-drying operation.

3. Developing a market for dried cassava

Experience of livestock producers in obtaining dried cassava. Even with the extremely high level of cassava plantings in 1974, and the relatively low level of demand so far for the dried root, problems of obtaining a dependably steady supply of well-dried cassava have been raised by would-be purchasers.

Interestingly, the reports from the firms visited were quite uneven. Two of them indicated they were experiencing no difficulties with obtaining adequate supplies, and their stock on hand seemed to be well-dried. Another two, on the other hand, specifically complained of inadequate and irregular supply, and especially of properly dried cassava that could be stored. (The subject was not discussed as such with the fifth.)

The type of channel used for purchase did not seem to be a factor; nor did price. Those experiencing difficulties were relying on brokers as well as those who were not; and in the same time period (early April 1974) that the two who were having difficulties were paying VN$80-90/kg and VN$90/kg, respectively, one who reported no problems at all was paying only VN$70-75/kg.[22] The explanation would seem to lie in the type of connections they were personally able to make. In any case, the unevenness

---

22/ Sources of supply, prices paid, and related comments by the five livestock producers were as follows:

Producer A. Purchases of dried slices in March and April 1974 from Long Khanh and Tay Ninh at VN$80-90/kg. (Comparable prices for fresh cassava, in truckload quantities, were quoted as VN$25-27 at the field, and VN$30 delivered.) Purchases made (a) through broker; (b) from farmers who contacted the livestock producer on a collective basis, with delivery at the pig-farm; and (c) from cassava-processing factories in the Saigon-Cholon area which, operating as cottage industries, buy fresh roots, and slice and dry them, selling the first quality to producers of MSG, polyethylene and starch, and the poor quality to pig farms. Was willing to pay VN$100/kg /as of early April 1974/ for properly dried cassava.

Supply of dried cassava was reported as inadequate (with the large demands for use in MSG- and polyethylene-production, as well as for pig feed), and the flow as uneven, making it difficult to have a constant supply on hand. The drying itself was also uneven, with excessive moisture-content for storage.

Expressed interest in a cassava chipping-and-drying operation.

Quoted prices in October 1974 of VN$70 for dried cassava unpeeled and VN$90 for peeled.

-- footnote continued

in the experience reported points up the absence of an organized market and, in the words of one of the producers, the need for a mobilization of demand and a stabilization of supply.

Suggested action. Whether or not it will be enough to solve all the problems, an obvious first step -- if further investigation supports the observation that the requirements for dried cassava are not being met -- would be to ensure that potential suppliers are apprised of the existence of the demand. Specific possible action that comes to mind would be the canvassing of both the livestock producers (especially those eligible in the past for PL 480 corn, and covering the smaller producers through their cooperatives or other organizations) and the large starch-manufacturing plants, to ascertain the quantity and timing of their probable demand, and the prices which they would find acceptable. To the extent feasible, it would probably also be helpful to identify current sources and channels of supply, with attention to the seasonality of supply from the various cassava-growing areas and, if possible, the type of supplier (farmers, cassava-starch home industries, etc.). Dissemination of the information, along with that on a

---

Footnote 22 continued:

Producer B. Purchases of dried slices from Binh Dinh at VN$45/kg in August 1973 /the retail price at the time for fresh roots in the Binh Dinh provincial market, it might be noted, is reported by DAE at VN$70/kg/. Purchases also made from Long Khanh in December; and farmers in Long Binh were currently /early April 1974/ selling at VN$90, though he had bought earlier at VN$55-60. Considered a price of VN$100/kg, or perhaps even more, as acceptable /again as of early April/.

Slices had excessive moisture content, and it was doubtful that the Vietnamese farmer could dry the root to a sufficiently low moisture content.

Stressed the need for an assured supply, and regular collection points. Felt that the mobilization of demand and the stabilization of supply would be critical problems.

Expressed interest in a chipping operation, with indication that would be prepared to sell chips to other producers. (Was in process of clearing some 25 hectares of land, to grow sugar cane and cassava.)

-- footnote continued

semi-mechanized cutting operation, could in turn be made to livestock producers (and especially those also selling feed), starch-manufacturers, and, as also suggested, collective farm groups and persons working with the war victim resettlement projects.

V. RECAPITULATION

1. The desirability of promoting cassava as a feedstuff. As an excellent source of carbohydrates, grown indigenously, cassava is a natural candidate as a basic ingredient in Vietnamese livestock feed. The Vietnamese farmer is already familiar with it as a crop and, despite the high levels of production in the past two years, the prospects for further sizable expansion of cassava plantings -- much of it on otherwise unutilized lands -- are good.

It is possible that the livestock industry may settle at lower levels of output than it was able to maintain

---

Footnote 22 continued:

Producer C. Had been using dried slices since September 1973. Purchasing from Long Khanh, through broker, with no difficulty in meeting his needs (was buying in shipment lots of 50-60 tons). Price being paid for unpeeled roots /late April 1974/ reported at VN$70-75/kg. While farm in the midst of cassava plantings, was not buying locally. Had no complaints on moisture-content, and slices on hand seemed to be well-dried. Noted that season for obtaining dried cassava from Long Khanh was from November through April or May.

Producer D. Paying VN$80-85/kg /late June 1974/. Purchasing from Long Khanh, Nha Trang and Phan Rang. Slices on hand seemed well-dried. No indications of any problems with supply. Was interested in a cassava-chipping operation.

Producer E. The only current source for cassava indicated was a nearby starch-producing plant from which the left-over ends, etc., were being bought. The price of fresh cassava was quoted, however (at VN$25/kg from Bien Hoa and Long Khanh as of early April), and a brick kiln was under construction; and it may be that a slicing/drying operation was being undertaken, since he was using dried cassava in his feed. In preparation for his upcoming starch plant, he had planted some 30-40 hectares of his holdings in Long Khanh to cassava, and had also already signed contracts with farmers for their cassava crop.

with subsidized inputs. But as long as there is continuing demand for livestock products, it would seem an economic waste not to utilize a feedstuff available domestically that would otherwise not be produced and that is not competitive to any large extent with other crops for land and other resources. Cassava as a commercial animal feed can be expected to add to aggregate crop production, to lead to new agri-business activity, and to help sustain, and perhaps even to increase, current levels of livestock production.

2. The potential problems. Preliminary investigation of the attitudes of the livestock industry, the stage of development of the cassava-processing industry, and Government activity in promoting the utilization of cassava in feeds indicates, however, that the full exploitation of cassava as a feedstuff is apt to be seriously hindered by uncertainties of demand and supply:

While livestock producers have manifested interest in using cassava, their utilization has been limited by unfamiliarity with its nutritive properties, failure to fully appreciate its cost advantages, lack of guidance in preparing balanced cassava-based rations, and difficulties in getting adequate, regular supplies.

On the supply side, difficulties in meeting demand for dried cassava slices or chips -- the form needed by the livestock producers but not now produced on a regular basis -- are expected to go beyond the lag normally accompanying the appearance of a new demand. The current unorganized hand-operation is almost certain to be inadequate in supporting a relatively high and steady supply of properly dried cassava; but even the livestock producers, who have a vested interest in promoting adequate supply, are inhibited from undertaking a more effective processing operation themselves by lack of information on the process, and where to acquire equipment. Additionally, the absence of an established market place, together with poor buyer-seller communications, is seen as an impediment to the recognition of, and response to, the new demand by other potential suppliers of hand-sliced as well as machine-cut cassava.

There may be other problems that have not been identified; and some of those that have been anticipated may not have materialized or may have since been resolved. Particularly since some time has elapsed since the discussions with the industry and the Government were held, further checking, and a wider sampling of the livestock producers, are in order.

3. Suggested remedial measures. To the extent that cassava is being seriously underutilized as a livestock feed because of inhibited demand and inadequate supply, it should be possible, as seen now, to get a more organized cassava industry, and fuller cassava use, under way simply through the dissemination of needed information that can be made available relatively readily:

- Publicizing the existing demand for dried cassava among potential suppliers of hand-sliced cassava.

- Advising the livestock farmers of the nutritional properties of cassava, and the amounts that can satisfactorily be used in animal diets; providing balanced sample diets utilizing high levels of cassava; and clarifying the choices among alternative feedstuffs based on relative costs as well as nutritive values.

- Collecting information on the probable requirements for dried cassava as a feedstuff (and perhaps as a raw material for starch-manufacturing plants) on the assumption of ready availability.

- Disseminating both the information collected on domestic demand for dried cassava, and the information already available on cassava-processing, among livestock producers, starch manufacturers, and other potential investors; and ascertaining which of them may be interested in undertaking a cassava-processing operation.

- To the extent that there is real readiness to invest in the operation -- and initially, there may be only a few prepared to go forward -- but also a need for additional information on the process and/or the equipment, collecting and providing the information.

4. Possible agents. The suggested input, in terms of time and money, is minor; the output, as visualized here, of potentially substantial consequence to Vietnamese crop as well as livestock farmers, even aside from the development of an agri-business. While both the interest and the participation of private industry are, of course, prerequisite to developing the potential of cassava as a commercial animal feed, providing the type of middle-man assistance that may be needed to get the development set in motion is essentially a public role. Because of the various facets involved -- increased crop as well as livestock production; the establishment of a new industry, especially suitable for resettlement activities; and the greater reliance on indigenous resources at a time of declining external assistance -- it would seem to merit the attention of a broad spectrum of public interest and a variety of government agencies.

Annex I

USES AND MARKETING OF CASSAVA IN SOUTH VIETNAM

A. USES OF CASSAVA IN VIETNAM

Types of use. The information collected on the various uses of cassava in South Vietnam can be stated briefly:

The cassava root is generally considered a lowly food in South Vietnam, and is of importance only in the diet of the lower economic classes. Otherwise, it is eaten as an occasional side dish, or in the form of processed macaroni or noodles.

It has traditionally been used as a feed in the countryside. It has recently become of increasing interest in commercial livestock production.

A cassava-starch home industry, started in the early 1960s in Tay Ninh, has now spread to other cassava-growing areas with concentrations in Long Khanh, Binh Tuy and Gia Dinh, as well as Tay Ninh.[1] There are now also several large starch producers that have either come into production or are planned.[2] In addition to the manufacture of macaroni

---

1/ The number of starch mills in the Tay Ninh area in 1973 has been variously reported as about 35-40, with most of them employing 15-20 people /P. Brown, formerly ADFA/; as about 100 home industry operations /a starch manufacturer representative/; and as about 150 small operations /1973 loan paper submitted by Mr. Tran Phat to the Agriculture Development Bank for a cassava flour-production and -processing project/. For the home industries in the four provinces listed, average daily production per family is given in "Cassava - Production Development and Export Market," prepared by the National Export Development Council (NEDC) in 1973, as about 100 kg.

2/ While not reflecting any organized compilation of information on the cassava-starch industry, the establishment -- or pending establishment -- of the following starch-manufacturing plants has been noted: (1) the Tran Phat project referred to in footnote 1, in Phuoc Tuy province, with projected annual starch output of 2,120 tons (loan request of VN$140 million); (2) a proposed project by Le Khoi in Cam Ranh with projected annual starch output of 480 tons (ADB loan request for VN$25 million approved in the amount of VN$16 million in 1973); (3) SATICO, in the Saigon area, scheduled for start-up in June 1974 with annual production of 1,600 tons, with plans for later expansion; (4) Khoi Vinh, under construction in mid-1974, projected production of 3,000 tons; (5) TAPHUNOCO, not yet under way in mid-1974, planned production of 12,000 tons; and (6) VINATGA (output, and status of establishment, not known).

There may also be other large or relatively large plants established in past years.

and noodles, the starch (or flour, as it is also referred to) is used in turn in the domestic manufacture of monosodium glutamate (MSG), sizing for textiles and paper, glues for plywood manufacture, and polyethylene.[3] The cassava waste meal generated as a by-product in starch manufacture is used for livestock feed (its nutritive value is still quite high) or, as reported in the tabular material below, turned back as fertilizer for cassava.

A shipment of 1,450 tons of dried sliced cassava was made to West Germany in 1965. It was considered unsatisfactory because of excessive mould and failure to meet the quality of the sample submitted.

Estimates of relative importance of the various uses. Little is known of Vietnam's cassava consumption patterns. Of uncertain reliability, quantitative estimates found on cassava usage indicate the following distribution of use in 1971 (weight in thousands of metric tons):[4]

	Unit weight	Fresh weight	Percentage distribution Of class		Of total
Fresh food:					
Home consumption	70-80	70-80		70-80%	26-30%
On market	30-20	30-20		30-20%	11- 7%
Total fresh food	100	100		100%	37%
Dried slices for feed	17.5	70		..	26%
Processed:					
Flour, used in the manufacture of:					
Macaroni	8.4	33	57%		12%
MSG	6.2	24	41%		9%
Textile sizing	.2	.8	1%		.3%
Dextrine glues	.15	.6	1%		.2%
Miscellaneous	.05	.2	..		.1%
Total flour	15.0	58	100%	58%	22%
Inferior quality flour[5]	.75	3	..	3%	1%
Waste meal (dried)					
Fertilizer for cassava	6	23	60%		9%
Feed	4	16	40%		6%
Total waste meal	10	39	100%	39%	14%
Total processed	26	100	..	100%	37%
TOTAL CASSAVA CONSUMPTION		270			100%

See following page for footnotes

The only other quantitative estimate found on Vietnamese cassava use is that 15,000 tons of cassava starch were consumed by MSG manufacturers in 1973 (as against the 6,200 tons shown in the table for 1971).[6]

Extent and usage of dried cassava slices. Reports on the extent to which the root is dried range from the National Export Development Council's statement that it is sliced and dried by farmers only during a poor market, for storage in anticipation of better prices, to that in the Tran Phat loan paper which reports slicing and drying as "common," for home use as well as marketing. /In context, the "home use" may refer to home processing of starch for family use, rather than for food (see footnote 3). This would seem the more likely since, for home food use, the root is generally harvested as needed./ It has also been reported that in the war victims resettlement projects in Phuoc Tuy this year, all the surplus over and above the food requirements has been sliced and dried, for sale to starch manufacturers;[7] and that there are cottage industries in the Saigon-Cholon area that buy the fresh roots, and slice and dry them, selling the first quality to starch manufacturers and processors, and the poorer quality to pig farms.[8]

Reports also vary on the uses to which the dried slices are put. While the tabular material above labels them as used for livestock feed and the NEDC paper notes that they are not used in starch manufacture because of the higher cost, the reports above would indicate that usage in the starch industry is not uncommon (see also footnote 9).

3/ According to the Tran Phat loan paper, some small amount of flour is also produced for home or local use. The paper also reports the use of cassava flour by the Dong Phuong Ky Nghe Cong Ty plant as a raw material for malt production.

4/ Source for yield from the fresh root of flour, inferior quality flour and waste meal, and the allocation of waste meal to fertilizer and feed, is given as a 1965 paper by Nguyen Quoc Khai; and the general source, as personal contacts with industrial users and GDA, DET and DAE specialists. As originally shown, 10 percent of the dried slices and 5 percent of the waste meal are reported as exported. For comments on the conversion ratios of fresh cassava to dried slices and starch, see note at end of section A.

5/ Noted as used to mix with wheat flour in making bread.

6/ Reported consumption as follows: VIFOINCO, 6,000 tons; Thien Huong, 6,000 tons; NABOCO, about 1,200 tons; and a fourth plant, 2,000 tons.

7/ As reported by L. Ramirez, ADRR/Phuoc Tuy.

8/ As reported by a large pig farmer.

Note on conversion factors for dried slices and starch. The conversion implicit in the tabular material above for dried slices is 4:1, in contrast to the NEDC figures of 3.5 kg of the peeled root, and 3.2 kg of the unpeeled root, to produce 1 kg of dried slices, peeled and unpeeled, respectively. (A recent investigative study of Thai cassava production gives the conversion at less than 2½:1. Much would depend of course on the cassava variety, the length of the crop season, and the timing of the harvest.)

The input for starch of 6-2/3 kg of fresh roots to produce 1 kg of starch and 2/3 kg waste meal again seems high. While the Council also cites a 6½:1 ratio, projections of starch manufacturers /not yet started up, however, and it is not clear whether they were based on Vietnamese experience/ postulate the significantly more favorable conversions of 4 or 4½:1.[9] The Arthur D. Little 1966 feasibility study of a Malaysian starch project states that, with modern equipment, a yield of 20 to 22 percent from the fresh root could be expected. Again, starch content would depend greatly on the variety of the cassava and the cultural practices.

B. MARKETING OF CASSAVA IN VIETNAM. While, as indicated above, there are few firm data on the extent to which cassava enters the Vietnamese marketing system, it seems fair to assume that especially in the areas where it is used primarily as a subsistence food relatively little is put on the retail market.

For the commercial starch market the roots -- offered in truckload lots during the harvest season -- move through middlemen who arrange for their collection and trucking. Apparently also common is either the contracting for a field's output, or the purchase -- at varying stages of root maturity -- of cassava in the field, with the starch mill operator bringing in his own labor at harvest time,[10] and

---

9/ The Tran Phat loan paper assumes an input of 6,000 tons of fresh cassava plus 1,000 tons of dried slices for a yield of 2,120 tons starch plus 630 tons of waste by-product. The Le Khoi paper assumes 480 tons starch from 2,400 of the fresh root. In conversations with two other firms, also not yet in production, one put the yield at 1 kg starch plus 1½ kg of waste from 4½ kg of the fresh unpeeled root; and the other, a conversion of 4:1.

10/ The only information found on Vietnamese manpower requirements for harvesting -- the only time-demanding phase in cassava root production is (1) the report from the Phuoc Tuy war victims resettlement projects that 10 strong workers can harvest a hectare in one day; and (2) the NEDC's estimate of 20 mandays per hectare.

sometimes even moving in his starch-making equipment. (Since harvest takes place in Tay Ninh during the rainy season, and in Long Khanh in the dry, Tay Ninh-based small industries may move temporarily to Long Khanh during harvest, returning to Tay Ninh at the end of the season.) The trader may also advance working capital to the farmer.[11]

The output of the small starch-manufacturing industries, often uneven in quality as well as quantity, in turn moves through middlemen to the large MSG plants and other starch-processors.[11]

11/ Primarily as reported in the NEDC paper on cassava. Dried slices also appear to move through middlemen, but as already indicated the channels for processing and distribution do not appear to be standardized.

Annex II

CASSAVA PRODUCTION IN SOUTH VIETNAM

MOVEMENT IN OVERALL PRODUCTION AND HECTARAGE, 1956-1973. As reported in the Ministry of Agriculture statistics,[1] cassava production in South Vietnam peaked in 1963 at close to 390,000 metric tons, rising rather steadily from about 125,000 tons in 1956 as the area planted to cassava increased from 28,000 to 52,000 hectares. The high levels were short-lived, however. After dropping to 290,000 tons in 1964, production, until 1973, ranged between 215,000 and 280,000 tons, and hectarage between 30,000 and 40,000. Against this background, the 380,000 tons and 48,000 hectares reported for 1973 represent not only increases of about 50 percent over the 1972 levels, but also the first marked upward movement over the past decade.[2] (Data from 1968 onward are shown in table 1.)

1/ Both the manner in which cassava is planted (often in small patches or intercropped) and in which it is harvested (in large part on an as-needed home-use basis) make the collection of reliable statistics on cassava difficult, even aside from the lesser attention given it as a secondary crop. Moreover, while the Vietnamese instructions call for the separate reporting of both hectarage and production, it is clear from the implicit average yields by province, which for the most part are unrealistically rounded and remain unrealistically constant over time, that in many cases production figures are being derived from hectarage figures, based on an assumed yield for the province, or vice versa. For other provinces, wide fluctuations in yield from year to year (in Long Khanh, for example, annual yields, beginning with 1960, run 10, 7, 7, 15, 16, 1, 20, 3, 10, 9, 15, 9, 12, 12) indicate significant inconsistency between the hectarage and production figures.

At a guess, it would seem more probable that the hectarage figures are generally the more reliable.

2/ Whether or not the increases reported are altogether realistic, sizable increases in cassava plantings have been corroborated for at least some of the areas by general reports.

The 1973 levels compare fairly well, it might be noted, with the levels projected in the Ministry of Agriculture's 5-year plan for 1971-75, dated 1970:

(in thousands of units)

	5-year plan		Actual		Difference over plan	
	Ha	MT	Ha	MT	Ha	MT
1971	35	280	36	270	+1	-10
1972	39	312	32	248	-7	-64
1973	44	396	48	380	+4	-18
1974	49	490	..	..	..	..
1975	53	530	..	..	..	..

(Cassava is not covered in the Ministry's later plan covering 1973-77, dated February 1973.)

THE CASSAVA-PRODUCING CENTERS. Prior to the change in regional production patterns also occurring in 1973, the more important cassava areas in recent years have been (1) the six northern provinces in the Central Lowlands, with about 40 percent of the country's production /down to 20 percent in 1973/, of which over 25 percent of the total production came from the two provinces of Quang Ngai and Binh Dinh, and (2) Tay Ninh province in the eastern part of the Southern Region (MR-3), which alone contributed 25 percent. Major expansion in cassava in 1973 has now turned five more provinces in the eastern part of the Southern Region into large producers: Phuoc Tuy and Long Khanh, accounting for almost 15 percent of even the high 1973 level of production, and Bien Hoa, Binh Duong and Binh Tuy, adding another 10 percent. While no single province in the western part of the Southern Region (MR-4) has been an important producer, the combined production of eight of its 15 provinces has continued to account for 10 to 15 percent of the country's total.

TRENDS IN REGIONAL DISTRIBUTION. Even before the changes taking place in 1973, there had been a long-continuing major shift in the regional distribution of cassava planting, reflecting, it would seem, the emergence and development of cassava as a commercial crop.

Accounting for some three-quarters of the country's total in 1956 (as against 15 percent for the Southern Region), cassava hectarage in the Central Lowlands increased rather steadily from 20,000 hectares in 1956 to 32,000 in 1962-63, but was overshadowed in relative importance by the spurt in Tay Ninh plantings in 1961 (apparently marking the beginnings of the Vietnamese cassava-flour industry), followed in turn by large increases in other Southern provinces in the next two years. By 1963, the Lowlands were making up only about 60% of the total while the Southern Region's contribution (17,000 hectares) had risen to a third. Since then, cassava hectarage in the Lowlands has followed a generally downward trend, reportedly started when earlier plans to set up cassava starch plants in Quang Ngai, Binh Dinh, Quang Nam and Quang Tri were abandoned because of the poor quality of the product. In the Southern Region, on the other hand, the downward trend after 1963 was reversed in 1970 (though Tay Ninh itself is reported at an almost constant level from 1963 through 1972), with sharp increases since. By 1972, the relative proportions had further shifted to 49 and 44 percent and, by 1973, to 36 and 54 percent.

At the same time, with the higher yields reported for the Southern Region (see below), the relative shares of production of the Central Lowlands and the Southern Region went from 62 and 30 percent in 1956, to 33 and 59 percent in 1972, and 19 and 66 percent in 1973.

Reported cassava production in the Central Highlands has remained erratic throughout the past two decades, both in absolute terms and as

Table 1

HECTARAGE, PRODUCTION AND YIELD OF CASSAVA IN VIETNAM, 1968, 1970-73

	Area planted ('000 hectares)					Production ('000 MT)					Yield (MT/ha)				
	1968	1970	1971	1972	1973	1968	1970	1971	1972	1973	1968	1970	1971	1972	1973
ALL VIETNAM	35.1	30.4	35.8	32.1	47.8	260	216	270	248	380	7.4	7.1	7.5	7.7	7.9
SOUTHERN REGION	11.8	11.4	14.1	14.2	25.7	128	115	152	146	251	10.8	10.1	10.8	10.3	9.8
Eastern part	8.1	8.3	9.3	10.1	19.3	90	82	100	103	193	11.0	9.9	10.8	10.3	10.0
Tay Ninh	6.0	6.0	6.0	6.0	9.2	72.0	60.0	70.0	59.5	92.0	12.0	10.0	11.7	10.0	10.0
Phuoc Tuy	.35	.45	.50	.90	2.30	2.8	5.4	6.0	10.8	27.6	8.0	12.0	12.0	12.0	12.0
Long Khanh	.26	.31	.55	.60	1.90	2.6	4.6	4.8	7.2	22.8	10.0	15.0	8.7	12.0	12.0
Bien Hoa	.20	.18	.28	.55	1.50	2.4	2.0	3.2	5.5	15.0	11.8	11.5	11.4	10.0	10.0
Binh Duong	.30	.30	.35	.80	1.30	2.4	2.4	2.8	8.0	10.4	8.0	8.0	8.0	10.0	8.0
Binh Tuy	.19	.34	.70	.79	1.65	1.9	2.4	6.0	7.9	11.6	10.0	7.0	8.6	10.0	7.0
Phuoc Long	.38	.30	.40	.14	.78	2.1	1.9	3.5	1.3	7.0	5.5	6.3	8.8	8.9	9.0
Other	.44	.44	.50	.33	.64	3.4	3.2	3.8	3.3	6.4	7.7	7.2	7.6	10.0	10.0
Western part	3.7	3.1	4.8	4.1	6.4	38.6	33.0	51.9	42.8	58.6	10.5	10.7	10.7	10.3	9.1
An Giang	...	.14	.25	.10	.05	...	3.5	4.5	1.8	.9	...	25.0	18.0	17.5	17.0
Chau Doc	.70	.10	.60	.30	.45	6.3	1.0	6.5	3.0	4.5	9.0	10.0	10.8	10.0	10.0
Chuong Thien	.05	.08	.10	.14	.88	.5	.6	1.0	1.3	7.0	10.0	8.0	10.0	9.3	8.0
Kien Giang	.22	.22	.25	.55	.83	3.3	4.0	4.5	8.2	8.3	15.0	18.2	18.0	15.0	10.0
Kien Hoa	.12	.12	.35	.20	.20	1.7	1.7	4.4	3.0	2.4	14.0	14.0	12.6	15.0	12.0
Kien Phong	.75	.06	.60	.15	.15	7.5	.5	6.5	1.2	1.2	10.0	9.0	10.8	15.0	8.3
Kien Tuong	.40	.78	.82	.92	1.38	5.0	5.8	5.7	6.9	10.3	12.5	7.4	7.0	7.5	7.5
Long An	.50	.50	.60	.55	.80	5.0	5.0	6.0	5.5	8.0	10.0	10.0	10.0	10.0	10.0
Vinh Long	.32	.39	.40	.40	.44	3.2	3.9	4.0	4.0	4.4	10.0	10.0	10.0	10.0	10.0
Other	.62	.69	.87	.84	1.27	6.1	6.9	8.8	7.9	11.6	9.8	9.9	10.1	9.4	9.1
CENTRAL LOWLANDS	22.4	17.7	19.8	15.8	17.4	125	94	108	81	74	5.6	5.3	5.5	5.2	4.3
Binh Dinh	6.0	5.0	5.0	4.9	6.0	30.0	20.0	20.0	19.4	21.2	5.0	4.0	4.0	4.0	3.5
Quang Ngai	6.5	6.0	6.1	4.0	2.7	45.5	42.0	45.0	31.5	18.9	7.0	7.0	7.4	7.9	7.0

-- table continued

Table 1

HECTARAGE, PRODUCTION AND YIELD OF CASSAVA IN VIETNAM, 1968, 1970-73 (continued)

	Area planted ('000 hectares)					Production ('000 MT)					Yield (MT/ha)				
	1968	1970	1971	1972	1973	1968	1970	1971	1972	1973	1968	1970	1971	1972	1973
CENTRAL LOWLANDS (con't)															
Cam Ranh	...	...	...	...	1.2	...	...	...	...	7.7	...	...	...	...	6.2
Khanh Hoa	.2	.3	.3	.2	1.4	1.4	2.1	2.1	1.8	4.4	7.0	7.0	7.0	7.0	3.1
Quang Nam	2.8	2.3	2.2	2.6	2.0	15.4	11.0	10.0	12.0	5.7	5.5	4.8	4.5	4.6	2.8
Quang Tin	3.8	1.0	2.3	1.5	1.5	17.0	4.5	10.2	3.8	3.9	4.5	4.5	4.5	2.5	2.6
Quang Tri	1.0	1.0	1.0	...	0.1	5.0	3.0	5.0	...	.2	5.0	3.0	5.0	...	4.0
Thua Thien	1.8	1.8	2.0	1.5	1.4	9.0	9.0	11.0	6.0	3.8	5.0	5.0	5.5	4.0	2.8
Other	.3	.3	.9	1.1	1.1	1.7	1.9	4.8	7.0	8.4	6.5	7.1	5.5	6.4	7.5
CENTRAL HIGHLANDS	1.0	1.3	1.9	2.1	4.6	7.0	7.3	9.9	20.2	54.2	7.4	5.5	5.1	9.7	11.8
Darlac	.18	.75	.80	.88	2.00	.9	3.7	5.0	13.1	28.5	5.0	4.9	6.2	15.0	14.2
Kontum	.40	.10	.10	...	.54	4.0	1.2	1.2	...	5.0	10.0	12.0	12.0	...	9.3
Pleiku	.15	.30	.80	.87	1.50	.8	1.2	2.0	5.2	14.3	5.1	4.2	2.5	6.0	9.5
Other	.23	.16	.23	.33	.60	1.4	1.1	1.7	1.9	6.4	6.0	6.8	7.3	5.6	10.6

SOURCE: Hectarage and production through 1971, and hectarage in 1972, from the Vietnamese Agricultural Statistics Yearbooks; hectarage in 1973 and production, 1972 and 1973, from unpublished statistics of the Directorate of Agricultural Economics, Ministry of Agriculture. (The 1972 production figures reflect revisions of those in the 1972 Yearbook for Hau Nghia province in the Eastern part, and for Bac Lieu and Sa Dec provinces in the Western part, of the Southern Region.) Yield has been computed from unrounded figures.

a percent of the total production, ranging, for the latter, from practically nothing in 1961, to 10 percent in 1959 and a sizable 14 percent in 1973 (primarily attributable to Darlac and Pleiku).

YIELDS. Yield for the country as a whole generally averages, over the past decade, 7 to 8 metric tons per hectare, with average yield of about 10 to 11 in the Southern Region, 5 to 5½ in the Central Lowlands (7 to 8 in Quang Ngai and Khanh Hoa), and 5 to 7 in the Central Highlands (though yields in 1972 and 1973 average 10-12 tons).[3]

ORIGIN OF CASSAVA EXPANSION IN 1973 AND INDICATIONS FOR THE FUTURE. As shown in table 2, 105,000 tons, or 80 percent of the 130,000-ton increase in cassava production from 1972 to 1973, is attributed to the Southern Region; and another 35,000 tons to the Central Highlands. While there were increases in Binh Dinh and Khanh Hoa provinces and in Cam Ranh city, production in the Central Lowlands as a whole declined. (Of the roughly 15½ thousand additional hectares planted, the Southern Region accounted for 11½; the Central Highlands, for 2½; and the Central Lowlands for 1½.)

Within the Southern Region, large absolute as well as percentage gains were registered in Tay Ninh as well as in the five other eastern provinces already mentioned, the six together accounting for 80,000 tons of the increase. The upward trend is pronounced, however, throughout the whole Region, with large percentages occurring in all but a very few provinces.

In the Central Highlands, where production of any importance was limited in the past to Pleiku and Kontum, Darlac is reported to have increased its production by 15,000 tons over the 1972 level, already 8,000 tons over that in 1971; and Pleiku, by 9,000 tons, for a total in 1973 of 14,000 tons.

One of the more important sources of the cassava expansion appears to have been the war victims resettlement programs, where the planting of cassava, along with corn and rice, has been encouraged by the Government (and where many of the settlers have come from cassava-growing areas). Four of the provinces with significantly increased cassava plantings, Phuoc Tuy, Long Khanh, Binh Tuy and Binh Dinh, accounting for about 4,700 hectares of the increased plantings and 40,000 tons of the increased production, can be pinpointed as provinces where sufficient resettlement sites were cleared early enough in 1973 to have permitted new plantings in these magnitudes during the year. Further sizable expansion of cassava can be expected here in 1974 under the program, if the market holds

---

3/ As already indicated, only qualified reliance can be placed on the yield statistics.

Table 2

CHANGES IN HECTARAGE AND PRODUCTION OF CASSAVA IN VIETNAM, 1972-73*

	Area planted (hectares)				Production ('000 MT)			
	1972	1973	Change Amount	Change %	1972	1973	Change Amount	Change %
ALL VIETNAM	32,100	47,800	+15,700	+50%	248	380	+132	+50%
SOUTHERN REGION	14,200	25,700	+11,500	+80%	146	251	+105	+70%
Eastern part	10,100	19,300	+9,200	+90%	103	193	+89	+90%
Tay Ninh	6,000	9,200	+3,200	+55%	60	92	+32	+55%
Phuoc Tuy	900	2,300	+1,400	+160%	11	28	+17	+160%
Long Khanh	600	1,900	+1,300	+220%	7	23	+16	+220%
Bien Hoa	550	1,500	+950	+170%	5	15	+10	+170%
Binh Duong	800	1,300	+500	+60%	8	10	+2	+30%
Binh Tuy	790	1,650	+860	+110%	8	12	+4	+45%
Phuoc Long	140	780	+640	+460%	1	7	+6	+460%
Other	330	640	+310	+100%	3	6	+3	+90%
Western part	4,100	6,400	+2,300	+55%	43	59	+16	+35%
Long An	550	800	+250	+45%	6	8	+2	+45%
Kien Tuong	920	1,380	+460	+50%	7	10	+3	+50%
Kien Giang	550	830	+280	+50%	8	8	0	0%
Chuong Thien	140	880	+740	+550%	1	7	+6	+460%
Chau Doc	300	450	+150	+50%	3	5	+2	+50%
Vinh Long	400	440	+40	+10%	4	4	0	+10%
Other	1,290	1,670	+380	+30%	14	16	+2	+15%
CENTRAL LOWLANDS**	15,800	17,400	+1,600	+10%	81	74	-7	-10%
Binh Dinh	4,850	6,000	+1,150	+25%	19	21	+2	+10%
Quang Ngai	4,000	2,700	-1,300	-35%	32	19	-13	-40%
Quang Nam	2,600	2,000	-600	-25%	12	6	-6	-50%
Khanh Hoa	250	1,440	+1,190	+480%	2	4	+3	+150%
Cam Ranh	...	1,250	+1,250	...	..	8	+8	...
Other	4,100	4,040	-60	0%	17	16	0	-5%
CENTRAL HIGHLANDS	2,100	4,600	+2,600	+120%	20	54	+34	+170%
Darlac	880	2,000	+1,120	+130%	13	28	+15	+120%
Pleiku	870	1,500	+630	+70%	5	14	+9	+180%
Kontum	...	540	+540	...	..	5	+5	...
Other	330	600	+270	+80%	2	6	+4	+140%

SOURCE: See table 1.

*Percent changes (which have been rounded to the nearest 5% for smaller magnitudes and nearest 10% for the larger) and quantity changes in production (which have been rounded to the nearest thousand tons) are based on unrounded numbers.

**Excluding Cam Ranh, hectarage increased by only 400 hectares or 2½%; and production decreased by 15,000 tons, or 20%.

up, as resettlement and land clearance proceed.[4] Still further increases in cassava production are probable in the remaining provinces with war victims resettlement programs, since the programs were under way too late in the year for 1973 cropping.[5]

In Khanh Hoa and Darlac, each with reported increases of a little over 1,000 hectares, much of the increased plantings can be accounted for by collective projects of military and ex-military personnel (two each of about 1,000 hectares and one of 500 hectares, primarily planted to cassava), apparently stimulated by anticipation of a burgeoning market for cassava by starch and livestock producers and, perhaps, of an export market. (One of these has been reported to have been unsuccessful and may not be continued.) Also in Darlac and, to a lesser extent in Pleiku (with an additional 600 hectares), the greater stabilization of the formerly nomadic economy has been suggested as a likely factor in the increased cassava plantings.

In Tay Ninh, where 80 percent of the Cao Dai had been earlier engaged in logging, a shift to cassava after logging was banned is reported as a probable explanation of at least a good part of the 3,200-hectare increase reported.

4/ A rough magnitude check of the war victims resettlement populations in Long Khanh, Phuoc Tuy and Binh Tuy as of the end of 1973 indicates that resettlement could easily explain most if not all of the increased cassava hectarage reported for these provinces, except for a small difference in Phuoc Tuy province, where there has also been a veterans resettlement project. In 1974, the resettlement sites in these provinces will have considerably expanded areas for cultivation with the increased availability from a half hectare to three hectares for the families settled at the beginning of 1973, and the land clearances for the later groups settled in late 1973 and 1974 (there had already been an increase of about 10,000 families resettled in these provinces during the first four months of 1974 alone).

Further cassava production can also be expected in Binh Dinh province in 1974, both because of the February-March harvest season (which may account for the relatively smaller increase shown for production than for area planted in the statistics), and because resettlement was not completed early enough in 1973 to register its full impact.

5/ Five of the provinces, Quang Ngai, Quang Nam, Quang Tin, Quang Tri, and Thua Thien, in the northern coastal area, have traditionally been cassava-planting areas; past cassava production in the remaining areas where resettlement sites have been located (Binh Thuan and Ninh Thuan, in the southern Central Lowlands, and Lam Dong in the Central Highlands) has generally been small.

For the rest, the likely sources of the expansion are the livestock and starch producers themselves /all the provinces in the western part of the Southern Region with significant increases either are themselves, or neighbor upon, large suppliers of hogs for the Saigon market; and even small samplings of the large livestock farmers and starch plants indicate sizable plantings of, or plans to plant, cassava on their own holdings, one to as much as 2,000 hectares, almost all of it on formerly uncultivated land/; veterans and civil servants resettlement programs; and as a way for the military who have acquired land under the Diem or Land-to-Tiller programs to hold on to the land without having to give it too much attention.

DISPOSITION OF 1973 PRODUCTION. It has not been possible to obtain any indication of how the 1973 cassava crop was utilized.[6] According to the Ministry of Agriculture Crop Production Service, no complaints were received on over-production, and the 1973 crop was apparently all disposed of.

POTENTIAL LEVEL OF PRODUCTION. As a rough indicator of potential production on land planted to cassava in the past, aggregating the past peaks for the individual provinces yields totals of 29,000 hectares for the Southern Region and 37,000 for the Central Lowlands. Adding another 5,000 for the Central Highlands, this comes to a total of 71,000 hectares or, with no increase in yield, almost 570,000 MT of cassava production. (Details are shown in table 3.)

NOTE ON CASSAVA VARIETIES USED IN VIETNAM. There is little compiled information on the cassava varieties grown in Vietnam.

The Joint Development Group Working Paper No. 44, 1969,[7] identifies three "varieties" commonly found in South Vietnam as (1) European, or white kapok, cassava; (2) Kapok cassava; and (3) Green, green kapok, or rubber cassava; the first with few roots per plant, but producing very white flour, and the other two as having many roots. In terms of sweet and bitter cassava, the Vietnamese mild cassava is described as having dark green leaves, violet nervules, red peduncle; and the bitter, as having light green leaves, and some spots of slight color in the lower part of the peduncle. Yields in experimental tests by the Directorate of Agricultural Research on high-yielding varieties are reported as

---

6/ Except for the 15,000 tons of cassava starch reported as consumed by MSG manufacturers, noted in annex I.

7/ "Measures to Develop the Cassava Planting in Vietnam," prepared by Le Xuan Hoa, Chief, Field Crops Bureau, Agriculture Research Institute, pp. 12-15.

Table 3

PEAK HECTARAGE AND PRODUCTION OF CASSAVA IN VIETNAM BY PROVINCE*

	Area planted ('000 ha)				Production ('000 MT)			
	Peak prior to 1973		1973	Peak	Peak prior to 1973		1973	Peak
	Year	Amount			Year	Amount		
SOUTHERN REGION								
Eastern part								
Tay Ninh	1966	6.5	9.2	9.2	1966	78	92	92
Phuoc Tuy	1972	.9	2.3	2.3	1972	11	28	28
Long Khanh	1966	1.2	1.9	1.9	1966	19	23	23
Bien Hoa	1972	.6	1.5	1.5	1972	6	15	15
Binh Duong	1964	.8	1.3	1.3	1964,72	8	10	10
Binh Long	1963	.5	#	.5	1963	5	##	5
Binh Tuy	1967,72	.8	1.6	1.6	1972	8	12	12
Hau Nghia	1964	.8	.4	.8	1964	6	4	6
Phuoc Long	1963	1.7	.8	1.7	1963	20	7	20
Other			.2	.2			2	2
Total			19.3	21.0			193	213
Western part								
An Giang	1967	.3	.1	.3	1967	6	1	6
Chau Doc	1966,67	.8	.4	.8	1966,67	7	5	7
Chuong Thien	several	.1	.9	.9	several	1	7	7
Kien Giang	1972	.6	.8	.8	1972	8	8	8
Kien Hoa	1971	.4	.2	.4	1971	4	2	4
Kien Phong	1962-68	.8	.2	.8	1962,67	8	1	8
Kien Tuong	1962	1.2	1.4	1.4	1960	10	10	10
Long An	1961	.8	.8	.8	1971	6	8	8
Vinh Binh	1971	.3	.2	.3	1971	3	1	3
Vinh Long	several	.4	.4	.4	1963,69-72	4	4	4
Other			1.1	1.1			10	10
Total			6.4	8.0			59	75
CENTRAL LOWLANDS								
Binh Dinh	1964	10.0	6.0	10.0	1964	45	21	45
Cam Ranh	...	...	1.2	1.2	...	..	8	8
Khanh Hoa	1970,71	.3	1.4	1.4	1970-72	2	4	4
Phu Yen	1963	1.4	.7	1.4	1963	6	3	6
Quang Nam	1962,65	4.5	2.0	4.5	1962	22	6	22
Quang Ngai	1962,63	9.0	2.7	9.0	1963	81	19	81
Quang Tin	1969	4.0	1.5	4.0	1969	18	4	18
Quang Tri	1962,63	2.0	.1	2.0	1963	12	##	12
Thua Thien	1963	3.0	1.4	3.0	1963	21	4	21
Other			.4	.4			5	5
Total			17.4	36.9			74	222

-- table continued

Table 3

PEAK HECTARAGE AND PRODUCTION OF CASSAVA IN VIETNAM BY PROVINCE (continued)

	Area planted ('000 ha)				Production ('000 MT)			
	Peak prior to 1973		1973	Peak	Peak prior to 1973		1973	Peak
	Year	Amount			Year	Amount		
CENTRAL HIGHLANDS								
Darlac	1972	.9	2.0	2.0	1972	13	28	28
Kontum	1964	.5	.5	.5	1964	5	5	5
Lam Dong	1960-1,4-5	.2	#	.2	1965	2	##	2
Pleiku	1962-3	1.4	1.5	1.5	1964	6	14	14
Quang Duc	1966	.5	.1	.5	1966	4	1	4
Other			.5	.5			5	5
Total			4.6	5.2			54	58
ALL VIETNAM			48	71			380	568

SOURCE: Same as table 1.

*Adjustment to avoid double counting of peak production as a result of province reorganizations during 1964-66 has been made where necessary. /Peak production in 1963 in An Giang was excluded since it took place before Chau Doc was formed from it. No adjustment was needed for the remaining reorganizations (Hau Nghia formed from parts of Long An, Tay Ninh and Binh Duong; Cam Ranh, from Khanh Hoa; Sa Dec, from Vinh Long; and Go Cong, from Dinh Tuong) since peak production occurred in the original provinces after they were divided to form the new ones./

#Less than 50 hectares

##Less than 500 MT

follows: (1) 25, 24, and 23 tons per hectare, respectively, for three varieties of Vietnamese origin (Binh-Duong kapok, red peduncle of Quang-Ngai, and kapok of Tuy-Hoa); (2) 26, 24, 23 and 23 tons/ha, respectively for four varieties introduced from Madagascar (H.34, H.54, H.43, and H.48);[8] and (3) 24 tons/ha for the red peduncle of Sudan, introduced from Malaysia.

It is not clear to what extent these high-yielding varieties were then being cultivated in Vietnam. Recent reports on plantings on some larger landholdings, apparently reflecting the developing interest in cassava for starch and livestock feed, do, however, indicate a major shift either in the recent past, or planned for the next crop, to the H.34 variety (more bitter than the local varieties), together with some H.54 and H.48. The Government, too, has been fostering the planting of H.34: in 1973, it planted two hectares of the variety in Cam Ranh for planting material, for both free distribution and sale.

It is also reported that in the war victims resettlement projects in Phuoc Tuy province started in 1973, the varieties planted are described locally as "red" and "white" /possibly the "mild" and "bitter," respectively, noted in the Working Paper/, both selling at the same price; and that the farmers consider the "white" preferable, and planned to turn to more of it in 1974.

SUPPLEMENTAL NOTE ON 1974 PRODUCTION. According to preliminary estimates as of mid-December 1974, cassava production continued to rise in 1974, reaching an all-time high of almost 450,000 tons, up 18 percent from the 1973 level of 380,000 tons. Area planted to cassava rose by 14 percent from 47,800 hectares to 54,300.

As shown in table 3-A, there was relatively little change in the Southern Region as a whole, with about 70 percent of the increase taking place in the Central Lowlands. Binh Dinh, Quang Nam, Thua Thien and Quang Tri -- all sites of war victims resettlement programs -- each had increases of 25 percent or more. (Only modest increases are reported for Quang Ngai and Quang Tin, also scheduled as program sites.) Cam Ranh also had a large percentage increase. Khanh Hoa is reported as having a 60 percent increase in production, while hectarage was reduced by half, which, possibly, might be due to the lag in harvesting. Despite a sharp drop in Darlac, there were also significant gains in the Central Highlands.

8/ The National Export Development Council's "Cassava - Production Development and Export Market" reports a yield for H.34, under laboratory conditions, of 26 tons at the experimental center in Quang Ngai in 1965, and of 24 tons at the EAKMAT research center.

With several of the provinces reporting record highs in 1974, the sum of the past peaks for the individual provinces, following the methodology in table 3, comes to 76,000 hectares and 630,000 metric tons.[8a]

8a/ Provinces with new peaks are as follows (in thousands of hectares or tons):

Southern Region: Phuoc Tuy (2.5 ha, 30 MT); Long Khanh (2.5 ha, 25 MT); Binh Duong (2.5 ha, 25 MT); Binh Tuy (1.7 ha); Kien Tuong (1.7 ha, 12 MT). Total region: 31.4 ha; 309 MT.

Central Lowlands: Cam Ranh (2.0 ha, 13 MT). Total region: 37.7 ha; 235 MT.

Central Highlands: Kontum (0.7 ha, 11 MT); Pleiku (2.7 ha, 27 MT); Phu Bon (0.7 ha, 14 MT). Total region: 6.8 ha; 86 MT.

Table 3-A

HECTARAGE, PRODUCTION AND YIELD OF CASSAVA IN VIETNAM, 1974
AS COMPARED WITH 1973*

	Area planted (ha)			Production ('000 MT)			Yield (MT/ha)	
	1974P	Change over 1973 Amount	Change over 1973 %	1974P	Change over 1973 Amount	Change over 1973 %	1973	1974P
ALL VIETNAM	54,300	6,500	14%	447	67	18%	7.9	8.2
SOUTHERN REGION	26,600	900	3	258	6	3	9.8	9.7
Eastern part	20,200	900	5	201	9	5	10.0	10.0
Tay Ninh	8,000	-1,200	-13	80	-12	-13	10.0	10.0
Phuoc Tuy	2,510	210	9	30	2	9	12.0	12.0
Long Khanh	2,500	600	32	25	2	10	12.0	10.0
Bien Hoa	1,500	0	0	15	0	0	10.0	10.0
Binh Duong	2,500	1,200	92	25	15	140	8.0	10.0
Binh Tuy	1,740	90	6	12	1	6	7.0	7.0
Phuoc Long	600	-180	-23	6	-1	-14	9.0	10.0
Other	840	190	30	8	2	30	10.0	9.9
Western part	6,400	0	0	56	-2	-4	9.1	8.8
Long An	700	-100	12	7	-1	-12	10.0	10.0
Kien Tuong	1,660	290	21	12	1	13	7.5	7.0
Kien Giang	830	0	0	8	0	0	10.0	10.0
Chuong Thien	400	-470	-54	3	-4	-60	8.0	7.0
Chau Doc	600	150	33	6	2	33	10.0	10.0
Vinh Long	440	0	0	4	0	0	10.0	10.0
Other	1,800	130	8	16	#	1	9.6	9.0
CENTRAL LOWLANDS	22,200	4,800	28	120	46	62	4.3	5.4
Binh Dinh	8,200	2,200	37	50	28	134	3.5	6.0
Quang Ngai	2,800	100	4	20	1	4	7.0	7.0
Quang Nam	2,500	500	25	8	3	45	2.8	3.3
Khanh Hoa	700	-740	-51	7	3	61	3.1	10.0
Cam Ranh	2,000	750	60	13	6	75	6.2	6.8
Thua Thien	2,500	1,140	84	7	3	82	2.8	2.8
Other	3,540	860	32	17	5	37	4.7	4.9
CENTRAL HIGHLANDS	5,400	800	17	69	15	28	11.8	12.8
Darlac	1,100	-900	-45	15	-13	-46	14.2	14.0
Pleiku	2,700	1,200	80	27	13	89	9.5	10.0
Phu Bon	700	230	49	14	9	180	10.6	20.0
Kontum	700	160	30	11	6	110	9.3	15.0
Other	230	100	77	2	1	80	10.4	10.6

SOURCE: Unpublished statistics of the Directorate of Agricultural Economics. Figures for 1974 are preliminary (as of mid-December 1974). Yield and percentages have been computed from unrounded figures.

P - Preliminary

*Comparable data for 1973 and prior years are shown in tables 1 and 2 (pages A-8,9,11).

Less than 500 MT.

Annex III

PRICES OF CASSAVA IN SOUTH VIETNAM, AND COSTS AS FEEDSTUFF

A. PRICES OF CASSAVA

*RETAIL PRICES OF FRESH CASSAVA. The only price series available on cassava is the Directorate of Agricultural Economics series on the retail prices of the fresh root in Saigon and the provincial markets,[1] shown for the larger producing areas in tables 4 and 5.

Given the likelihood, noted in Annex I, that by far the bulk of the cassava production either is consumed at home or is sold in large lots, the retail figures at best tend to relate to a very thin market and, in general, give little indication of either the "value" placed on cassava in relation to alternative foods or the prices at which cassava moves commercially. In Quang Ngai, for example, until 1973 the country's second largest cassava producer, the reported retail prices fluctuate widely with no readily recognizable pattern; and, as noted earlier, in Binh Dinh, another sizable producer, dried sliced cassava was reported as purchased in truckload lots at VN$45/kg in August 1973 when the retail price in Binh Dinh for fresh cassava was reported at VN$70/kg.

It seems possible, however, to obtain a reasonably reliable indication of commercial fresh cassava prices from the retail prices in Tay Ninh, where the commercial market in cassava has been large enough to have an appreciable effect on the retail market. Running markedly below the retail cassava prices in the other areas from 1967 until recently, and showing a relatively clear seasonal pattern with large dips in July, August or September during the harvest season, the Tay Ninh retail cassava prices moved not too differently from paddy prices received by the farmer from 1964 through 1969.[2] From 1969 to 1973, however, the Tay Ninh cassava prices rose by about 25 percent less than the paddy prices did; and in 1974 they appear to have levelled off. Interestingly, the smaller increase for cassava is attributable to the years prior to 1973: despite the greatly increased production in 1973 both in Tay Ninh and the nearby areas, the Tay Ninh prices appear to

---

1/ Even here, there are very few periods for which continuous monthly data are available, even for Tay Ninh and Quang Ngai, the two large producers in the past.

2/ The changes noted in paddy prices are based on the ADFA weighted index (1969=100), from 1965 through 1973 as follows: 21, 34, 63, 60, 100, 125, 141, 220 and 360.

*Table 5 has been updated since the time of writing to include prices for September through November 1974. The more recent prices have not been incorporated into either table 4 and 6 or the text.

have increased by some 80 percent from 1972 to 1973,[3] as compared to an increase of about 65 percent in paddy prices. /Still holding during the first half of 1972 at the 1969 level of VN$10/kg, the Tay Ninh prices appear to have doubled in the second half of the year, rising further in 1973 to VN$25 to VN$30, except for a drop to VN$21 in August./ In 1974, possibly reflecting the increased supply from other provinces with later harvest seasons, Tay Ninh's prices continued at VN$30 for the first six months, rising to VN$33 in July and August.

Also of note is the considerable narrowing of the spread between the Tay Ninh prices and those reported for the newly important cassava-growing provinces in the eastern part of the Southern region, beginning toward the end of 1972 and becoming more pronounced since (table 6). Sometimes running in the earlier years at twice the Tay Ninh prices and even higher, the retail cassava prices in Phuoc Tuy, Long Khanh, Bien Hoa and Binh Duong are now much closer to the Tay Ninh levels, ranging from only 7 to 15 percent higher in 1973, and 6 to 20 percent higher in the first eight months of 1974. It is not clear, however, that there has actually been a lowering of commercial prices in these provinces relative to those in Tay Ninh. What seems more likely is that it is only within the last two years that their commercial markets have expanded sufficiently to register their impact on the retail prices, and that the prices reported for these provinces tend to reflect the levels and movements of commercial prices only for the recent past.[4]

PRICES OF FRESH CASSAVA IN TRUCKLOAD LOTS. The only two reports available on prices at the farm for fresh cassava in truckload lots give a price in Tay Ninh of VN$14/kg as the low point in August 1973 (for which the Tay Ninh DAE retail price was reported at VN$21), and a price of VN$25 to VN$27 in Tay Ninh and Long Khanh in March-April 1974 (when Tay Ninh's retail price was reported at VN$30 and Long Khanh's at VN$30 and VN$35). It is not known whether the two August 1973 prices relate sufficiently to the same narrow time period as to indicate the normal spread between "retail" prices and those for truckload lots; but the

---

3/ For 1972, retail prices in the Tay Ninh market are available only for January through May, August and December, and it is not possible to obtain even an unweighted monthly average for the year. The 80 percent increase assumes the average price for 1972 at VN$15.5/kg (the average of the quarterly averages shown in table 4), rather than VN$14 (the average for the seven months, shown in table 4 as the average for the year).

4/ That Long Khanh's retail prices in the past did not reflect commercial prices would seem to be borne out by the report in the NEDC cassava paper that in 1972 Long Khanh's cassava was commanding, because of its higher quality, a 1 to 2 piastre differential over the Tay Ninh price, far below the 15 to 35 piastre differential shown in the DAE reported prices.

Table 4

AVERAGE RETAIL PRICES OF FRESH CASSAVA IN SAIGON AND SELECTED PROVINCIAL MARKETS, 1964-74

(in piasters per kg)

		Southern Region							Central Lowlands		Central Highlands	
		Eastern part					Western					
Year	Saigon	Tay Ninh	Phuoc Tuy	Long Khanh	Bien Hoa	Binh Duong	Kien Tuong	Long An	Binh Dinh	Quang Ngai	Dar-lac	Lam Dong
1964	2	1.5	2.4#	1.1	2	2.8	2.5	1.9	3.1	2.6	2.4	2.8
1965	2.5	2	..	2#	2#	2.5	2#	2	3.5	6	2.5	3#
1966	5.5	5	5	3	9#	5	5	3.5	9	6.5	..	5
1967	9	6	8.5	7	11*	7.5	4.5#	5.5	13	8	..	6
1968	11*	5.5	9.5	10*	11*	13	..	10	..	10	..	11
1969	..	10	..	..	14	15#	..	12	..	10	..	15*
1970	16	..	..	..	18	22	..	17	..	14	..	21
1971	24	9#	22#	23#	20	23	23#	17	20#	15	18*	23
1972	33	14	24	38	23	23	28	27	24	17	26	23
1973	44	28	32	30#	32	30	39	38	56	49	31#	33
8 mos '74	49	31	37	33	33	37	49	49	72	80	48	45
Quarter												
1972												
I	31	12	17	35	20	25*	26	26	20*	12*	24	26*
II	33	10*	20*	35*	25*	20*	30	28	20*	..	25*	24
III	31	15*	33	45*	23	20	24	24	22	15*	23*	20
IV	37	25*	25	40*	26	27*	30	30	30	20	30	24
1973												
I	42	25*	29	30*	29	25*	32*	29	30*	38*	32	27
II	43	30	31	..	28	25	34	38	38*	..	..	31
III	43	25	31	..	34	30*	42	37	67	50*	..	37
IV	47	30*	37	30	38	38	47	49	72*	58	29*	39
1974												
I	52	30	35	27	38	43	55	48	67	70*	40*	44
II	46	30	37	37	35	37	50	50	78	..	48	47
Jy-Ag	44	33	40	40*	24	28	40	48	70	100*	60*	42

SOURCE: Annual averages from Agricultural Statistics Yearbooks and, for 1972 and 1973, special issues of the Bulletin of Agricultural Economics, except for the following where the averages shown have been adjusted to conform with the monthly data reported (figures in parentheses are as shown in the Bulletins): 1972, Saigon (32), Long Khanh (48), Lam Dong (49); 1973, Binh Duong (33). Averages for prior years were not checked for consistency with monthly prices reported. Figures for 1974 based on unpublished data obtained from the Directorate of Agricultural Economics.

NOTE: The yearly averages are almost all based on less than 12 months' data. Those based on less than 6 months' data have been footnoted.

*Prices available for only one or two months of the period.
#Prices available for only three to five months of the period.

Table 5

RETAIL PRICES OF FRESH CASSAVA IN SAIGON AND SELECTED PROVINCIAL MARKETS,
Monthly averages, 1970-74

(in piasters per kg)

		Southern Region							Central Lowlands		High-lands
		Eastern part					Western				
Month	Sai-gon	Tay Ninh	Phuoc Tuy	Long Khanh	Bien Hoa	Binh Duong	Kien Tuong	Long An	Binh Dinh	Quang Ngai	Dar-lac
1970											
Jan	16	..	..	..	16	17	..	15	..	..	..
Apr	15	..	..	..	..	22	..	30	..	14	..
Aug	16	..	..	..	18	25	..	12	..	10	..
Nov	20	..	..	..	17	20	..	17	..	17	..
1971											
Jan	20	..	..	..	20	..	..	16	..	20	..
Mar	17	..	..	..	20	..	..	20	..	20	..
Aug	..	..	..	..	20	20	..	10	20	..	..
Sep	28	7	25	25	20	23	20	12	20	7	..
Oct	36	7	22	22	17	25	20	17	20	7	..
Nov	30	9	20	25	20	25	27	20	20	8	..
Dec	28	13	20	20	25	25	25	20	..	11	18
1972											
Jan	30	15	15	30	20	25	26	25	20	12	23
Feb	33	10	16	30	20	25	25	25	..	12	25
Mar	30	10	19	45	20	..	28	28	20	..	25
Apr	35	11	20	30	25	..	33	35	20	..	25
May	35	10	..	..	..	..	32	25	..	..	..
Jun	30	..	..	40	25	20	25	25	..	..	25
Jul	35	..	30	40	20	20	24	20	20	..	25
Aug	28	15	35	50	23	20	23	23	20	..	20
Sep	30	..	33	..	25	20	25	30	25	15	..
Oct	33	..	25	40	25	..	24	30	30	15	30
Nov	40	..	25	..	25	25	30	30	30	20	30
Dec	38	25	25	..	28	30	35	30	30	26	30
1973											
Jan	40	..	28	30	28	25	33	28	..	27	30
Feb	45	..	33	..	30	..	..	30	..	..	30
Mar	40	25	25	..	30	25	31	30	30	40	35
Apr	48	25	30	..	30	25	30	35	30	..	..
May	40	35	33	..	30	25	33	38	..	..	..
Jun	42	30	30	..	25	25	40	40	45	..	..

-- table continued

Table 5:

RETAIL PRICES OF FRESH CASSAVA IN SAIGON AND SELECTED PROVINCIAL MARKETS, Monthly averages, 1970-74 (continued)

(in piasters per kg)

		Southern Region							Central Lowlands		Highlands
		Eastern part					Western				
Month	Saigon	Tay Ninh	Phuoc Tuy	Long Khanh	Bien Hoa	Binh Duong	Kien Tuong	Long An	Binh Dinh	Quang Ngai	Darlac
1973											
Jul	44	25	30	..	33	..	45	40	65	..	..
Aug	40	21	30	..	35	30	40	35	70	..	..
Sep	45	28	33	..	35	30	40	35	65	50	..
Oct	45	30	40	30	40	35	40	50	..	50	28
Nov	50	..	38	30	38	38	50	50	80	60	30
Dec	47	30	33	30	35	40	50	48	65	65	..
1974											
Jan	55	30	35	25	35	40	55	50	60	70	..
Feb	55	30	35	25	38	40	50	50	65	70	30
Mar	45	30	35	30	40	48	60	45	75	..	50
Apr	47	30	40	35	40	40	50	50	90	..	35
May	45	30	35	35	40	40	50	50	75	..	50
Jun	45	30	35	40	25	30	50	50	70	..	60
Jul	45	33	40	40	25	30	40	50	70	..	60
Aug	53	33	40	..	22	27	40	45	70	100	..
Sep	48	24	33	..	18	30	40	42	75	100	40
Oct	47	30	28	..	20	30	47	40	60	95	30
Nov	44	..	30	27	24	28	50	50	60	95	..

SOURCE: Agricultural Statistics Yearbooks, supplemented by Monthly and Special Bulletins of Agricultural Statistics and, for recent months, unpublished data obtained from the Directorate of Agricultural Economics.

Table 6

COMPARISON OF RETAIL PRICES OF FRESH CASSAVA IN SAIGON AND SELECTED PROVINCIAL MARKETS WITH THOSE IN THE TAY NINH MARKET, 1964-74

Year	Retail price Tay Ninh (VN$/kg)	Percentage difference over Tay Ninh price**									
		Saigon	Southern Region						Central Lowlands		Highlands
			Eastern part				Western				
			Phuoc Tuy	Long Khanh	Bien Hoa	Binh Duong	Kien Tuong	Long An	Binh Dinh	Quang Ngai	Darlac
1964	1.5	35	60#	-25	35	90	70	25	100	70	60
1965	2	25	..	0#	0#	25	0#	0	80	200	25
1966	5	10	0	-40	80#	0	0	-30	80	30	..
1967	6	50	40	15	80*	25	-25#	-8	125	35	..
1968	5.5	100*	70	80*	100*	125	..	80	..	80	..
1969	10	..	..	..	40	50#	..	20	..	0	..
1970	..	..	..	..	..	..	..	..	..	..	..
1971##	9#	175	150#	150#	125	150	150#	90	125#	175	100*
1972	14	125	70	175	60	60	100	90	70	20	90
1973	28	60	15	7#	15	7	40	35	100	80	10#
8 mos '74	31	60	20	6	6	20	60	60	125	150	50
Quarter											
1972											
I	12	150	40	200	70	100*	125	125	70*	0*	100
II	10*	225	100*	250*	150*	100*	200	175	100*	..	150*
III	15*	100	125	200*	50	35	60	60	45	0*	50*
IV	25*	50	0	60*	4	8*	20	20	20	-20	20
1973											
I	25*	70	15	20*	15	0*	30*	15	20*	0*	30
II	30	45	3	..	-7	-15	15	25	25*	..	..
III	25	70	25	..	35	20*	70	50	175	100*	..
IV	30*	60	25	0	25	25	60	60	150*	90	-3*
1974											
I	30	70	15	-10	25	45	80	60	125	125*	35*
II	30	50	25	25	15	25	70	70	150	..	60
Jy-Ag	33	35	20	20*	-25	-15	20	45	100	200*	80*

SOURCE: Tables 4 and 5

*Prices available for only one or two months of the period.

#Prices available for only three to five months of the period.

**For percentages between ±10 and ±50, rounded to nearest 5%; between 50 and 100, rounded to nearest 10%; over 100, rounded to nearest 25%.

##The percentage differences shown here may overstate the actual differences for the year as a whole, since the Tay Ninh base data cover only September through December, a period during which Tay Ninh prices appear to take a marked seasonal dip.

larger spread in August need not be inconsistent with the smaller spread indicated for March-April 1974 if, as also reported, Tay Ninh's low prices for truckload lots are generally limited to the harvest season.

PRICES OF SLICED DRIED CASSAVA. As noted earlier (footnote 22 of the main paper), prices per kilo of sliced dried cassava in truckload lots delivered to the Saigon area have been variously reported by individual pig farmers as follows (the DAE retail prices in Tay Ninh of fresh cassava are also shown, for rough comparison):

Date	Dried cassava, truckload lots, Saigon area: Source	Peeled or unpeeled	VN$/kg	Fresh cassava, Tay Ninh	Ratio, dried to fresh
Aug 73	Binh Dinh	Not specified	45	21	2.2
Apr 74	Long Khanh	Unpeeled	70-75	30	2.3-2.5
	Tay Ninh, Long Khanh	Not specified	80-90		2.7-3.0
	Long Binh	Not specified	90		3.0
Jun 74	Khanh Hoa, Phan Rang, Long Khanh	Unpeeled	80-85	30	2.7-2.8
Sep 74[5]	Not specified	Unpeeled	70	..	
		Peeled	90	..	

In addition, there are available the prices reported (in April 1974) as received by farmers in the War Victims Resettlement projects in Phuoc Tuy (harvest took place in December 1973 and January 1974; prices of the dried roots might relate to the period thereafter as well):

Fresh:	25-30	
Dried, unpeeled:	70-80	(Ratio to fresh: 2.8-2.7)[6]
Dried, peeled:	100	(Ratio to fresh: 4.0-3.3)

B. COMPARATIVE COSTS OF USING CASSAVA VS CORN IN LIVESTOCK FEEDS IN VIETNAM. On the basis of the data available, there would seem to be little question that, under the price interrelationships currently prevailing in Vietnam among livestock feed ingredients, it is significantly more economical to substitute cassava for corn in a balanced animal diet.

5/ Reported by same producer who reported prices of VN$80-90 in April 1974. A drop in prices would be consistent with the customary drop in Tay Ninh prices during harvest season, not yet reflected in the DAE price as of August.

6/ Computed as 70:25 and 80:30.

The diets used as the measuring stick (the only one at hand) are three sets of alternative sample diets for pigs, each set having approximately equivalent nutritive values, prepared by Dr. B. G. Harmon, professor of animal nutrition at the University of Illinois, with emphasis upon indigenous Vietnamese ingredients. To project costs under varying price relationships for the feedstuffs (and allow, at the same time, for possible unreliability of the price data used), costs have been computed both at estimated going prices as of April, June and September 1974, and at arbitrarily assumed prices that give the utilization of cassava a significantly lesser advantage than it enjoys under the estimated price relationships. The relative costs of the various rations, together with their composition and the feedstuff prices used, are shown in table 7 and summarized in table 7-A.

Unfortunately for the present purposes, the composition of the alternative rations has not been varied in any set pattern, and it is difficult to derive definitive functional relationships between the several ingredients and ration costs. It is clear, however, as seen in table 7-A, that, within each of the three sets, the least expensive rations are those using a high proportion of cassava vis-a-vis corn.[7] It is to be noted, moreover, that the comparisons do not show up the full cost advantage of using cassava rather than corn, since the illustrative diets, addressed as they were toward the greater utilization of indigenous feedstuffs, do not include any rations relying on corn as the primary carbohydrate-source.

Even so, it can be seen that, at the estimated 1974 prices [cols (A),(B),(C)], which reflect varying price interrelationships among the ingredients, the rations using as much as 30 percent corn, even with some cassava use, run 10 to 18 percent higher than those using 40 percent cassava (the maximum utilized in the sample diets) and no corn. Were nutritionally equivalent diets with corn as the primary carbohydrate-source available, the spread would undoubtedly be even higher.

Not intended as a limiting case of the most disadvantageous position for cassava, but probably reflecting price relationships that are more unfavorable than are likely to occur, columns (D) and (E) both use the lowest price for corn, and the highest for fishmeal and bran (added as supplements in the diets as corn is decreased), as estimated for the three points in time; and postulate the price of cassava at 69 and 77 percent of that of corn, as against the 52 and 63 percent for the three estimated 1974 price relationships. Despite the expected lowering of

---

7/ While the finishing rations are included in table 7-A, their cost intercomparison is less valid than for the other two sets, since their caloric values are not available and the comparison is based on costs per kilo, which (as can be seen in table 7 for the other rations) may differ somewhat in caloric value.

the cost advantage, higher-corn rations under assumption (D) are 7 to 10 percent higher in cost than the 40%-cassava ration, and, under assumption (E), still 5 to 7 percent higher. Again, a better-designed cassava/corn cost comparison would show even higher differentials.

Table 7: COMPARATIVE COSTS OF BALANCED PIG RATIONS UTILIZING VARYING PROPORTIONS OF CASSAVA

Ration	Percent in ration of:[1] Corn	Cassava	Fish meal	Bran[3]	Calories per kg	Cost of ration, under alternative assumptions as to the relative prices of the ration ingredients (in VN$s)[2] Per kilogram (A)	(B)	(C)	(D)	(E)	Per 1000 calories (A)	(B)	(C)	(D)	(E)
Weanlings															
(1)	0	39.7	17.0	42.0	3300	103	111	106½	118	122	31.3	33.6	32.3	35.8	37.0
(5)	10	39.7	15.7	33.3	3340	106	112½	108	119	123	31.7	33.7	32.4	35.6	36.8
(8)	20	29.5	13.7	35.3	3330	109½	116	114	121½	124½	32.9	34.8	34.2	36.5	37.4
(4)	0	10.1	10.6	77.4	3170	103	113	117	121½	122½	32.5	35.6	37.0	38.3	38.6
(11)	30	8.0	9.6	50.4	3270	113	120	123½	125½	126½	34.6	36.7	37.8	38.4	38.7
Growing pigs															
(1)	0	39.4	10.6	48.4	3320	99½	106½	104½	114½	118	30.0	32.1	31.4	34.4	35.6
(2)	0	29.1	8.3	60.7	3280	99½	107	108	115½	118	30.3	32.6	32.9	35.1	36.0
(5)	10	39.4	10.8	38.2	3360	103	109	106½	116	120	30.7	32.5	31.7	34.5	35.7
(6)	20	39.5	11.7	27.3	3390	107	112½	108½	118	122	31.6	33.1	32.1	34.8	36.0
(12)	20	9.0	7.6	61.4	3250	108½	116	120½	123	123½	33.3	35.7	37.1	37.8	38.1
(4)	30	10.0	8.2	49.9	3310	112	119	122½	124½	125½	33.9	35.9	37.0	37.6	37.9
Finishing															
(1)	0	40	7.6	50.4	n/a	90	96½	92½	102	106					
(2)	0	30	7.6	60.4	n/a	89½	97	95	102½	105½					
(3)	0	20	7.6	70.4	n/a	89½	98	97½	103	105					
(15)	20	0	7.6	70.4	n/a	99	107½	110½	111	111					
(6)	30	30	7.6	30.4	n/a	104½	109	107	113	116					

SOURCE AND DESCRIPTION: Rations shown have been selected from a set of 38 sample balanced diets for pigs (with nutritive content equalized within each of the three groups on the basis of the amino acid content), prepared by B. G. Harmon, professor of animal nutrition at the University of Illinois, in conjunction with a seminar held in Saigon in February 1974 promoting the use of feedstuffs native to South Vietnam. As originally presented, corn is replaceable by sorghum on a 1:1 basis. The 16 rations here (identified by Dr. Harmon's numbers) have been selected from among the 38 as representative of those involving varying amounts of cassava versus corn. Costs of rations have been computed on the basis of feedstuff prices per footnote 2 below.

-- table continued

Footnotes to table 7 (cont):

1/ Additionally, all rations include 1.0% of vitamins and 0.3% salt, and most include oyster shell at 0.2 to 0.7%, taken into account in computing ration costs.

2/ Prices used in computing cols (A),(B),(C) are "best estimates" of feedstuff prices prevailing as of April, June and Sept 1974, respectively. Cols (D),(E) use the lowest price for corn, and the highest for fish meal and bran, during the period, and arbitrarily raise the price of cassava, thus giving cassava as a substitute for corn a lesser advantage than it "actually" enjoyed.

Prices per kilo of Vitamin Pre-Mix, salt and oyster shell (any price changes in which would probably have only a negligible effect on the relative costs of the rations) have been held constant at VN$500, VN$30 and VN$16, respectively. The prices used for the remaining ingredients are as follows:

	Price per kilo (in VN$s)						Ratio of price to corn price				
	Corn	Cas-sava	Fish meal	Rice bran Fine	Rice bran Coarse	Wheat bran	Cas-sava	Fish meal	Rice bran Fine	Rice bran Coarse	Wheat bran
A:	130	82½	150	95	80	80	63%	115%	73%	62%	62%
B:	"	"	170	105	90	90	63	131	81	69	69
C:	135	70	150	115	95	95	52	111	85	70	70
D:	130	90	170	"	"	"	69	131	88	73	73
E:	130	100	"	"	"	"	77	131	88	73	73

Sources of prices for (A),(B),(C) as follows:

Corn: (A),(B): Established prices for imported corn, April-June 1974. (C): Sept 1974 price of domestic corn /imported corn no longer available/ reported by Directorate of Animal Husbandry (DAH).
Cassava: Prices as reported by pig producers (see section, "Prices of sliced dried cassava").
Fish meal: As reported by pig producers for good-quality unsalted meal for April, June and Sept.
Rice bran: (A),(C): DAH prices for Feb, Sept. (B): Per pig producer's report for fine bran, June.
Wheat bran: Priced same as coarse rice bran, on basis of the respective DAH prices in Feb 1974.
Vitamin Pre-Mix and oyster shell: DAH prices for Feb 1974.

3/ Refers to rice bran, except for finishing diets (15) and (6) where the percentages shown also include 20% and 10%, respectively, of wheat bran. In the absence of specifications for the rice bran, costs have been calculated on the assumption of fine bran for the weanling and growing pig rations, and coarse bran for the finishing rations.

Table 7-A

SUMMARY COMPARISON OF COSTS OF PIG RATIONS
UTILIZING VARYING PROPORTIONS OF CASSAVA

Ration	Percent in ration of:[1] Corn	Cassava	Fish meal	Bran[3]	Relative cost of ration under price assumption:[2] (A)	(B)	(C)	(D)	(E)
Weanlings									
(1)	0	40	17	42	100.0	100.0	100.0	100.0	100.0
(5)	10	40	16	33	101.5	100.3	100.2	99.5	99.4
(8)	20	30	14	35	105.2	103.5	105.8	102.1	101.1
(4)	0	10	11	77	103.8	106.0	114.3	107.0	104.4
(11)	30	8	10	50	110.6	109.3	117.0	107.5	104.6
Growing pigs									
(1)	0	39	11	48	100.0	100.0	100.0	100.0	100.0
(2)	0	29	8	61	101.0	101.7	104.6	102.1	101.2
(5)	10	39	11	38	102.4	101.2	100.8	100.2	100.1
(6)	20	39	12	27	105.5	103.3	102.1	101.1	101.0
(12)	20	9	8	61	111.2	111.3	118.1	109.8	106.9
(4)	30	10	8	50	113.0	111.9	117.7	109.3	106.5
Finishing									
(1)	0	40	8	50	100.0	100.0	100.0	100.0	100.0
(2)	0	30	8	60	99.7	100.8	102.7	100.5	99.5
(3)	0	20	8	70	99.4	101.6	105.4	101.0	99.1
(15)	20	0	8	70	110.0	111.4	119.5	108.8	104.7
(6)	30	30	8	30	116.4	113.2	115.7	110.8	109.4

SOURCE: Table 7

1/ Additionally, all rations include 1.0% vitamins and 0.3% salt, and most include oyster shell at 0.2 to 0.7%, taken into account in computing costs.

2/ Calculated from costs shown in table 7. For each of the three groups, ration (1) has been taken as 100. For weanling and growing pigs, based on cost per 1000 calories; for finishing pigs, in the absence of the caloric value of the rations, on cost per kilogram.

Assumptions (A),(B),(C) are estimated prices prevailing in April, June and Sept 1974; assumptions (D),(E) postulate cassava substitution in the ration as less advantageous than it was estimated to have been. For prices used and further detail, see footnote 2 to table 7.

3/ Rice bran, except as noted in footnote 3 to table 7.

Annex IV

THE PROCESSING OF CASSAVA CHIPS*

A. INTRODUCTION. When Europe first began importing dried cassava as a livestock feed, the bulk of the shipments were in the form of meal. In the 1960s, unutilized European milling capacity gave rise to preferential tariff treatment to the less-processed chips, and a consequent shift to the import of chips.[1] Beginning in 1967, Thailand started pelletizing its cassava (essentially a pressing rather than a milling-and-compressing operation) to reduce transportation, handling and storage costs. Even when sold in the form of pellets or meal (but not waste meal), the cassava root is first processed into dried chips.

While the literature on cassava includes schematic drawings of completely integrated mechanized chipping and pelletizing operations carrying the whole fresh root through washing, slicing, drying, pelletizing and bagging, Thailand, the world's largest processor of dried cassava for commercial use, with pellet exports in 1973 of 1½ million tons, still processes its chips as a separate, only semi-mechanized operation, and uses outdoor sun-drying.

B. THAILAND'S DRIED-CASSAVA PRODUCTION AND MARKETING SYSTEMS. The elements in the Thai production and marketing systems for cassava as a feedstuff are, roughly, (a) the growers, (b) the driers, who cut and dry the chips, (c) the pressers (i.e., pelletizers), (d) the exporters, and (e) the shippers. In practice, some of the enterprises may engage in more than one of these activities. Fresh roots are offered to driers by growers or middlemen by the truckload. It can be done on an individual basis, but also often in the market place where growers, dealers and driers meet. Sometimes the driers (who may also be in trucking) collect the product from the growers, providing their own transportation (and sometimes even doing the harvesting themselves).[2] Again, some farmers and -- at the other end -- some pressers may also have their own cutting/drying

---

*Numbers in parentheses refer to source, shown at the end of the annex.

1/ "Chips" is used here in a generic sense and is intended to include slices and broken roots as well as the more common irregular-shaped, relatively thin chunks specifically designated as "chips" (which is the form of processing in Thailand).

2/ It is also reported that, in some areas in Thailand, the collector may also assist with land preparation (1).

and/or trucking operations. (2) In 1972, according to one source (2), there were 500 driers and 90 pressers, of whom three (two European and one joint European/Thai) accounted for 25 percent of the pellet production. Another source (3), however, puts the number of modern pellet factories as about 10, with another 200 small factories producing 50,000-60,000 tons annually /the estimated number of driers is not given/.

According to a Dutch investigative study in 1972 of the production and marketing of Thai pellets, the cassava at the various stages is traded in a completely free market, with prices decided by supply and demand. Trade is in no way controlled or coordinated, and no price agreements exist. The products are not subject to any official control prior to exportation. Competition between buyers is keen; and monopoly situations are non-existent. (2) Given the small number of exporters and large producers of cassava pellets, however /in 1972, there were ten exporters, of whom five, some with their own pelletizing plants and shipping facilities, handled 80 percent of the non-European Thai pellet production (2)/, prices in fact appear to be highly influenced by the buyers at the various stages of processing; and the Dutch study itself recognizes that the prices paid for non-European pellets and, in turn, chips are inadequate to permit a quality product. At times, prices for the fresh roots have fallen so low that concerned authorities have been urging the organization of the farmers into associations, to provide a better bargaining base.[3]

3/ Relevant references are:

(a) "The price obtained for /the fresh cassava roots/ is not worth the important role they play. This is due to the mere fact that the price of cassava roots is under the control of tapioca /i.e., cassava/ factories that purchase them. Such has placed the planters at a disadvantage. A possible means of solving this problem would be for the planters to organize themselves into agricultural groups, credit co-operatives, or associations, /to/ ensure for them the power of bargaining and the backing they need to secure a reasonable price for their product."

--An article in the Bangkok City Bank Bulletin (3)

(b) "Until 1972, the state of tapioca production and trade /in Chonburi Province/ remained unsteady, due mainly to the ever fluctuating prices of tapioca products. Also to blame was the unsympathetic attitude of some buyers and exporters, who tried to impose their own prices..."

-- Governor of Chonburi Province (4)

(c) "Markets are few and planters have to sell their produce at whatever price offered them by local tapioca factories..."

-- Governor of Petcha Buri Province (5)

-- footnote continued

C. THE CUTTING-DRYING OPERATION. Once harvested, the cassava root deteriorates rapidly unless it is dried. Because of its high water-content, generally about 65 to 70 percent (though there is wide variation, depending on variety, climate, stage of growth at which harvested, etc.), the root is first cut or broken to facilitate drying. Optimally, it should be dried down to 14 or 15 percent moisture, for storage, though, as noted below, this is not always done. As best as can be ascertained, the cutting/drying process for a product suitable for livestock consumption must be started within 24 to 48 hours after the root is lifted.

In Thailand, the root is cut into irregular chunks by a power-driven mechanical cutter, manually fed from a wooden platform; and the chips are then dried in the open air on concrete or cement drying-floors (8,9). Cutting generally takes place in the early morning hours, to take maximum advantage of the day's sun -- in the case of an operation personally visited, the day's cutting had begun at 4 A.M. and ended at 7:30 A.M. The chips are first spread to dry in thin layers; on succeeding days, the previous days' chips are pushed into thicker layers (10). About once

---

Footnote 3 continued:

(d) Among other problems, "the selling prices obtained by growers are sometimes lower than their cost of production; /and/ a lack of group spirit among the growers makes working co-ordination difficult." Recommendations include "that cassava growers be organized into groups or communities, with a centre established to co-ordinate their activities and to uphold their bargaining power"; and "that a tapioca marketing board be created to help producers obtain a fair price for their products," among other objectives.

-- Report of a May 1973 seminar held under the auspices of the Dept of Commercial Economics, the Ass'n of Chonburi Agricultural Communities, the Ass'n of Thai Tapioca Producers and the Thai Tapioca Trade Ass'n, included in a July 1973 Commerce Ministry's Report to the Prime Minister (6)

(e) "/Based on the above report, the Ministry of Commerce recommends that/ the Committee for the Assistance of Agriculturists...consider the establishment of agricultural institutions..."

-- Commerce Ministry's Report to the Prime Minister (6)

(f) "Our study...leads to the following conclusions:...On the whole, the driers receive far too little for their product to enable them to do the drying well. The prices paid for the dried chips bear no relation to the prices of the fresh roots and the costs of drying.../Also/, in general, the native pressers are being paid too little to be able to do the pressing well..."

-- The Dutch investigative study of the Thai cassava industry (7)

an hour during daylight, the chips are turned over by pushing them with wooden rakes, alternating direction each time in criss-cross fashion, e.g., north to south, then east to west. (The operation uses a fair amount of labor: at the factory visited, five workers were turning the chips on the 1-acre drying floor.)[4] If rain threatens, the chips are collected into piles and covered with portable tents of corrugated iron (or, as observed in some cases, with plastic sheets), as shown on page A-37; they are spread out again when the weather clears (9). /Given the tendency of the freshly-cut roots to heat up if left in high piles for any length of time, it is important, if the chips are not relatively dry, that piles left for more than 12 hours be broken up and spread out (about 6" high) for about a half-hour, to permit them to cool (11)./ Chips left overnight are collected into piles and sheltered only if rain is expected (9).

The drying process in Malaysia is apparently essentially similar to that in Thailand. As for other countries, there are references in the literature to drying by other means, but the practice is described as only occasional, and the locale is not given.[5]

4/ Total labor force during the peak season was given by the factory (which had one cutter) as 10 workers.

5/ References found are as follows:

(a) Malaysia's "backyard processing" is similar to that in Thailand (12).

(b) Apparently speaking of Malaysia, "cassava chips...are produced by passing the raw roots through rotating knife blades that cut them into irregular-shaped ribbons from 1" to 3" long and approximately ¼" square. These chips are then sun dried by spreading them in the open air on concrete ap ons...In climates where humidity is lower then in Malaysia, some drying is done in tunnels or sheds by moving large volumes of heated air over the chips by the use of power driven fans." It is also noted that in general sun-drying is the most widely used method. (13)

(c) "For industrial purposes,...chips...are dried in the sun or in the oven with controlled heat and air flow." (14)

(d) "In Africa...chips...are dried in the sun on small platforms, roof tops or heated concrete slabs, or in a drying oven...

"For the most part, the technology of drying the tubers is primitive...There are a few tunnel driers and cabinet driers in use, but they are the exception rather than the rule. The Brazilian Instituto de Tecnologia Alimentar is experimenting with solar energy as a source of heat for drying chips in a cabinet." (15)

Drying time is dependent, of course, upon the size of the chips as well as the climate. In the Chonburi growing area in Thailand, the chips of two relatively dry chips selected at random from a drying field, one measured 2 cm wide, with thickness varying from 0.5 to 0.8 cm; the other, 2½ cm wide and 1 cm thick -- were reported as drying in one to 1½ days in good sun, and in three days in cloudy weather (9). According to the 1972 Dutch study of the Thai cassava-pellet industry (16), however, too little time was being given to drying chips in Thailand because of low prices, leaving them generally with about 19% moisture (as against the 15% desirable), and giving rise both to technical problems with pelletization and the deterioration of the pellets during ocean shipment and storage. Longer drying time (or artificial after-drying) and/or smaller chips (down to 1 cm x ½ cm) were recommended. (How important this would be for chips not processed into pellets and consumed locally is not clear.)

Drying time of the hand-sliced chips produced in Vietnam is reported at 24 to 48 hours (17). Other references to drying time found in the literature are (i) between two and three days in Malaysia, depending on weather conditions (13); and (ii), neither geographic area nor climate specified, four to six days (15).

D. THE CUTTING MACHINE

Thai machines. The cassava-cutter commonly, and perhaps universally, used in Thailand is a rather simple machine, as shown in the following pictures taken in Chonburi, Thailand's largest cassava-growing province, in November 1974. The machine, made locally on a custom-order basis by small Chonburi workshops, uses a rotating grater made from the head of a 55-gallon drum, with the size of the chips determined by the height and the length of the cutting-teeth. The cutting disc must be replaced frequently -- in one conversation, it was indicated that it lasts about twenty days, but its durability by tonnage was not clear -- and during its lifetime it is serviced by sharpening and raising the cutting-teeth when dulled and flattened. The machine is fed by hand, but the flow of roots to the hopper is facilitated by a wooden feeding-table; and the cut chips are loaded onto carts via a belt conveyor. (Further details on the machine and its operation are given in the commentary accompanying the photographs.)

The cutter photographed uses a 6-H.P. Japanese-made diesel engine, but 5 H.P. is apparently a more common size, for either a diesel engine or an electric motor. An August 1973 USOM/Thailand communication (18) reports the machine as being available ex factory only, with arrangements for export, internal transportation, shipping, etc., to be made by the buyer (though see footnote 6).

Also reproduced, on pages A-38 and A-39, are excerpts from the Chonburi Karnlo Factory brochure on the "Winster" cassava-cutter -- apparently put on the market quite recently -- which is available for export.[6] Essentially similar to the machine in local use, though the supporting frame and feeding-table are of metal rather than wood, it does offer the improvement of a slanted rather than a horizontal feeding-table, facilitating the flow of the roots into the hopper -- a feature presumably readily incorporable into the wooden table.[7]

The cutting capacity of the "native" machine photographed was given by the workmen as two truckloads or 2½ tons of fresh roots an hour. While, given the size trucks usually used in the area to haul cassava, this did not appear to be entirely self-consistent, the 2½ tons hourly does appear to be in the right magnitude. /The USOM's August 1973 memorandum reports Chonburi Karnlo Factory as quoting hourly capacity at 5 MT and another potential supplier,[8] as giving a range of 2 to 4 tons, depending on the operator's skill and the handling facilities (both assuming a 5-H.P. engine), with the comment that, in the second supplier's opinion, the 5-ton estimate was too high. Additionally, a prototype chipper constructed in Cali, Colombia (19) using the Thai machine as a model but powered by a tractor power take-off was reported, in limited tests, as cutting 1½ to 2 MT of fresh roots per hour. (Cutting capacity would appear to be lower than in the Thai operation, inasmuch as the chips, described as about 1¼ cm wide and less than ½ cm thick, were significantly smaller than the Thai chip, and -- as illustrated in the article -- the feeding procedure appears less efficient.)/

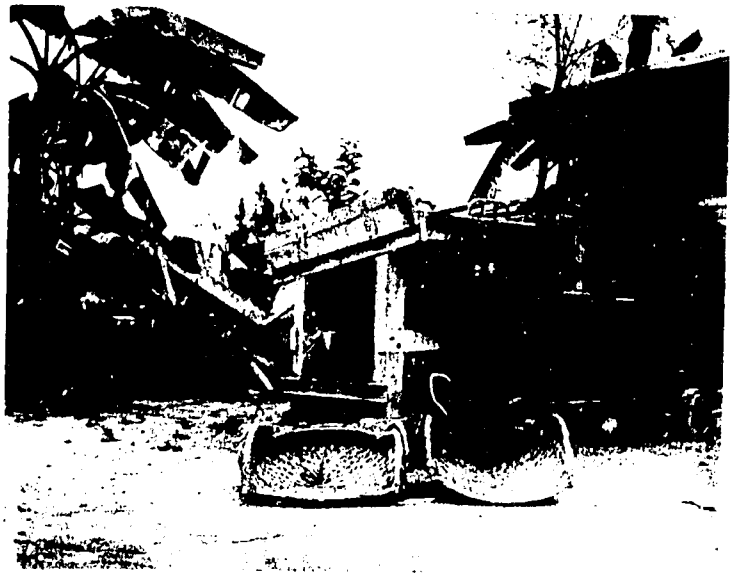
6/ In the August 1973 USOM/Thailand communication, the manufacturer of the Winster /Chonburi Karnlo Factory (or, alternatively, the Chonburi Casting and Machine work Co., Ltd), 360 Bansuan, Amphor Muang, Chonburi Province, Thailand/ was identified as a supplier of the "native" machine described above, with no reference to the "Winster" model. From the wording of the brochure's text, it seems likely that the Winster is a new line built specifically for export.

Whether the company, which now has facilities for export sales, would be willing to ship the "native" model was not ascertained.

7/ This change in design appears to be a simpler version of that recommended in the Dutch study: "It would be possible to cut small chips /at a reasonable rate, if the pressure on the cutting plate were increased and the flow of roots improved/ by building a bunker with its bottom slanting down to the die plate, above the existing table of the cutting machine." Feeding the roots to the bunker by a small conveyor belt was also recommended as a labor-saving device. (16)

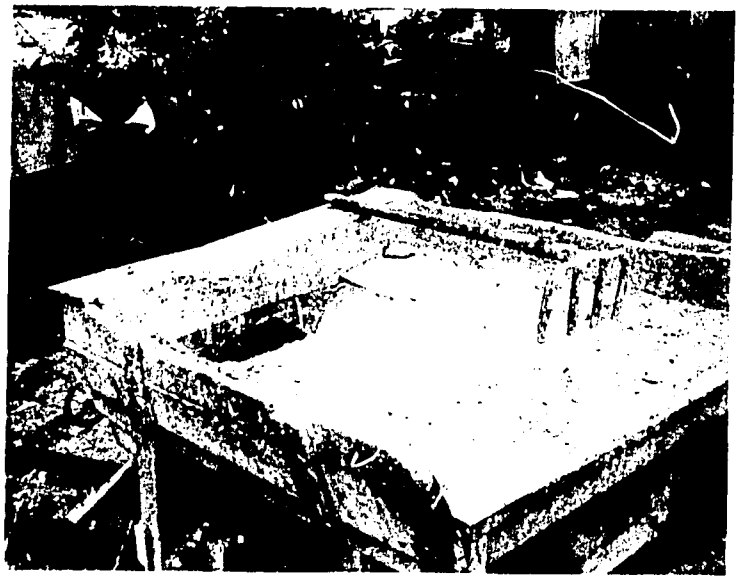
8/ As of November 1974, the manufacturer, located in the Bangkok metropolitan area, reported he was not producing the machine because of inability to compete with the lower costs in Chonburi (9).

CASSAVA CHIPPER COMMONLY USED IN THAILAND

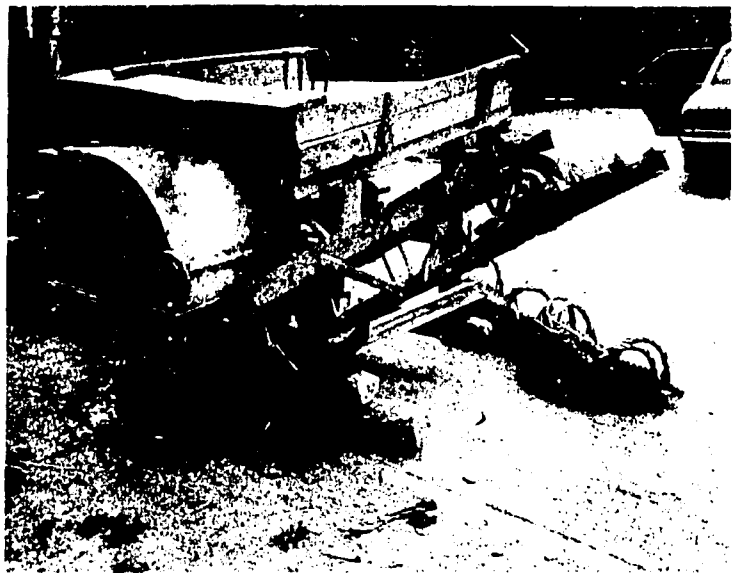


Cutter and diesel engine are mounted on wooden frame, which is topped by rimmed wooden feeding-table. Roots are brought to table in straw scoop-baskets shown in foreground. Frame has wheels at engine-end only, with wooden blocks inserted at other end when machine is in use, presumably to provide greater stability against the vibrations of the diesel engine.

Feeding table, cut to receive the vertically-positioned metal hopper at rear, is lined with sheet metal. (Hopper is also commonly centered in rear, rather than in corner as shown.) Feeding of roots is two-man operation: one worker throwing the roots toward the hopper; the other, perched on the raised back of the table, pushing the roots into the hopper with a rake.

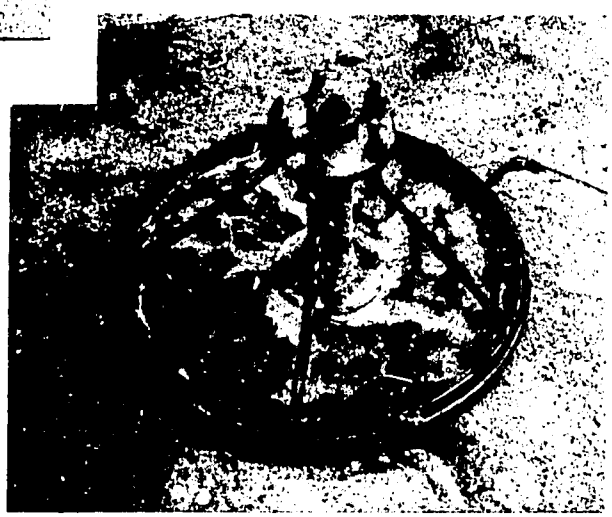


CASSAVA CHIPPER COMMONLY USED IN THAILAND



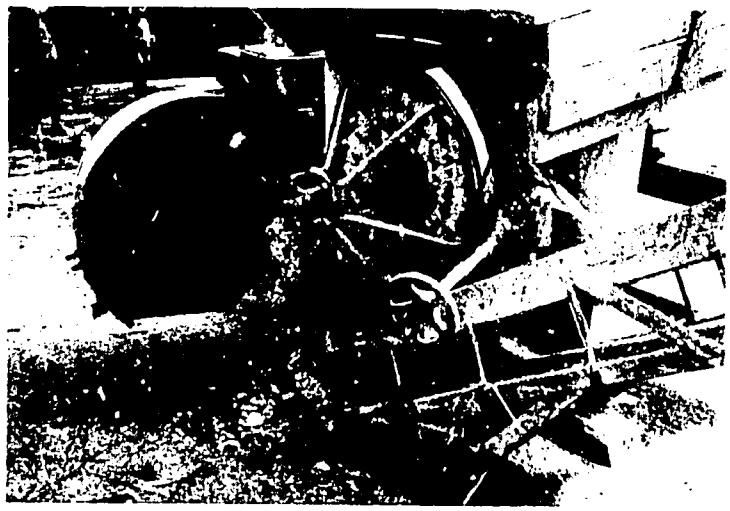
Rear of machine, showing hinged housing of the cutting head, which directs the flow of the chips to the flat belt conveyor. Housing is fastened with a screw clamp.

Cutting disc is a rotating grater made from the head of a 55-gallon drum. The height and length of the cutting teeth determine the size of the chips.



Cutting disc in its mounting, which slips over the drive shaft.

CASSAVA CUTTING AND DRYING IN THAILAND



Cutter-head housing swung back, showing cutter-head in place.

Two-wheeled pushcart which receives the chips from the belt conveyor. Chips are shaken from the cart onto the drying floor with a slight trotting motion. Getting a thin even layer is considered as demanding a high degree of skill. Also shown in the foreground, leaning against the cart (not part of it), are the wooden rake used to turn the chips on the drying floor, and the wooden pusher for pushing the chips into piles.

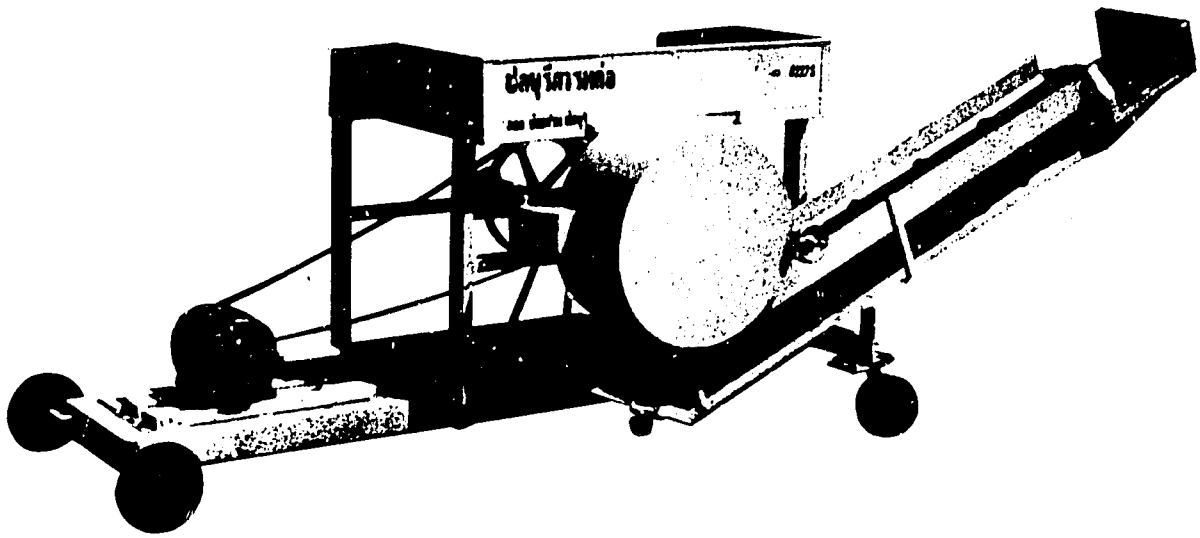
Chips piled and sheltered on the drying floor, as rain threatens. Floor--this one, 5 acres in area--undulates, to facilitate drainage. Smaller floors, for drainage, are constructed as single mounds.

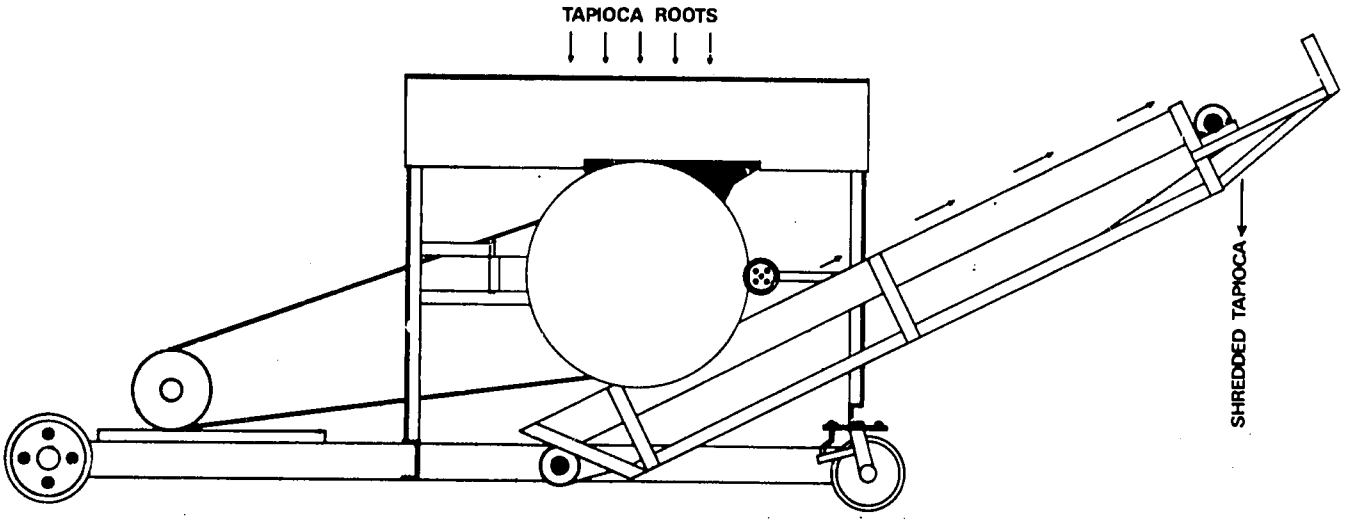
THAI-MANUFACTURED WINSTER CASSAVA-CUTTING MACHINE AVAILABLE FOR EXPORT

WINSTER

The present is a time when the tapioca industry of different countries has a favourable income. The higher the production per day per hour, the higher the profit. At the present time many countries still lack the relevant labour-saving equipment. The old production method is still employed and production is as limited as before.

In view of this, the CHONBURI CASTING AND MACHINE WORK Co., Ltd. of Thailand has therefore conducted a research for some labour-saving method so as to obtain a higher production. After a number of years of research, improvement and experience, we have now invented a machine for grinding shredded tapioca (from tapioca roots) that is highly efficient. From tests made on various occasions, our "WINSTER" machine has proven itself to be capable of an approximately 10 tons per hour production. The machine can readily and conveniently be moved about, is not voluminous and weighty.



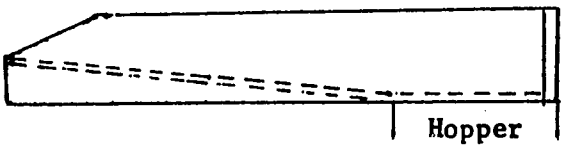


WINSTER

Excerpts from brochure on the "Winster tapioca grinding machine" manufactured by the

Chonburi Casting and Machine Work Co., Ltd.
360 Bansuan, Amphor Muang, Chonburi, Thailand
(Mr. Suan Pusanguansit, owner and manufacturer)

Machine is similar to that pictured on the preceding pages except that it is all-metal; the feeding-table is slanted downwards to improve the flow of the roots, as illustrated at right; and there is no perch provided for a helper to push the roots into the hopper (which according to the manufacturer is obviated by the gravity flow). Also, as shown, machine is powered by electric motor and frame is four-wheeled.



Rough-drawn side-view of feeding-table, showing slope of table

Price f.o.b. Bangkok, exclusive of motor, quoted in November 1974 at $1200.

The capacity of the Winster model is given as 10 tons per hour, also using a 5-H.P. motor.[8a]

Prices of the machines were reported as follows:[9]

Source	Date	Terms	Cutter	Engine	Total
"Native" machine:					
Chonburi Karnlo (18)	Aug 73	Ex factory	$225	$300*	$525
Bangkok workshop (18)	"	" "	250	250*	500
Cutting operation visited (not a supplier)	Nov 74	" "	325	400**	725
"Winster"					
Chonburi Karnlo (9)	Nov 74	F.o.b. Bangkok	$1200	...	...

*Japanese-made 5-H.P. diesel **Japanese-made 6-H.P. diesel

Japanese-made 5-H.P. water-cooled diesel engines were quoted in Saigon in November 1974 at VN$260,000-VN$264,000 (including 10% Value Added Tax), or about $390 (at 670:1).

Price for the woodwork (frame and feeding table) was given by the cutting operation visited as $10 to $15.

Price for the cutting disc (3 cutting teeth per row, 20 rows) was given by the cutting operation as $2.25, but was available at a local shop for $1.60. (A disc with 4 teeth per row sold for $1.70.) F.o.b. Bangkok price for a replacement disc for the Winster was quoted by Chonburi Karnlo at $5.00. The clamp holding the cutting disc was priced at the local shop at $8.25.

The total cost of the Colombian prototype, including the power drive shaft for the tractor power take-off but, as illustrated, without a belt conveyor, was reported in late 1972 as less than $100 (apparently covering labor and parts only). It was estimated that future models without the power unit could be built for less than $50. (19)

Cassava-cutters in South Vietnam. Within recent months, the Vietnamese Agricultural Machinery Directorate, with USAID/Vietnam assistance, has constructed a prototype cassava-slicer.

8a/ No supporting detail for the much higher capacity attributed to the Winster versus the essentially similar "native" model was given by the manufacturer (9). The Winster, it may also be noted, is produced by the same manufacturer whose quotation of a 5-ton capacity for his "native" machine was considered too high (see page A-34).

9/ Prices for the Winster machine and the replacement disc were quoted in dollars. Other prices relating to the Thai products were given in baht, converted here to dollars at 20:1.

The machine uses two steel cutting blades, which can be adjusted for thickness of slice. No formal tests have been conducted, but capacity is estimated at about 300 kg of fresh roots per hour. Cost of the prototype (labor and materials only), including a ½-H.P. electric motor, was VN$80,000 (about $120), with the cost of the slicer alone estimated at about VN$50,000 (about $75). The machine has been exhibited both in Saigon and Can Tho. (11)

Additionally CARIC (Chantiers et Ateliers Réunis d'Indochine or Cong-Ty Ky-Nghe Thu-Thiem, Saigon) at last report was considering the possibility of manufacturing a cassava-slicer under franchise from a foreign firm. Details are not as yet available.

A sophisticated chipping operation. A rough idea of the cost of a sophisticated operation can be gotten from the 1966 feasibility study for a cassava chipping/drying operation in Malaysia by Arthur D. Little, Inc. (20). Outlay for the belt-line operation recommended (capacity of 6½ MT per hour) was estimated at the time at about US$4,000 for the chipper, US$80,000 for the drier, and US$26,000 for the washer, conveyors, etc.

E. THE DRYING FLOOR. It will have been noted that the operations that cut and dry cassava are referred to in the Dutch study as "driers"; and indeed the drying process does appear to be the focus of the operation, as evidenced by the early hours at which the chipping takes place in order to maximize the utilization of the drying floor. This is understandable if the impression formed was correct that the floor represents the bulk of the investment.

Size of the floor. The size of the Thai drying floors would appear to vary from 0.4 acres (1620 square meters) for the small farmer operators to 4 to 8 acres (1.6 to 3.2 hectares) for the large collectors.[10]

In terms of the area needed to service the output of one machine, the drying floor of the one-machine operation visited at length, which tended to be quite a bit smaller than most of the floors in the collector operations seen in the Chonburi area, measured off at 1.15 acres or 4650 square meters. (Another floor, measured at about 5 acres or 2 hectares, appeared also to be supplied by a single cutting-machine, but this was not checked out.) If floors as small as 0.4 acres are indeed used, it would seem that either the cutters (apparently of the same type as in the larger operations) are run for fewer hours daily or, possibly, that they are shared by two or more farmers/driers.

10/ Measurements here and in the later references were actually given in "rai," which are 0.4 acres.

In terms of area per quantity of roots, best guess for the 1.15-acre floor is that there were 0.18 acres (730 sq m) for each ton of fresh roots held. Other estimates indicate that the floor-area might be as high as 0.20 to 0.32 acres (810 to 1300 sq m) per ton. At these rates, estimated tonnage held on a 0.4-acre field would range from 2¼ tons down to 1¼.

The estimates, which are highly tentative, are based on the following:

Type of operation	(a) Total acreage of drying floor	(b) Acres of floor per machine	(c) Acres of floor per MT of fresh chips	Source of estimate
Small operators	0.4	0.4(?)	..	USOM/Thailand (10). Not ascertained that cutter not also utilized elsewhere.
Operator A	1.15	1.15	0.18	Field measured. Col (c) assumes floor held 6¼ tons of chips.*
Operator B	5	5(?)	..	Field measured. Appeared to be only one machine, but not checked.
Large operators	4 to 8	..	.32-.20	Per gen'l mgr of a large mfgr of cassava starch and pellets. Col (c) based on estimate given that 1 hour's cutting would cover 0.8 acres.**
General	..	..	.20	Per Chonburi Karnlo Factory (i.e., 10 tons would require a 8,000 sq m drying area).

*Based on statement that the field, which was totally covered, held the morning's cutting of 5 truckloads or, according to their calculations implying 1¼ tons per truckload, 6¼ tons.

**Range postulates tonnage cut per hour at (i) 2½ MT and (ii) 4 tons.

It is also reported that Chonburi province which produced 500,000 tons of dried chips in 1972 had at the time about 400 acres of drying yards, or about one acre for each 1250 tons of dried-chip production annually (4).

Type of construction. The field must be hard-surfaced, to prevent contamination by dirt or other foreign materials /asphalt topping cannot be used if the chips are for human or animal consumption/, but does not have to be able to withstand much weight (9). In Thailand, either concrete, or about

4" of soil mixed with 3% cement, layered with sand and a higher proportion of cement, is reported as being used (10). Both the general manager of the large operation referred to above, and the smaller operation visited, however, gave the thickness as 3 inches. The floor of the latter was 10 years old, and had been patch-paved twice.

Careful attention is given to drainage. The smaller field of about an acre was visibly high in the center and sloping downward in all directions. The 5-acre field, pictured on page A-39, was undulating with intermittent troughs. Both fields were well-curbed with concrete/cement to provide drainage gutters.

In the relatively even climate of Thailand, expansion joints are not used.

Estimated cost of construction in Vietnam. Based on Vietnamese prices prevailing in early 1974, rough calculations indicate the costs in U.S. dollars for paving materials (exclusive of land preparation and labor) for 3" and 4" floors as follows:[11]

Composition and thickness	Per square meter	Per acre (4050 m^2)	Per 0.4 acre (1600 m^2)
Concrete (1") over:			
Aggregate (2")	$0.732	$2,970	$1,190
Aggregate (3")	.825	3,340	1,320
Traditional method -- Sand/cement over:			
Aggregate with sand/cement (2")	.705	2,860	1,140
Aggregate with sand/cement (3")	.753	3,050	1,210
Concrete (1") over:			
Traditional base (2")	.659	2,670	1,070
Traditional base (3")	.707	2,870	1,130

F. RELATIVE COSTS OF OPEN-AIR AND ARTIFICIAL DRYING. While, as indicated earlier, there are various passing references in the literature to artificial drying, the only source found treating explicitly with the costs of such drying is the Dutch study of the Thai industry (21). In its tests with cassava strips (finer than the standard chips), using diesel-

11/ Details of the calculations for a 4" floor are shown in the following table. Cost of construction for a Thai drying floor, 3" thick, was given by the general manager of the large starch/pellet company visited at Baht 20,000 per one rai ($1,000 for 0.4 acres).

Work table

ESTIMATED COST OF RAW MATERIALS FOR DRYING FIELD*

Composition of field	Unit prices (VN$)**	Cost per m^3 of finished product	Cost for 4" thickness: Per square meter	Per acre (4050 m^2)	Per 0.4 acre (1600 m^2)
A. Concrete (1") over aggregate (3")					
1. Concrete - for top layer					
Aggregate (1x2cm), 2/3	3,000/m^3	VN$2,000			
Sand, 1/3	900/m^3	300			
Cement, 4 50-kg bags per m^3	2,500/bag	10,000			
Total - VN$		VN$12,300			
2. Total field					
Concrete (see 1 above), ¼	12,300/m^3	VN$3,075			
Coarse aggregate, 3/4	2,500/m^3	1,875			
Total - VN$		VN$4,950			
Total - US$		$8.25	$0.825	$3,340	$1,320
B. Traditional method***					
1. Sand/cement - for top layer					
Sand, 1	900/m^3	VN$ 900			
Cement, 5 50-kg bags per m^3	2,500/bag	12,500			
Total - VN$		VN$13,400			
Total - US$		$22.33			
2. Sand/cement - for filler in base					
Sand, 1	900/m^3	VN$ 900			
Cement, 3 50-kg bags per m^3	2,500/bag	7,500			
Total - VN$		VN$8,400			
3. Total field					
Sand/cement (1 above), ¼	13,400/m^3	VN$3,350			
Aggregate (5x7cm), 3/4	1,000/m^3	750			
Sand/cement (2 above), 5%	8,400/m^3	420			
Total - VN$		VN$4,520			
Total - US$		$7.53	$0.753	$3,050	$1,210
C. Concrete (1") over traditional base (3")					
Concrete (A.1 above), ¼	12,300/m^3	VN$3,075			
Aggregate (5x7cm), 3/4	1,000/m^3	750			
Sand/cement (B.2 above), 5%	8,400/m^3	420			
Total - VN$		VN$4,245			
Total - US$		$7.07	$0.707	$2,870	$1,130

FOOTNOTES TO TABLE

*Formula for concrete over aggregate (A), from ADCCA/ETA/Hwys; for traditional Vietnamese construction for cement floors (B), from Miss Tran Thi Kim Dung/ADEPP, except as noted in footnote (***). Prices used (as of early 1974 when the piaster was valued at 600 to the dollar) are as provided identically by both sources [ADCCA's prices were described as "delivered," but at no specified site; Miss Dung's, as delivered in Bien Hoa (where the raw materials are available locally, involving little transportation cost)], except for the following:

(a) The price for sand is an average of ADCCA's VN$1,000 and Miss Dung's VN$800; and

(b) The aggregate for use in the base layer was priced by ADCCA at VN$2,500 to VN$3,000 (the upper range being as high as that for the finer aggregate); and by Miss Dung, at VN$1,000, specifically related to 5x7cm rock used in local construction. It has been assumed in the table that the difference in the prices reflects difference in size rather than disparity in estimation; and a price of VN$2,500 has been used in formula A, and VN$1,000 in formulas B and C. (If a price of VN$1,000 is actually applicable, the costs of concrete over aggregate (A) would be $6.375 per cubic meter and, for 4" thickness, $2,580 per acre and $1,090 per 0.4 acre.)

According to the calculations, it might be noted, the computed cost of $20.50/m^3 for concrete [which falls within the $20-$25 rule-of-thumb estimate for concrete delivered to site (site not specified) also given by ADCCA/ETA] is actually lower than that for the sand/cement mixture used as the top layer in the traditional construction. Formula C assumes concrete over the traditional base.

Costs have been converted from piasters to dollars at 600:1.

**Prices are as of early 1974 when the piaster was valued at 600:$1.

***Top layer of 1" to 1½" of sand/cement mixture, using 5 bags of cement to 1 cubic meter of sand. Lower layer made up of 3" of 5x7cm rock filled in first with soil, tamped down, and then with a dry cement and sand mixture (which is later watered) using 3-4 bags of cement to 1 cubic meter of sand. The amount of the mixture used was not known.

As costed out here, the top layer has been taken at 1", and the price of the cement/sand mixture for fill-in of the base layer has been calculated on the basis of 3 bags of cement. The amount of the mixture has been arbitrarily taken at 5% of the total, or 6-2/3% of the base layer. [If in fact it is as high as 13½% of the total (i.e., 18% of the base layer), the cost of the base layer would become as high as that of the coarse aggregate at VN$2,500 used in formula A; and, if still higher, the cost of the base layer would exceed that in formula A.]

oil heating and a whizzer with a 23 MT/hr capacity, the costs of drying the roots to a moisture content of 15% were calculated at Baht 22 per 100 kg of dried product, as against Baht 6.90 for sun-drying of the standard chips.

More attractive, it was believed, would be the sun-drying of the root down to about 20% moisture and then using mechanical drying to further reduce the moisture to 14%. Working again with fine strips and using a cascade-drier with 10MT/hr capacity, the mechanical drying came to Baht 1.85 per 100 kg of dried product. At the same time, the cost of drying on the drying field was reduced by Baht 1.40 per 100 kg,[12] for a net additional cost of only Baht 45 per 100 kg.

The tests, it should be noted, were carried out in early or mid-1972, before the sharp increases in oil prices.

Translated to dollars at 20.8 to 1, and from dollars to piasters at 1 to 670,[13] the relative costs in terms of the dried product are as follows:

	Baht per 100 kg	Dollars per 100 kg	Piasters per kg[13]	Ratio to sun-drying
Sun-drying (chips)	B 6.90	$0.33	VN$2.2	100%
Heat drying (strips)	22	1.06	7.1	319%
Sun/mechanical drying (strips):				
Sun-drying	6.90	.332	2.22	
Less Reduced cost in sun-drying	1.40	.067	.45	
Sun-drying to 20%	5.50	.264	1.77	
After-drying to 14%	1.85	.089	.60	
Total	7.35	.35	2.4	106½%

After-drying has the advantages of lessening dependence on weather conditions and providing better controls on moisture content.

12/ It is not clear whether this reflects only the difference in moisture content, or whether it also postulates thin strips.

13/ While presented here, the piaster values are of dubious value as an indicator of Vietnamese costs since (a) the difference in conversion rates from fresh to dry roots /1.95 to 1 in Thailand versus 3.2 to 1, and even higher, reported for Vietnam/ would seem to imply a far higher water content in the Vietnamese root; and (b) the overall Vietnamese price level appears considerably higher than that of Thailand.

G. NOTE ON CASSAVA PRODUCTION IN THE THAI PROVINCE OF SUPAN BURI. The following digest of an article on one of Thailand's newly emerging cassava-producing centers, written by the Province Agricultural Officer (22) may also be of interest. (While monetary values, presented originally in baht, are shown here in piasters as well as dollars, the former are again of dubious value in indicating the absolute levels that might be expected in South Vietnam.)

The terrain of Supan Buri is predominately low paddy-land, forest and hills. Rice has been, and still remains, the backbone of the province economy. Cassava is now grown, however, in the areas where the terrain is hilly and the soil is sandy loam in structure, on lands that were formerly open country or woodland.

Of little importance before 1970, cassava root production was given impetus with the establishment in the area that year of the first cassava-processing factories. Because of its strong resistance to pest and drought, and its easy cultivation, cassava quickly became a favorite local crop. As the industry began to grow, provincial authorities assisted with distribution of seedlings to needy farmers and the provision of a pest-control service. By 1973, with the number of factories increased to 29 chippers and two pelletizers, area under cassava cultivation had grown to 25,300 acres (10,250 ha).

Cost of production and returns (converted from baht to dollars at 20.8:1 and to piasters at $1:VN$670) are given as follows:

Costs of production, per hectare:		
Soil preparation, plowing (by tractor), and bed-raising	$23.75	VN$15,900
Seedlings	8.90	5,950
Planting	11.85	7,950
Two weedings (the minimum number needed)	23.75	15,900
Insect spray	8.90	5,950
Harvesting	11.85	7,950
Total cost of production (as reported)	101.00	67,650
Actual total of items listed	(89.00)	(49,600)
Receipts per hectare after a 10-month growing season /based on yield of 4 MT/rai and root price of Baht 0.20/kg (i.e., 24.7 MT/ha and $9.62/MT or VN$6.45/kg)/[14]	237.60	159,200
Profit per hectare	136.60	91,550

/Net returns, assuming family labor, would presumably be about $200 per hectare./

14/ See following page for footnote.

There is generally little difficulty in disposing of the crop, since it is usually sold in advance to the factory owners who extend credit for working capital. Any root surplus is sold by the factory to Bangkok.

While the returns are relatively good, most of the farmers /many of whom rent the land/ are heavily in debt and much of the earnings is used to repay the loans extended at high interest by factory owners and landlords.

14/ Average output is given as 3.5 to 4 MT per rai; average root prices, as 0.20 to 0.25 baht per kg, depending on the quality (i.e., 21.6 to 24.7 MT per ha; and $9.62 to $12.02 per ton, or VN$6.45 to VN$8.0 per kg). /Using the top of the range for yield, and the bottom for price, as is done in the article, provides, in effect, for a rough averaging within the ranges./

The yield estimate, it might be noted, is significantly higher than the official Thai Ministry of Agriculture estimate of 2.46 MT per rai (15.2 MT per ha) for the country as a whole (23); though, apparently, yields as high as 5 MT per rai are not uncommon in Thailand on newly opened lands (9). It is also higher than the 3 MT per rai (18.5 MT/ha) given as the yield for Supan Buri and the neighboring province of Chainat (also a new cassava-producer) combined (24).

On the other hand, the root prices cited appear to be below those paid in the major producing areas: wholesale price quotations delivered at the Chonburi factory (the Supan Buri prices above do not include any transportation) in October and December 1972 convert to $15.50 and $19.25 per metric ton; and one of the three large pelletizers gives, for the year 1972, the equivalent of $16.50 per metric ton (VN$11 per kg in 670:1 prices) for fresh root prices at the Chonburi factory, and $39.76 per ton (VN$59 per kg) for Bangkok wholesale prices for chips. /With Bangkok wholesale quotations for chips at the high level of $68 per MT (VN$45½ per kg) at the end of October 1974, Chonburi delivered root prices were given as 0.50 baht per kg (or, at the currently prevailing baht/dollar exchange rate of 20:1, at $25 a ton or VN$17 per kg) (9). Prices received by farmers in northeast Thailand, with the collector doing the plowing, were given as Baht 0.25 per kg (1)/

REFERENCES PERTAINING TO ANNEX IV

1. As reported for northeast Thailand by Mr. Atisai Pangspa, Field Assistant, Office of Field Operations, USOM/Thailand.

2. Mathot, P.J., et al, "The Production and Export Control in Thailand and the Marketing in Europe of Tapioca Pellets, a Raw Material for the Production of Compound Feeds" (an investigative study of the Thai cassava-pellet industry conducted by Cehave n.v., Veghel, Holland, the largest compound-feed producer in the European Economic Community, published by the Thai Tapioca Trade Association), August 1972, pp. 4,15-16.

3. Rajatamethi, Supat, "Cassava," reprint in the 1972 Yearbook of the Thai Tapioca Trade Association from the Bangkok City Bank Bulletin.

4. Damrong Sunthornsarathul, Governor of Chon Buri, "Chon Buri's Tapioca Industry -- Its Past, Present and Future," published in the 1972 Yearbook of the Thai Tapioca Trade Association.

5. Anek Phayakhantra, Governor of Petcha Buri, "Cassava Growing in Petcha Buri," published in 1972 TTTA Yearbook.

6. Thai Ministry of Commerce Report to the Prime Minister, July 9, 1973, published in the July 1973 Bulletin of the Thai Tapioca Trade Association.

7. Mathot, supra, pp. 5-6, 9-10.

8. Mathot, supra, pp. 4,8.

9. Visits, accompanied by Mr. Atisai Pangspa, supra, to cassava-processing operations and machine workshops, November 1974.

10. Telephone communication, April 1974, from Mr. Howard Johnson, Principal Officer, Office of Economic Development and Investment, USOM/Thailand. (There was no one on the USOM staff at the time who was familiar with the Thai cassava operation, and Mr. Johnson was merely passing on the information he had been able to collect.)

11. Mr. George Otey, Agricultural Engineering Advisor, ADFA, USAID/Vietnam.

12. Praminik, A., "Prospects for Tapioca Cultivation and Pelletization in Malaysia," published in The Planter, Vol. 47, No. 543, June 1971, p. 243.

13. Arthur D. Little,Inc., "An Investment Opportunity for Cassava Processing in Malaysia," Report to the Ministry of Commerce and Industry, Government of the Federation of Malaysia, Draft report, April 1966, pp. 5,58.

14. University of Georgia, "A Literature Review and Research Recommendations on Cassava," March 1972, p. 59.

15. Ayres, John C., "Manioc - The Potential Exists for Increased Use of this Tropical Plant and its Products," Food Technology, Vol. 26, No. 4, copyright 1972.

16. Mathot, supra, p. 6-8.

17. National Council for Export Development (NCED), "Cassava - Production Development and Export Market," Saigon, November 1973, p. 26. (The sulphur drying process reported on pp. 26,28 was stated by NCED to have ceased in 1966.)

18. Memorandum, Donald C. Marsden, Chief, Private Enterprise Division, USOM/Thailand, to Emory Howard, ADFA, USAID/Saigon, 8/23/73, "Availability of Locally Made Cassava Chippers."

19. Centro Internacional de Agricultura Tropica, in its bi-monthly publication "Noti-CIAT," February 1973.

20. Arthur D. Little, Inc., supra, pp. 58,61.

21. Mathot, supra, p. 5.

22. Paisal Thongdonson, Supan Buri Agricultural Officer, "Cassava Growing in Supan Buri," 1972 TTTA Yearbook.

23. 1972 TTTA Yearbook, Table 4.

24. "Annual Report of the President of the Thai Tapioca Trade Association for the Year 1972," 1972 TTTA Yearbook.

25. 1972 TTTA Yearbook, Table 5.

Annex V

THE ACCEPTABILITY OF CASSAVA AS A FEEDSTUFF

A. INTRODUCTION. There is unfortunately a relative paucity of organized, compiled information on the characteristics of cassava in general, and the reporting in the literature on cassava as a livestock feed is, not unexpectedly, rather spotty. On the basis of the material that is available, however, it seems quite clear that cassava (on a dry-weight basis) can make up a significant portion of animal feed, and can replace feed-grains to a substantial extent. The conclusions reached here are that it can substitute satisfactorily for at least half, or even more, of the grain in the animal diet -- a level rather higher than that generally talked about. This presupposes (1) that the cassava used is sufficiently mature and/or of a variety to have a "normal" starch content (about 70 percent on a 100% dry-matter basis); (2) that the cassava is not spoiled; and (3) that it is fed as part of a reasonably well-balanced diet.

Given the higher-than-usual estimate made of the levels that can be satisfactorily used, the basis for the estimate is given in some detail below, in turn a condensation of Part Two and Annex I of "A Survey and Analysis of the Literature on Selected Agricultural and Economic Aspects of Cassava," (A. R. McClelland, draft), which furnish sources as well as further detail.

Additionally, there are available the nutritionally-balanced sample diets for pigs prepared by Dr. B. G. Harmon (already referred to in annex III) that draw on raw materials available locally in South Vietnam. These diets, it will be noted, limit cassava to 40 percent of the ration, but within this limitation, cassava is treated as substitutable for 100 percent of the grain component for pigs of all ages and types.

B. COMMON FORMS OF CASSAVA FOR USE AS A LIVESTOCK FEED. The cassava root can be fed fresh, unpeeled (if of a non-toxic variety). Once harvested, however, it cannot be stored in fresh form for any appreciable length of time (the various estimates of the time it can be held vary from within 24 hours up to a week.)[1] For relatively early use, the root can be boiled. Alternatively, silage, either of the roots alone or together with the leaves and young stems, apparently permits storage for up to several months. For longer storage, the roots are commonly sliced, diced, or cut into chips (irregular-shaped chunks), and then dried. They can then be fed directly, or they may be ground into meal or flour for feeding, or for mixture with other ingredients. In the past five

---

1/ Taking into account the sources of the various estimates, 2-3 days would appear to be the outside limit for a good-quality product, and particularly if there has been any bruising of the root during harvest.

years or so, Thailand has been further pressing the dried chips into pellets for export to Europe, because of the lower transportation and storage costs involved; but the European feedmills have in the past and, to some extent, are still using dried roots in all of the forms listed.

C. BASIS FOR THE LEVEL OF USE ESTIMATED.[2] The data on the value of cassava as a feedstuff are less complete than one would like, and show divergences among them. Taken as a whole, however, the various materials available on the feeding value of cassava, its performance in animal-feeding trials, and its actual utilization in compound feeds, all combine to suggest that it can serve as an important ingredient of the animal diet.

1. Protein and energy values. Research on the feed value of cassava has been very scanty as compared with that on the more conventional feeds (despite the evident wide variation in the biochemical composition of the various current varieties, estimated as in the thousands, the analysis in Morrison's "Feeds and Feeding," for example, is based on a sampling of seven trials as against hundreds for each grade of each of the common grains), and it is not surprising to find differences in the estimates that are available. Morrison puts the digestible protein value of the cassava root at practically zero, whereas other materials (also based on small numbers of trials) suggest a value of 2.3% or even higher. In terms of energy value, the Morrison figures would put the feed value of cassava at about 16% below that of corn and 9% below that of sorghum, while three other sources indicate a value roughly equivalent to corn.

Whether or not cassava is completely short on protein, its general feed value, even at the Morrison level, is still generally high; and Morrison itself states that cassava waste meal /the residue from the manufacture of starch, of lower value than the dried root/ may be used as a substitute for part of the grain in feeding animals, being approximately equal to grain except for its lowness in protein. The investigative study of the Thai cassava industry and the European market, conducted in 1971-72 by the largest compound-feed producer in the European Economic Community,[3] reports that cassava in combination with soybeans is an excellent grain substitute in feeds.

2/ The various data referred to are summarized in table 8.

3/ Mathot, P.J. et al, "The Production and Export Control in Thailand and the Marketing in Europe of Tapioca Pellets, a Raw Material for the Production of Compound Feeds," published by the Thai Tapioca Trade Association. (Study was conducted by members of Cehave n.v., Veghel, Holland.)

2. Utilization of cassava in compound feeds in West Germany and the Netherlands. The cassava root has been of significant importance in the last decade in commercial livestock production in West Germany, the Netherlands and Belgium, where insufficiency of domestically grown feedstuffs, combined with protectionist pricing and tariff policies, have made imported cassava competitive with feedgrains, despite the high transportation cost involved.

In 1965-66, dried cassava roots made up a reported 6½ percent of all ingredients, or 15 percent of the grain-cassava component, in compound feeds produced in West Germany.[4] While the quantity ratio of cassava to total grains for Holland was given at the time at only 3 percent, there was an almost sixfold increase in its cassava imports from 1966 to 1971; and the 1972 Thai study by the Dutch firm indicates its own utilization of cassava at about 9 percent of its total feed production, which would appear to translate to 15 to 20 percent of the grain-cassava component. An even higher proportion in 1973 is suggested by the January-October totals for Thai exports (accounting for almost two-thirds of German imports in 1970-72, and over 95 percent of Dutch imports in 1970-71), which were already well in excess of previous years' annual totals.

It seems clear, moreover, that problems with the poor quality of the cassava available (attributable to man-made rather than intrinsic deficiencies) have checked the use of cassava significantly below its technical acceptability as a feed; and it seems fair to consider the indicated level of 15 to 20 percent as the bottom level of substitutability, given the end-product-mix in the two countries.[5] (The Dutch study, in fact, makes the statement that Holland's consumption of cassava could be almost tripled if untainted, firm-textured pellets were made available.)

Almost certainly, the 15 to 20 percent is considerably below the levels permitted for cassava under the German Government regulations which set the maxima for raw materials used in the various compound feeds. While couched in terms of percent of total ingredients,

---

4/ In Germany -- where there is still heavy reliance on locally available materials -- compound feeds made up an estimated 50 to 60 percent of all feedstuffs during 1960-66; and in the Netherlands, 85 to 90 percent.

5/ During each of the years 1960-66, about 23% of Germany's compound-feed production was for cattle (for which the preponderant ingredient is oil cake or meal, with feedgrains small or absent), 28% for pigs, 43% for poultry, and 6% for other. In Holland, the distribution was 26% for cattle, 41% for pigs, and 32% for poultry.

they would seem, at a conservative estimate, to indicate a 35 to 40% substitution for grain on the average, not counting a close to 100%-substitution for cattle.[6]

Even here, there are indications that the limitations may have been imposed because of the health hazards and limited tolerance resulting from the high incidence of spoilage and adulteration in the cassava imported, a fear of toxicity (found unwarranted in the Dutch study, at least as far as Thai cassava was concerned), the desire for leaner meat, and/or even to protect domestic agriculture.

Finally, if we can accept the statement that Dutch consumption could be tripled, given good quality, it seems reasonable to expect that dried cassava can replace as much as half, and even more, of the grain component in the animal diet.

3. Experience of Malaysian feed producers. The 50% or more figure, it should be noted, is higher than that apparently indicated in the 1966 feasibility study on cassava in Malaysia prepared by Arthur D. Little, Inc.:

> "According to the experience reported by feed companies in Malaysia, 30% substitution would not adversely affect feed quality for pigs and laying hens. A greater proportion might result in soft pork and thin-shelled eggs unless careful offsetting changes in formulation were worked out. For table chicken and cattle feeds, however, a somewhat higher proportion of cassava could probably be used without ill effect."

4. Performance of cassava in animal-feeding trials. The lower tolerances, suggested in the Malaysian experience, unless "careful offsetting changes in formulation" are made, may perhaps be explained

---

6/ The limitations for cassava are as shown in a study of the European cassava market by UNCTAD-GATT's International Trade Center, published in May 1968. Also shown in the ITC study are the maxima in the Netherlands ("recommended" by the quality control organization of the cooperatives, rather than regulated by the Government), which are quite a bit lower. Given the sixfold increase in Dutch cassava imports from 1966 to 1971, together with the statement in the 1972 Dutch study (which does not refer to any limitations) on the potential tripling of Dutch imports, it seems quite likely that the limitations may have been revised upwards.

In any case, it seems fair to postulate that the German standards, even though less restrictive than the Dutch limitations reported, are entirely acceptable, particularly in a food-short economy.

in part by the more sophisticated formulation of feeds in Europe, where the formulas based on feeding value and comparative prices are electronically computed. On the other hand, the findings of cassava-feeding experiments (as described in the secondary sources available) would again seem to indicate that the amount of cassava that can be fed satisfactorily in a reasonably (though not necessarily optimally) balanced diet is substantial, and that the estimate of a 50% or more of grain-substitution is not unreasonable.

For pigs, even among the early experiments, before the 1940s, when there was an apparent tendency to utilize locally available materials without adequate knowledge of their composition, making it difficult to balance the diet, three tests reported entirely satisfactory results with cassava at ¼ to ⅓ of the total dry matter. /In one, cassava at over ⅓ of the ration was reported as causing scours (diarrhea)./ In two further tests, including one with young weanlings, where cassava totally replaced corn (apparently in a straight corn or cassava ration), cassava was 5 to 8% less efficient and the young weanlings registered a 10% smaller weight gain. In a sixth, the use of a straight 100% cassava ration for finishing pigs produced very satisfactory results.

In four of the more recent trials, good results in both liveweight gain and feed efficiency were reported when cassava made up 40 to 48% of the ration, replacing from two-thirds to all (dry basis) of the feedgrains. A fifth trial with cassava free choice (i.e., replacing all of the grain), plus protein supplements, tested against a basal corn completely-mixed diet, the cassava-fed pigs are reported as having performed very well, with very little difference in rate of gain, and feed efficiency was greater. While details are not given, "satisfactory" results are also reported in two other trials where cassava made up 50 to 55 and even as high as 60 percent (dry-matter basis) of the total ration.[7]

Quality of the meat, even where the cassava component of the feed was high, appears to have been generally equal, and sometimes even superior, to that of cereal-fed pigs in the ten trials for which carcass quality was reported.

Even for chickens, where the general impression seems to be that cassava is not as suitable, the reports on feeding trials -- somewhat fewer in number and wider in variation -- also include

---

7/ Of these seven trials, two of the first group of four referred to were made on growing pigs, porkers, sows and finishing pigs, with no specification reported for the remaining two. The fifth trial, while details are not given, apparently included young pigs, since low consumption by young pigs at the start of the trials is reported.

findings of high grain-substitutability not only for layers and growing chickens,[8] but also for chicks. One recent experiment with chicks does note that supplements of methionine are needed for proper growth rate when cassava replaces more than 30% of the corn in the ration. In another extensive set of trials, however, carried out on baby chicks using seven different combinations of supplements (but not methionine as such) to cassava-versus-corn rations, it was concluded that both growth rate and feed utilization were satisfactory and that cassava meal could be used to totally replace ground corn in baby chick diets.

D. THE IMPORTANCE OF BALANCED RATIONS. While most of the reports on the animal-feeding experiments do not provide much detail on the remaining ingredients of the rations used, those that do indicate rather clearly that the type and proportion of the supplements fed are important factors in producing good results. Particularly in the younger animals, high-protein supplements are undoubtedly needed, not only for the protein as such but also, according to Morrison, because the digestibility of the other nutrients, as well as the digestibility of protein, is depressed when the protein content of the feed is low or when it is small in relation to the easily digested carbohydrates.

Balanced rations are of course also needed for optimal results with grains; and it is not readily clear from the materials at hand -- particularly since the component feedstuffs vary from trial to trial -- how much, if any, additional supplements, or different supplements, are needed when cassava is used in place of grain.[9] Some indication of the

---

8/ Three trials with layers reported satisfactory results when cassava meal (1) made up 20% of the ration; (2) replaced 40% of the feedgrains; and (3) totally replaced corn meal. (In the second case, somewhat lower egg production, but no difference in body weight, was reported.)

In a fourth trial using growing chickens, with cassava meal again totally replacing corn meal, it was considered a good substitute.

9/ E.g., in one of the experiments reporting successful results with porkers, grain sorghum at 52% of the ration was replaced with 40% cassava plus 12% additional palm-kernel meal and peanut cake, but the average daily liveweight gain using boiled cassava was 7% greater and feed efficiency, 20% greater, than with the sorghum-fed pigs; and with raw cassava the benefits doubled. Another with pigs reports little or no difference in gain per unit of feed when (1) 48% cassava flour plus 8% cottonseed meal substituted for 55% corn meal, and (2) when cassava flour replaced cornmeal on a 1:1 basis at 45% of the ration. In the baby-chick experiment referred to above, the 1:1 replacement of corn by cassava yielded differential performance depending on the remaining ingredients, but the trials apparently did not include any where there was not a 1:1 replacement.

degree of offsetting changes needed is provided by the diets prepared by Dr. Harmon, discussed in section F below, but, designed as they were for other purposes, here too the patterns are not entirely clear.

E. THE IMPORTANCE OF UNSPOILED CASSAVA. According to the report on a German study on imported cassava, the high content of bacteria and fungus spores found presented a danger to livestock, particularly to young pigs and poultry: nutritive value was decreased by the presence of the toxin-forming bacillus cereus which can rapidly destroy protein in feedstuffs; the fungus spores present were particularly dangerous to young animals, causing diarrhea in pigs and even death among piglets; and spoiled cassava flour, even when making up only 10 percent of the feed, led to depression of growth in chickens.

In the case of the imported cassava, the high mould and bacteria content, attributable to inadequate drying time and the failure, in the case of pellets, to cool them after pressing (both, in turn, attributed largely to too low prices paid) is compounded by heat during transportation and probably the longer storage required in Europe for assurance of a steady supply. Domestic use of the dried root would probably avoid some of the problem. But adequate drying (down to about 15 percent moisture) would still seem important.

F. ADDED NOTE ON CASSAVA SUBSTITUTABILITY AND BALANCE OF RATION. Additionally, there are available sample diets for pigs directed toward the greater utilization of raw materials available locally in Vietnam, as prepared by Dr. B. G. Harmon, professor of animal nutrition at the University of Illinois, and distributed at his USAID/MOA-sponsored seminar for Vietnamese livestock producers and feedmillers held on February 12, 1974. Set up as alternative rations for five types of pigs, divided into three groups (weanlings; growing pigs, and lactating sows; and finishing swine, and gestative sows), the 11 to 15 rations within each group have been balanced nutritionally, providing roughly equivalent caloric value and amino acid composition, based on tables of estimated feeding values.

The feedstuffs used are cassava, corn (replaceable on a 1:1 basis by sorghum), rice bran (partially replaced by wheat bran in some of the diets for the third group) and fish meal, supplemented by 1-2% of vitamins, salt and oyster shell. Alternative formulas are provided for substituting soybean meal for fish meal.

As developed by Dr. Harmon, the total amounts of cassava, corn, and bran combined are roughly equalized at from 82 to 88% of the total ration for weanlings; at 87 to 91% for the growing and lactation pigs;

and at 90% for finishing and gestating pigs. Of this, the corn/cassava component ranges from zero to 60% of the total ration; and cassava alone ranges, within each of the groups, from about 10% to 40% of the ration (except for three formulas for the third group that have no cassava, including one with no corn or sorghum either).

Within the corn/cassava component, as can be seen in table 9, cassava is treated as substitutable for corn in amounts up to 100%, with no apparent pattern in relation to the size of the corn/cassava component except for the limitation imposed by restricting cassava to 40% of the total ration. In the case of the diets for weanlings, increases in the levels of cassava in the feed are clearly accompanied by the increased use of fish meal. For growing pigs, increased use of fish meal appears to be a function of the combined cassava/corn level as well as the level of cassava. In the case of the finishing pigs, the fish meal is held practically constant regardless of either the level of cassava or the level of corn.

Table 8: RECAPITULATION OF CASSAVA UTILIZATION AS A FEEDSTUFF*

	Cassava as proportion of: All ingredients	Cassava as proportion of: Grain-cassava component	Comments
OVERALL USE IN COMPOUND FEEDS			
Germany, 1965/66	6½%	15%	Calculated from data in the ITC report[1]
Large Dutch feed-producer, 1971 (?)	9%	15-20%	Estimated on basis of data provided in 1972 Dutch study[2]
PIGS			
German feed-producer:**			
Initial fattening	9%	16%	
Later fattening	16-20%	26-43%	
Malaysian feed-producers[3]	...	30%	Noted that greater amount might result in soft pork, unless offsetting changes made.
Permissible under German regulations	10-40%	...	Only the range of 10-40% is given in the source material.[1] The maxima for cassava in the total ration by type of animal, here assumed, have been translated to % of the grain-cassava component on the basis of the formulas of the "German manufacturer."**
Weanling	10%	15%	
Grower	20-30%	35-50%	
Finishing pig) Reproductive sow)	40%	65% or more	
Animal trials where results satisfactory:[4]			
Sows	40%	67%	
Porkers	40%	70%	
Porkers	40%	100%	Tested against sorghum
Not specified	48%	100%	Tested against corn
Not specified, but including young pigs	...	100%	Tested against corn. Problem noted of low consumption by young pigs at start of trials, but apparently overcome.
Growing, finishing	50-55%	...	Lower carcass grade noted
Fattening	60%	...	
Finishing	100%	100%	

-- table continued

Table 8: RECAPITULATION OF CASSAVA UTILIZATION AS A FEEDSTUFF (continued)

	Cassava as proportion of: All ingredients	Cassava as proportion of: Grain-cassava component	Comments
CATTLE			
German-feed producer**	0%	0%	
Malaysian feed-producers[3]	...	Somewhat more than 30%	Could presumably be even higher if offsetting changes made.
Permissible under German regulations	20-25%	100%	See under "pigs" above
Animal trials where results satisfactory:[4]			
Calves	38%	100%	Tested against wheat
Finishing	75%	...	
CHICKENS			
German-feed producer:**			
Chicken breeding	7%	13%	
Pullets	10%	17%	
Laying hens	12%	23%	
Malaysian feed-producers:[3]			
Laying hens	...	30%	Noted that greater amounts might result in thin-shelled eggs unless offsetting changes made in the ration.
Table chickens	...	Somewhat more than 30%	Could presumably be even higher if offsetting changes made.
Permissible under German regulations	10-20%	...	See under "pigs" above
Baby chicks	10%	15%	
Pullets	15%	25-35%	
Other	20%	35-60%	

-- table continued

Table 8: RECAPITULATION OF CASSAVA UTILIZATION AS A FEEDSTUFF (continued)

	Cassava as proportion of: All ingredients	Cassava as proportion of: Grain-cassava component	Comments
Animal trials where results satisfactory:[4]			
Baby chicks	40%	100%	Tested against corn
Chicks	...	30%	Tested against corn. Noted that higher rates could be fed satisfactorily with addition of methionine.
Layers	...	40%	Tested against corn. Noted that egg production somewhat lower.
Growing chickens) Layers)	...	100%	Tested against corn

*Percentages relate to either dried cassava or cassava on a dry-matter basis. The figures for the German feed-producer and the animal trials do not include the full range of utilization, but rather the middle and upper ranges, as indicators of the potential for satisfactory use.

**Based on the fairly detailed composition of compound feeds produced by "a German manufacturer," covering 7 feeds for pigs, 15 for chickens and 11 for cattle, as shown in the ITC report.[1] (The formulas are undated, and since there was a major shift in the spread between cassava and grain prices in Germany over the period covered by the report, it is not possible to ascertain even roughly the relative prices prevailing at the time.)

1/ UNCTAD-GATT, International Trade Center, "The Market for Manioc as a Raw-material for the Manufacture of Compound Animal Feeding Stuffs in the Federal Republic of Germany, the Netherlands, and Belgium," Geneva, 1968.

2/ Mathot, P.J. et al, "The Production and Export Control in Thailand and the Marketing in Europe of Tapioca Pellets, a Raw Material for the Production of Compound Feeds," published by the Thai-Tapioca Trade Association. (Study was conducted by members of Cehave n.v., Veghel, Holland)

3/ Little, Arthur D., Inc., "An Investment Opportunity for Cassava Processing in Malaysia," Report to the Ministry of Commerce and Industry, Government of the Federation of Malaysia, Draft report, April 1966.

-- footnote continued

Footnotes to table 8 continued:

4/ Based on findings in animal experiments reported in the following sources: Jones, Wm. O., "Manioc in Africa," pp. 274-279; Mahendra-athan, T., "Potential of Tapioca as a Livestock Feed--A Review," the Malaysian Agricultural Journal, Jan 1971, p. 84, and "The Effect of Feeding Tapioca Leaves to Pigs," ibid, June 1971, pp. 60-68; Morrison, F. B., "Feeds and Feeding," 1959 edition, pp. 394,552; and University of Georgia, "A Literature Review and Research Recommendations on Cassava," pp. 164-175.

Table 9: SUMMARY ANALYSIS OF SAMPLE DIETS FOR PIGS, USING LOCAL VIETNAMESE INGREDIENTS*

Weanlings (up to 15 kg)				Growing pigs (15-45kg) or lactating sows				Finishing swine (45-90kg) or gestating sows			
No. of diets	(A)	(B)	(C)	No. of diets	(A)	(B)	(C)	No. of diets	(A)	(B)	(C)
...	...	...	...	...	...	...	...	3	0-20%	0%	7½%
4	10-40%	100%	10½-17%	3	20-40%	100%	7½-10½%	5	10-40%	100%	do.
...	...	...	...	1	20%	50%	7½%	2**	20%	50%	do.
1	30%	67%	12½%	2	30%	30,67%	do.	2	30%	33,67%	do.
3	40%	20,50,75%	9½,12,14%	3	40%	25,50,75%	8,9,9%	2**	40%	50%	7½,8½%
2	50%	60,80%	13½,15½%	2	50%	60,80%	10,11%	...	...	...	...
1	60%	67%	16½%	1	60%	67%	11½%	1	60%	50%	7½%
11				12				15			

LEGEND:

A: The total of cassava and corn (or sorghum) combined, as a percent of the total ingredients
B: Cassava as a percent of the cassava and corn (or sorghum) component
C: Fishmeal as percent of total ingredients. Where more than one percentage is shown, they are in the same order as in col (A) or (B) /e.g., for the three weanling diets where corn/sorghum and cassava make up 40% of the ration, fish meal is 9½% of the ration when cassava is 20% of the corn-cassava component; 12% of the ration when cassava is 50% of the corn-cassava component; etc./

*Based on the composition of sample diets prepared by Dr. B. G. Harmon, U. of Illinois, distributed at USAID-sponsored seminar, 2/12/74, for Vietnamese livestock and feed producers. The percentages have been rounded for summary purposes. In the diets for weanlings, cassava, corn (replaceable by sorghum), and rice bran combined make up 82 to 88% of the ration; for growing pigs, 87 to 91%; and for finishing pigs, 90% (with wheat bran partially replacing rice bran in some of the diets). In absolute percentages of the diet, cassava ranges from 8 to 40%, 9 to 40%, and 0 to 40%, for the three groups, respectively.

-- footnote continues

Footnotes to table 9 continued:

Aside from 1-2% of vitamins, salt and oyster shell, the balance of the rations is made up by fish meal, with adjustment formulas provided for substituting soybean meal. Total calories (which do not appear to be a direct function of the cassava component) range from 3170 to 3370 for the weanlings, and from 3220 to 3390 for the growing pigs. They are not shown for finishing swine.

**Difference between the diets is a shift between rice bran and wheat bran.

Annex VI*

TO : Mr. M. V. Sorenson, AD/ADFA/AES Date: December 13, 1973*

FROM : Anne R. McClelland, ADFA/Econ

SUBJECT: Prospects for Vietnamese exports of cassava products

I. INTRODUCTION. The recently published paper on cassava by the National Council for Export Development concludes that, with favorable security conditions, Vietnam should be able to export 100,000 tons of dried cassava for livestock feed to West Germany and the Netherlands in 1974. Apparently in line with the findings, the Council at its October meeting decided to ask the Industrial Development Bank to provide assistance and financing to firms processing cassava for export.

Without prejudice to the possible expansion of cassava production and processing facilities for domestic use -- it seems entirely possible that increased production of cassava as a domestic livestock feed may prove to be commercially profitable and economically desirable -- information currently available on the state of the international market would seem to make the outlook for Vietnamese exports of cassava products in the relatively near future appear somewhat less than promising.

II. THE INTERNATIONAL MARKET SITUATION. At least part of the Vietnamese optimism seems to stem from analogy with the spectacular increase in Thailand's cassava exports over the past two decades (which rose from less than 50,000 tons in the early 1950s to almost 500,000 in 1961 and over 1.2 million in 1972, earning $60 million in foreign exchange in 1971 and reaching $74 million in 1972). Rather than serving as an indicator of the prospects for new suppliers on the international market, however, the high level of Thailand's export capacity would in fact appear to be a deterrent to Vietnam's entry into the market, even if it were able to produce the required steady supply and to sell at competitive prices. Nor is there reason to assume that Vietnam is in a better position than Thailand in coping with the problems that have been confronting the industry.

---

*Section V, updating section III,B, was written in December 1974.

A. Cassava starch. The trend in the cassava starch market is definitely downward. Imports by the U.S., while running at 150,000 to 180,000 MT during the early 1960s fell to below 100,000 MT in 1968 and declined steadily to 70,000 tons in FY 72. While Thailand is still the major supplier of the U.S., providing some 75-80% of the imports, the export-oriented Thai Tapioca Trade Association definitely considers the future prospects as unpromising, recognizing the U.S. declining interest as it resorts to corn and other starch substitutes. Nor does Thailand look towards any increase in sales to Japan, its other large customer, where cassava starch imports are restricted by quota, as well as high tariffs, to protect the local starch industry. From a peak of over 200,000 tons in 1967, Thai exports of cassava starch had dropped to 146,000 in 1971, with a further drop suggested in the exports in the first half of 1972.

B. Dried cassava for livestock feed.* While Thai exports of pellets for livestock feed to the European Economic Community -- totalling over a million tons in 1970, and tentatively forecast in mid-1973 by the Thai cassava industry as reaching 1.3 or even 1.5 million tons in 1973 -- still are on the rise, prospects for Vietnam being an effective competitor do not seem hopeful, even if Vietnam were able to meet Thai prices:

(1) Thai productive capacity appears to be in a position to respond to any likely increase in demand. The Council's favorable outlook for cassava exports appears to be predicated on the poor crop in exporting countries resulting from drought and flood conditions in 1972 and early 1973,** thereby providing an opportunity for

---

* The discussion here is limited to the production and trade of Thailand, by far the principal supplier of the EEC (and the sole producer of pellets), accounting for almost two-thirds of German imports in 1970-72, and over 95% of Netherland imports in 1970-71 (1972 data are not available). Imports of dried cassava from the other important source, Indonesia (which also enjoys the advantages of good trade connections dating to its preeminent position in world cassava trade prior to World War II), have been declining, in absolute terms as well as in relative importance. While imports from Mainland China, Malawi, Angola and other African countries have been making up some 7-10% of German imports and 1-2% of Dutch, it seems quite doubtful that Vietnam can compete with them since they are all quality products commanding premium prices over Thai and Indonesian cassava.

**Thai shipments in late 1972 and early 1973 were seriously affected by rains during November and December, described as most unusual (and attributed by the Thai Meteorological Department to the invasion of anti-cyclones from China), which impeded the open-air drying of the chips; and by the inactivity of the market as a result of the dollar devaluation and anticipation of revaluation of the Deutsche Mark.

Vietnam since it suffered no inclement weather. In actual fact, Thai production of cassava roots has already been overly responsive to anticipated demand. Formerly limited to three or four provinces, cassava is now being grown in about 40. Fresh root production in 1972 reached 4.9 million tons, more than double the 1967 output of 2.1 million (while tonnage of exports increased by only a little over 55% over the same period); and acreage currently planted is expected to be 30 to 40% greater than that of the last crop. The Thais are in fact seriously concerned with a flooding of the market -- root prices in October 1973 of 30 Baht a 100-kg picul (i.e., $15/MT or, at the current export exchange rate of 575:1, VN$8.6/kg) are reported as the lowest within the last 2-3 years -- and both the Government and the industry are working on measures to control surplus supply.

While information on the expansibility of the processing capacity is not available, the seeking of new markets, noted below, would indicate that this too could readily be forthcoming.

(2) The Thais themselves are anticipating no further expansion of their current markets, and are seeking new markets themselves. In a recent report after attending an international conference on animal feeds, the President of the Thai Tapioca Trade Association noted the dangers of flooding the pellet market with too much dependence on the Netherlands and West Germany [which now take about 98% of Thai pellet exports] since these markets were now saturated, and stressed the necessity of finding new outlets in Europe. While Italy, Great Britain and Denmark could be expected to prove better prospects, he continued, difficulties were anticipated in breaking into the market, because the Association had not traded with them in the past [and, presumably, trade channels were not developed]. Faced with growing capacity and a levelling of the foreign market, both the Government and private industry are currently exploring the possibilities for developing domestic industrial and livestock uses for cassava.

Given the difficulties foreseen by the TTTA in entering new markets, with the European connections it now has, it would seem unlikely that a less-connected supplier could easily do so.

(3) The institutional and physical framework for both production and trade are already highly organized and well-developed in Thailand. Dried cassava products have been a major Thai industry for several years now, and while it is still in the process of resolving some serious problems, its infrastructure is well developed.

The channels of trade between Thailand and the German and Dutch markets are well-established. Except in very rare instances,

the pellets all move through seven European shippers [apparently all German], all based in Bangkok, four of whom have their own ship-chartering services (which are used for all pellet exports), and all but one of whom are members of the Hamburg Bourse. Additionally, two of them, and a third in conjunction with a Thai firm, are exporters with their own pelletizing operations, which alone account for 25% of the total exports. The remaining 75% of the pellets, produced in about 90 Thai factories, move to the European shippers through some 10 Thai exporters, five of whom handle 80% of the Thai-produced pellets, with some of them exporting as much as 15,000 tons a month. At the European end, much of the product is sold by the shippers directly to the large feed-producers, wholesale dealers and importers without recourse to brokers. At least one of the German pelletizers-exporters-shippers also has its own compound-feed manufacturing plant in Europe.

The Thai Tapioca Trade Association of cassava exporters and related firms has been in existence for many years, and appears to be quite active. More recently, in 1972, the Thai Tapioca Producers Association was formed by pelletizers in the large cassava-producing area of Chon Buri to help improve quality control. The local market place is also well-established.

The physical plant, geared to the rapid and steady flow of the product from grower to chipper/drier to pelletizer to godown and ocean-going vessel, is extensive, from vast fleets of trucks through large warehouses and efficient loading facilities; and competent chemical testing facilities are available.

The Government also has been actively interested in the cassava industry -- dried cassava was declared to be a "standardized commodity" subject to meeting Government-established standards on quality and packing in 1963 -- taking action to develop quality control and fair trade practices and otherwise promoting a favorable climate for cassava exports.

The Export Development Council paper does indeed recognize the advantages of the Thai-German connections and recommends a similar approach by encouraging joint Vietnamese-German ventures. Given the large scale to which operations are geared in Thailand, and their firm base there, it is difficult to see why the German companies would give up established territory to try new ones, unless there were strong overriding reasons.

(4) The European market has been discontent with the quality of Thai pellets, but effective efforts seem to be under way to alleviate the problems. In any event, it seems unlikely that the market is ready to shift to an unproved product without an established reputation for good quality control. The quality of Thai dried cassava

products has apparently long been a sore point with the European feed-producers, and it was perhaps with this in mind that the first pelletizing operation was established in 1967 by one of the German exporter-shippers. Changes made by the Government in the quality control procedures -- cassava became the only Thai export commodity entirely controlled by the Government -- did not prove successful. By 1971, the situation had deteriorated so badly that the Dutch feed-producers began to lend support to the grain-farmers and other groups pressing for the imposition of high import duties [similar to those put on grains, which had permitted cassava, with its high transportation cost, to become an economic substitute in the first place], so as to restrict cassava imports, or even to curtail them completely.*

The threats have apparently not been taken lightly. Following a Government-requested in-depth investigative study carried out in 1972 by a Dutch firm, the largest feed-producer in the EEC, effective remedial measures along the lines recommended by the study appear to be well under way, on the part of both the Government and the producers themselves.** Faced with the alternatives

---

* An objection, common to the German-made as well as Thai pellets, has been the soft texture and excessive meal which block the automatic transportation systems of the feed mills (and which raise sufficient dust to have given rise to labor-union threats to refuse to unload ships). Additionally, much of the Thai-pressed pellets have frequently contained dangerous mould and bacteria, which has had the health authorities concerned, as well as being adulterated with cassava wood, corncobs and sand and falling short of starch content, which has not only caused unnecessary wear-and-tear on the mills but has also occasioned radical and expensive changes in the programmed feed-formulation. Excessive heat in the product has also caused transportation problems and reduced storageability.

Over and above problems with quality, short-weighting has also been a major source of friction between seller and buyer.

** While an organized report of the measures being taken is not available, some indication of the current activities can be obtained from periodic TTTA reports and newspaper items. Initiating its campaign to stamp out the adding of extraneous matter with a public bonfire, in November 1972, of adulterative materials rounded up from member factories, the newly-formed association of forward-looking Chon Buri pelletizers has followed up with offering cash rewards for reports on factories adding foreign matter, as well as requiring 50,000 Baht deposits from their members, to be forfeited -- and the member expelled -- upon evidence of adulteration. For its part, the Government standards office was reported in October 1972 as applying stricter controls and disallowing exports of sub-standard pellets. Additionally, the new Thai Government is introducing

-- footnote continued

and having much at stake, it seems likely that the Thai processors will come up with a product that is reasonably acceptable to the consumer -- who is apparently sufficiently economy-minded, or otherwise linked to Thailand, to have continued to buy inferior Thai pellets while better-quality dried cassava has been available from China and elsewhere.

Having struggled thus far, and apparently having the cooperation of the Government and at least some of the producers, as well as the TTTA and the Thai Board of Trade, in trying to resolve the problems, the Dutch and German importers and feed-producers again seem hardly likely to want -- other things being equal -- to take on a supplier which, unfortunately, does not yet have a reputation for either quality, or quality control.* As a large Hamburg importer responded to an exploratory inquiry on the prospects for Malaysian exports, "We have enough Thai soil in our country, and we do not need any more Malaysian soil."

** (Cont'd)

legislation in December which will provide for the identification of the Thai-processed pellets by pelletizer and exporter /currently, the Thai-pressed pellets are, with one exception, sold as an undifferentiated product, with no price differential -- or incentive -- for better quality/, and the imposition of stringent controls for both quality and weight.

While not specifically listed in the reports, it can also be expected that additional recommendations of the study on the productive process itself, designed to improve pellet quality at little additional cost, will also be followed.

That some significant improvement has already taken place is suggested by the fact that Belgium, which banned the importation of pellets with ash content in excess of 3% in 1971 or 1972, effectively putting a stop to imports of cassava pellets from Thailand, has now resumed buying them.

* Even specifically with regard to the one shipment of dried cassava made by Vietnam in the past (1450 MT to West Germany in 1965), there were complaints of excessive mould and of the shipment failing to live up to the quality of the sample.

III. COMPETITIVE PRICES. Given the prices at which Europe can buy its pellets from Thailand, it is also difficult to see how Vietnam can even begin to compete, without major changes in its general price level.

A. Thai-EEC prices

1. Recent Hamburg quotations. The interest in cassava export possibilities has undoubtedly been given impetus by reports of quotations for pellets c.i.f. Hamburg of $85 to $95 a ton in late 1972, and of quotations, either as of late 1972 or early 1973, that were even higher. Hamburg quotations for Thai "native" (i.e., Thai-processed) pellets, c.i.f. North European ports, were indeed sharply up in late 1972, reaching (for cargo afloat) DM 295 a long ton in October and peaking at DM 305 ($94 a metric ton at the November 1972 rate, and $124 at the September 1973 rate) for one week in November. Stocks were running extremely low, both in Europe and Thailand, where chip-drying was still awaiting the end of the monsoon rains; demand was further running abnormally high in order to replace the Government-rejected pellets; and freight rates had risen from DM 48 a long ton to DM 56. Despite the unseasonable winter rains, however, the quotation had dropped to less than DM 210 in February 1973 and, after a relatively small increase, settled at DM 180 during mid-summer when German cattle are grazed outdoors. Reflecting further sharp increases in freight rates due to the oil crisis (up to DM 75 a long ton in October and DM 85 in November), and perhaps pre-harvest dwindling stocks as well, the price quotation for cargo afloat was up to DM 245 on November 11th.

Even for what appears to have been an abnormal year, the weekly quotations for the period 11/13/72 through 11/11/73 average out at DM 239 per long ton ($73 per metric ton at the November 1972 rate, and $97 at the September 1973 rate).

2. Recent Thai quotations. In any case, these Hamburg resellers' quotations give little indication of what the local producer can expect to receive. As can be seen in attached table 1, there is a large and varying spread between the Hamburg and Bangkok quotations, covering not only transportation, insurance, fees, etc., and presumably also import duties, but also the speculative margins of shippers who sell on the spot, during ocean transportation, or on long term, while mostly buying on the spot or on short term.

Following a somewhat different pattern, Bangkok commodity prices of pellets over the same period ranged from a high of Baht 75 per 60-kg picul in early December 1972 and again in June 1973,

to lows of Baht 52 in March and Baht 55 at end October, with weekly quotations averaging Baht 62. Quotations on chips tended to follow those for pellets, with a differential, on the average of 6 to 7 Baht -- though the spread over the period ranged from 3 to 10 Baht. Fresh root prices (per 100-kg picul) are reported at Baht 32 in October 1972, at the all-time peak of Baht 40 in late November - early December, 32-33 in April, 35-36 in May, and, reflecting the recent overproduction, down to Baht 30 as of October and November 1973. (Within the domestic Thai market, the cassava at the various stages is traded in a completely free, highly competitive market, with prices decided by supply and demand.*)

In terms of dollars, Bangkok commodity prices of chips and pellets, and local prices of roots, for the highs and lows, and for the periods for which root prices are available (they are treated below as averages for the month to which they refer, though they may not necessarily have prevailed during the entire month) are as follows:**

	Baht per picul			Dollars per metric ton					
				At Baht 20.8 to $1			At Baht 20 to $1		
	Roots	Chips	Pellets	Roots	Chips	Pellets	Roots	Chips	Pellets
Oct. 1972	B32	B56½	B63½	$15½	$45½	$51	$16	$47	
11/27 - 12/10/72	40	65½	74	19¼	52½	59½	20	54½	
3/19 - 4/1/73	n/a	46½	52½	..	37½	42	..	39	44
April 1973	32½	50½	57½	15½	40½	46	16¼	42	48
May 1973	35½	57½	64	17	46	51½	17-3/4	48	53½
6/18 - 7/1/73	n/a	70½	73½	..	56½	59	..	59	61½
October 1973	30	54	59	..	..	..	15	45	49
10/29 - 11/4/73	30	51	55	..	..	..	15	42½	46
AVERAGES:									
11/13/72-11/11/73	..	55½	62.2	..	..	..	..	46¼	52
1/1/73-11/11/73	..	55¼	61.8	..	..	..	..	46	51½

3. Trend in prices. It is a little difficult to ascertain the trend over time in Thai prices from the average value of exports of

---

* In the aftermath of the flooding of the market in 1973, there has been some talk of attempting to organize the growers, to help uphold their bargaining power, but it is not known how far the activities may have progressed.

**100-kg picul for roots; 60-kg picul for pellets. Baht price for roots shown as for 11/27/72-12/10/72 is late year's price reported as an all-time high by the President of the Thai Tapioca Trade Association (TTTA Yearbook 1971); the remaining quotations are from the Thai Board of Trade Bulletins.

dried cassava products (see table 2), for which long-term data are available, since the earlier years shown reflect a shift in composition from more processed meal to less processed chips and, in later years, a continuingly increasing shift from chips to the more processed pellets. Taking this into consideration as well as the average c.i.f. value of German imports (which presumably do not include shippers' and agents' margins and which from 1969 onward consist almost exclusively of pellets), there does not appear to be any significant trend upward, when viewed in terms of Baht or Deutsche Mark. (For comparison with the Baht 1010 per metric ton in 1971 and 1050 in 1972 shown for the average value of Thai exports in table 2, the average of the weekly quotations for pellets of Baht 62 per picul shown above is equivalent to Baht 1030 per metric ton). The upward trend in average values of German imports, when dollar-denominated, would appear to be solely attributable to the decreasing value of the dollar.

B. Can Vietnamese prices compete? Using dollar values at the current exchange rate of 20 Baht to the dollar, and assuming piaster-dollar conversion at the current export rate of 575:1, comparable prices in piasters per kilo at the average, and the peak, for the Thai price quotations during the period 11/13/72-11/11/73, are as follows:*

	Average price		Peak price	
	$/MT	VN$/kg	$/MT	VN$/kg
Roots	16½	9.5	20	11.5
Chips	46½	26.6	59	33.9
Pellets	52	29.9	61½	35.4

Actually to compete with Thai prices, Vietnam must also absorb the unfavorable freight differential, attributable not only to the longer distance involved, but also to the use in Thailand of chartered vessels. Aside from the upsurge in freight rates in October and November, due to the oil crisis, freight rates to North European ports from Bangkok have swung between $15 to $23 per metric ton over the past three or four years, while those from Saigon are reported by the Export Development Council as ranging between $30 and $40, a difference of $15-$17/MT or VN$8.6 to VN$9.8 a kilo. Assuming, on the basis of the ratio of root to pellet prices for

*In the absence of continuous data on root prices, the average root price has been calculated as 30-33% of the average pellet price, on the basis of the ratio of root to pellet prices for the time periods available. The $16½ also seems to be in line with the root prices that are available (see preceding table).

the time periods available, that 30-33% of the differential would be applicable to root prices, it would mean that, if Vietnam had the necessary root production and chip- and pellet-processing facilities, and if it were as efficient in converting roots to pellets as Thailand,* it would have to be able to sell its roots at no more than:

VN$ 8½ to VN$ 9 per kilo to meet what appears to have been an all-time high price for Thai roots; and

VN$ 6½ to VN$ 7 per kilo to meet the average Thai prices.

Vietnam's best performance in low prices is in Tay Ninh province, which alone accounts for a quarter of the country's cassava production and which has a ready buyer in the local starch-producing market. Even here, and even for August, the seasonal low point of the year, truckload lots at the farm were reported as selling at VN$ 14-15 per kilo -- down VN$3-4 from two-three weeks earlier. September and October prices were apparently back up. (The August price in the Tay Ninh retail market, for which price data are more or less regularly collected, was VN$ 21, down from VN$ 25, 35, 30 and 25 in April through July, and followed by increases to VN$28 in September and VN$30 in October.)

In other words, at the seasonal low-point in prices in the province with the lowest prices, roots in truckload lots were going at prices that were at least 50%, and very probably 100%, above those that would permit effective competition with Thai exports.

IV. SUMMARY. The world market for cassava starch is definitely declining. While there has been a rising market for dried cassava for livestock feed, the market in the European Economic Community appears to be

---

*While the physical conversion of roots to dried chips in Thailand, as reported in the recent investigative study is less than 2½:1 (with a further loss of 6% in converting chips to pellets), the Vietnamese have an input of 3.2:1 for unpeeled roots, according to the Export Development Council study, and other reports put it even higher. (Actually, according to the Council, the "chips" are slices cut by hand, and there is now no equivalent of the Thai machine-cut chips). The higher ratio of fresh to dried product may be due to a variety of reasons, among them the varieties used and a less-than-optimum growing season, not all of which might be readily remediable. Additionally, it might be noted, internal transportation distances from producing area to port are generally low in Thailand.

leveling off and Thailand, by far the world's largest supplier and apparently able to meet any likely increase in demand, is itself now looking for new markets. The Thai cassava industry has a great advantage vis-a-vis an untested newcomer, both in retaining its current markets and in breaking into new ones, in that it is able to provide a continuous high-level flow of the product, an exceedingly important consideration to the foreign compound-feed industry; its channels of trade with the German and Dutch markets are well-established, and it has been selling to France, Belgium and Japan as well; and both private industry and Government are becoming increasingly quality-conscious. While it is entirely possible that a new supplier with either a high-quality product, or significantly lower prices, could break into market, Vietnam does not yet have either a tradition or the institutional framework for high quality; and it is not now foreseeable that it will be able to sell at competitive prices.

V. SUPPLEMENTAL NOTE ON THAI AND VIETNAMESE PRICES AS OF LATE 1974. A quick look at late-1974 prices indicates that, despite the slackening in local cassava prices during 1974 and recent highs in Thai prices (which may only be seasonal), the gap is still too large to bridge. At end October 1974, Bangkok wholesale chip prices rose to the equivalent of $68 a ton (versus a peak of $59 in the November 1972 - November 1973 period, and up from about $50 in August 1974); and fresh roots delivered at the Chonburi factory were selling at $20 a ton. In late-1974 piasters at 685:1, this is VN$46½ a kilo for chips and VN$13½ a kilo for fresh roots. Using the same $15-$17 per ton ocean-freight differential as in the past (before the oil crisis, undoubtedly understating the current difference), the differential comes to VN$10-11½/kg, about one-third of which would be applicable to the fresh root. To compete with Thai prices, this would mean a price of VN$10/kg for fresh roots at the cutting factory, and about VN$36 for chips at Saigon. Fresh roots in truckload lots at the Tay Ninh farm were reported at VN$25 to VN$27 per kilo in March-April 1974. At the lowpoint for the year -- lasting no more than a month -- they appear to have been down to about VN$16.* Prices of dried cassava (which in Vietnam are cut by hand, and may not be indicative of a machine-operation) were reported at about VN$80 to VN$85 earlier in the year, and at VN$70 in September.

---

*Truckload prices as of September -- the seasonal dip came later this year -- are not readily available. The VN$16 estimate is based on the September retail price of VN$24, assuming the same percentage spread as in August 1973 when the retail price was VN$21. (At VN$30 for the first half of 1974, Tay Ninh's retail price rose to VN$33 for July and August, and was once again back to the VN$30 level in October.)

ARM/ttt

Table 1

Thai Chips and Pellets: Wholesale Price Quotations in Bangkok, and Resellers' Quotations for Cargo Afloat (c.i.f. North European ports) in West Germany, August 14, 1972 through November 11, 1973

Week ending:	Prices in local currency[1]				Prices per MT in dollars converted at: Prevailing exchange rate[2]			Prices per MT in dollars converted at: Sept 1973 exchange rate[3]		
	Per picul in Bangkok (Baht)		Pellets per MT		In Bangkok		Pellets in West Germany	In Bangkok		Pellets in West Germany
	Chips	Pellets	Bangkok (Baht)	Germany (DM)	Chips	Pellets		Chips	Pellets	
1972:										
Aug 20	52½	58½	B 975	DM 207	$42	$47	$64½	$44	$49	$85½
Oct 1	54½	61	1015	249	43½	49	78	45½	51	103
Oct 29	54	61	1015	285	43½	49	89	45	51	118
Nov 26	54½	64½	1075	300	43½	51½	94	45½	54	124
Dec 3	65½	74	1235	290	52½	59½	90½	54½	61½	120
Dec 31	51	59	985	261	41	47½	81½	42½	49	108
1973:										
Jan 28	52½	59	985	261	42	47½	82½	44	49	108
Feb 25	45½	53½	890	204	36½	43	72	38	44½	84½
Apr 1	46½	52½	875	217	37½	42	76½	39	44	89½
Apr 29	50½	57½	960	226	40½	46	79½	42	48	93½
May 27	63	67½	1125	234	50½	54	85½	52½	56	96½
Jul 1	70½	73½	1225	202	56½	59	83	59	61½	83½
Jul 29	57	66	1100	177	47½	55	75½	47½	55	73
Sep 2	54	63	1050	221	45	52½	89½	45	52½	91½
Sep 30	57	62½	1040	231	47½	52	95½	47½	52	95½
Oct 28	53½	57	950	231	44½	47½	95½	44½	47½	95½
Nov 11	53½	59	985	241	44½	49	99½	44½	49	99½
AVERAGES:[4]										
11/13/72 - 11/11/73	55.5	62.2	1035	231	..	..	..	46.3	51.8	95½
1/1/73 - 9/2/73	55.3	62.1	1035	220	..	..	..	46.1	51.8	91
1/1/73 - 11/11/73	55.3	61.8	1030	222	..	..	..	46.1	51.5	91½

SOURCE: Weekly quotations reported in Thai Board of Trade Bulletins

1/ Actually quoted per picul (60kg) in the Bangkok market, and per long ton (1.016 MT) in the German market.
2/ Conversion rates used for Baht: 20.80:1 through 6/30/73; 20.00:1, thereafter. For DM: 3.20:1 (as of 9/30 and 12/31/72) through 12/31/72; for Jan-Sept 1973, end-of-month rates; thereafter, at rate as of end September.
3/ Baht 20:$1; DM 2.42:$1.
4/ Represents averages of all weekly quotations during the period rather than of only those shown.

Table 2

Dried Cassava Products: Average Value per Metric Ton of Total Thai Exports (f.o.b.), and of West German Imports from Thailand and All Sources (c.i.f.), 1962-1973

Year	Local currency value of: Thai exports (Baht)	German imports: From Thailand	German imports: All imports	Exchange rates used: Baht	Exchange rates used: DM*	Dollar value of: Thai exports	Dollar value of: German imports: From Thailand	Dollar value of: German imports: All imports
1962	880			20.8		$42		$66
1963	770			do.		37		60
1964	720			do.		35		58
1965	780			do.		38		65
1966	770			do.		37		65
1967	720			do.		35		n/a
1968	740			do.		36		n/a
1969	810	DM 220	DM 225	do.	3.92	39	$56	57
1970	860	227	237	do.	3.64	41	62	65
1971	1010	239	240	do.	3.42	49	70	70
1972	1050[e]	211	214	do.	3.18	50[e]	66	67
1973:								
Jan-Mar		240	241		2.95		81	82
Jan-Aug		232	234		2.70		86	87
August		225	229		2.42		93	95

DESCRIPTION AND SOURCE:

Values in Baht, covering Thai exports of all cassava products other than flour (including meal, chips and waste as well as pellets), derived for 1962-71 from Bank of Thailand data on quantity and total value, as shown in the Thai Tapioca Trade Association Yearbook, 1971. Estimate for 1972 based on quantity and value of all cassava exports, and the quantity of cassava exports other than flour, as reported in Thai Board of Trade Bulletin 3/73, dated January 19, 1973, assuming the same percentage increase in average value of the dried products as for all exports.

Values of German imports for 1962-66 derived from quantity and total dollar values from West German Trade Statistics as shown in the International Trade Center (UNCTAD-GATT), "The Markets for Manioc as a Raw Material for Compound Animal Feeding Stuffs;" those for 1969-73, from quantity and total Deutsche Mark values from West German Trade Statistics.

Figures from 1962 to about 1967 reflect a shift in composition from more processed meal to less processed chips, and from 1967 onward, a

-- table continued

DESCRIPTION AND SOURCE (continued):

shift from chips to more processed pellets. Much of the higher trend from 1969 onward in the average value of Thai exports as compared with the value of German imports from Thailand is attributable to the fact that the German imports, beginning with 1969, consist almost entirely of pellets, whereas the Thai exports continue to reflect a changing trend toward pellets, rising from 77% of the total in 1969 to 89% in 1972.

*Exchange rates for 1969 through 1972 represent annual averages of the rates at the end of each quarter; that for 1973, the applicable averages as of the end of each month.

PROJECT NUMBER:

PROCESS:	ACTION:	DATE:	INITIALS:
CATALOGUE			
ABSTRACT			
FICHE	RANDD		

COMMENTS:

DS/DIU

Copy Edited by : Luise Lackland Shields

**Printed by : Printing Services Inc.
4 Nhat Linh Gia Dinh,
Republic of Vietnam**