STATUS OF ROOT CROP RESEARCH IN THE PHILIPPINES

— *by* —

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This paper aims to assess the status of root crops research in the Philippines based on the work done on this group of crops. For the first time a critical analysis of the results of experiments is presented as well as data of some important applied researches.

Studies involving some of the cultural practices with root crops are rather limited. Most workers have conducted variety tests; several have carried fertilizer trials, and a few have studied processing, storage and utilization. However, the data on some of these subjects were either extremely meager or non-existent.

Before I go further let me assess the food supply situation in the Philippines.

Food Supply Situation in the Philippines

The average annual gross available supply of food items in 1965 amounts to 11.5 million metric tons of which 9.7 million metric tons or 84.1% is of plant origin and 1.8 million metric tons or 15.9% is of animal origin. Of the food items derived from plant resources about 9.0 million metric tons or 92.8% is produced in the country and 7.2% is imported. About 43.5% of the total food crops produced is cereals; 17.0% is root crops and tubers; 18.0%, fruits; 9.6%, vegetables and 11.9% sugar, dry beans and nuts.

Root and tuber crops are the second suppliers of carbohydrate foods in the Philippines with a total production of about 1.5 million metric tons. About 208,000 metric tons of starchy roots and tubers produced in this country are used for non-food purposes leaving 1,314,000 metric tons available for human consumption. This is equivalent to per capita supply of 43.1 kg. per year or 118 grams per day. Actual intake of starchy roots which amounts to an average of 42 grams per capita per day shows that it is almost one-third of the per capita supply. The wide gap existing between the actual intake of roots and the supply indicates a possibility that a large quantity of the country's supply of starchy roots and tubers for food is not actually utilized for that purpose.

Except in a few places of the country, root crops are used only as substitute food when the supply of rice and corn is low and price of these cereals is high. Practically all of the supply of starchy roots in this country is produced locally. Of the total root crops produced, about 51.9% is sweet potato, 35.7% is cassava and 7.0% is gabi or taro. The rest or about 5.4% are ubi, tugni, arrowroot and yauntia. (Anonymous, 1966).

RESEARCH ON CASSAVA

Originally the cassava tuber was a main food crop among Latin-American people. At present it is grown as a substitute for rice or alternately with rice on large acreage in regions where, for centuries, rice has been the sole crop.

Realizing the importance of cassava in this country, the U.P. College of Agricuture began the study of its culture in its early history. Foreign varieties have been introduced and assessed. Analyses were made on the storage roots. Also, processing and utilization of this root crop were studied. The possibility of alcohol and starch extraction were undertaken and recently experiments on the value of cassava as a livestock feed have been done.

Guanzon (1927) expounded on the possibilities of cassava production in the Philippines. He enumerated the following reasons:

1. Cassava is a very easy plant to grow under most field crop conditions in the country.
2. There is an exact parallel between the planting and cultivation of sugarcane and cassava.
3. Cassava has many advantages over sugarcane which few people seem to realize.
4. Simple machines for starch processing are needed.
5. Local demand for cassava exists.
6. It is a cheaper source of starch than corn.
7. Cassava is not a permanent crop.

To promote the processing of cassava flour, the Philippine Congress passed in 1951 Republic Act 657 known as the Cassava Flour Law (Acena 1953). Section 1 of the said act states that, "it is declared to be in the interest of the country's economy and development of its agriculture and industry, to encourage and promote the production, processing and consumption of cassava flour as a measure to conserve dollars to prevent the scarcity of wheat flour and to regulate its importation consistent with the commitments of the Republic of the Philippines under the International Wheat Agreement".

Propagation

Guanzon (1927) pointed out that any part of the cassava stem may be used for propagation, including the stumps, but the best part is the mature portion of the stem with the exception of that nearest the root and green portion at the top. Mendiola (1931) stated that in planting cassava, the young top portion is removed while the remaining part is cut into pieces and used for planting. The bottom pieces seem to be better than the upper cuttings as planting materials.

Galang (1931) reported that the average yield of roots per hectare of base cuttings obtained in a trial planting was 36.5 tons, of the middle, 34.9 tons and of the apical cuttings, 19.7 tons. From there he suggested the use of the base and middle portions of the stem for planting.

Certain planters claimed that longer cuttings are better than the shorter ones. Planting the entire stem will reduce the expenses for labour. In order to determine the effects of planting the entire stalk upon the yield of cassava, Palis (1938) conducted an experiment on this aspect. Some of the important results of the experiment were given below:

	Entire Stalk	*Ordinary cuttings*
Yield of roots per hectare (tons)	32.99	30.13
Yield of starch per hectare (tons)	3.45	2.97
Yield of cuttings per hectare (meters)	69,935.60	84,302.40

The entire stalk planting produced more plants and yielded more storage roots and starch than the ordinary planting. However, the stalks from the former were shorter and more slender.

Huertas (1940) studied the effect of age of cutting on the yield of cassava. Old cuttings (near the base) gave better stand and more root yields than the younger ones (upper cuttings towards the tip). The results are shown on Table I.

Table I. Percentage germination, yield of roots and starch in tons as affected by age of cassava cuttings (Huertas, 1940)

Group	Cutting No.	Germination %	Yield of roots/ha T	Starch yield/ha T
Top	1	15.1	4.4	0.57
	2	45.2	15.6	1.81
	3	63.9	19.6	2.25
Middle	4	74.1	18.2	2.21
	5	77.0	19.7	2.12
	6	82.4	19.2	2.07
Base	7	82.1	19.4	2.02
	8	82.5	18.5	2.01
	9	82.7	21.4	2.31

Intercropping

Martinez (1947) found that intercropping corn with cassava between the rows and hills gave a fairly good yield of roots when the two crops wete planted at the same time (Table II).

Harvesting

Soliven (1921) determined the effect of age or time of harvesting on the starch content of six varieties of cassava. When the plants were over-matured, there was a decrease in the amount of starch (Table III).

Sison (1921) has a similar study but he determined the effect of the yield of roots (Table IV). There was an insignificant increase in the yield of roots among the varieties from the 11th and 12th month after planting except Aipin Mangi.

Table II. Effect of intercropping corn with cassava

Treatment	Cassava kg	Marketable ears kg	Non-marketable ears kg
Ordinary field:			
1. Corn alone	—	930.7	2185.8
2. Cassava between hill of corn after the latter was hilled up	1115.9	909.3	2214.3
3. Cassava between rows of corn after hilling up	707.2	863.5	2220.1
Bulldozed field:			
1. Corn planted alone	—	641.3	747.6
2. Cassava planted between hills of corn at almost the same time	2286.3	884.8	1142.6

Table III. Starch content of cassava varieties as affected by age of harvesting (Soliven, 1921)

Variety	Age	% starch (air-dry basis)	Variety	Age	% starch (air-dry basis)
	10	77.15		10	75.36
	11	78.45		11	75.50
Aipin Mangi	12	87.90	Angular	12	81.00
	13	99.60		13	76.27
	14	73.10		14	59.22
	8	68.50		10	76.20
	9	76.50	White Smooth	11	77.12
Aipin Valenca	10	84.31	Intermediate	12	79.04
	11	84.00		13	69.00
	12	84.10		14	66.00
	13	75.05			
	8	67.66		7	70.65
	9	83.16		8	71.60
	10	91.09	Red	9	82.50
	11	86.46		10	75.60
	12	79.00		11	70.48

Table IV. Storage root yield of different cassava varieties as affected by age of harvesting (Sison, 1921).

Variety	Age at harvest (in months)		
	10	11	12
Kapo Colorado	7140	9960	10840
White Smooth Intermediate	8640	12360	12300
Angular	9280	12940	13860
Rough Intermediate	10640	13280	14320
Kapo White	11260	11740	15220
Casjave Singkong Manis	12980	15120	16140
Aipin Valenca	18320	20320	20970
Aipin Mangi	19200	22620	35700
Mandioca Basiorao	36060	37780	38280
Mandioca Sao Pedro Preto	27880	37180	38500

In a study at the U.P. College of Agriculture on the relation of age of cassava plants to their yield of roots and starch, Uichangco (1959) stated that the percentage of commercial starch decreased as the plants grew older (Table V).

The highest yield of roots and starch was obtained when the plant was fourteen months old, in the case of Seedling No. 2152. The maximum yield of roots of Aipin Valenca was obtained when the plant was fourteen months old but the maximum production of starch was obtained at the twelfth month.

Storage and Processing

Baybay (1922), in a study on the storage of some perishable root crops, found that gabi was successfully stored in the dark for 92 days; ubi in the cellar for 92 days; yauntia for 40 days in the cellar and tugni for 72 days in the cellar; cassava for 25 days in the cellar had the lowest percentage loss of 63.96%.

Table V. Yield of fresh roots, starch and percentage extraction as affected by age of harvesting in cassava

Age of plants (months)	Av. yield per ha (tons)	Commercial starch per harvest (800 plants)	% Extraction
Seedling No. 2152		kg.	
10	23.6	254.4	13.48
11	28.3	255.3	11.28
12	31.1	255.8	10.29
13	37.5	324.0	10.80
14	41.8	333.0	9.96
Aipin Valenca			
10	19.6	167.0	10.65
11	20.9	171.7	10.27
12	23.4	188.0	10.04
13	23.7	178.0	9.39
14	24.0	170.0	8.85

Roxas and Manio (1921) determined the hydrolysis of cassava on different conditions and its fermentation to alcohol by different yeast preparations. They suggested that for every 100 kg. of cassava flour, use 50 litres of acid solution containing 1 litre sulphuric acid (sp. gr. 1.84) hydrolized under pressure at 120°C (15 lb. per sq. inch) for 2.5 hours. Then neutralized it with 2 litres of ammonium hydroxide (sp. gr. 0.9), and dilute it to 600 litres plus 6 litres of yeast prepared by Wolhvent process. Distil the fermented liquid after the second day but not later than the third day.

They also attempted to extract starch from cassava. This method consisted simply of grinding the peeled cassava roots without water and drying in the sun or with the aid of artificial heat to a moisture content of 15%. Their results are shown below:

Test No.	Wt. of roots (kg)	Already starch (kg)	% extraction
1	24.95	5.8	23.3
2	148.00	36.24	24.2

The chemical composition of cassava is of interest to the planter, the starch processors and consumers. Adriano, et al. (1932) gave the proximate analysis of different varieties of cassava at the U.P. College of Agriculture. They used Mandioca Sao Pedro Preto, Mandioca Basiorao, Aipin Valenca, Aipin Mangi, Kapo White and Rough Intermediate. The results are shown in Table VI.

Table VI. Proximate chemical analysis of cassava roots (After Adriano, et al, 1932)

Composition	Percentage
Edible portion	81.40
Moisture	63.80
Ash	1.44
Proteins	0.96
Fats, ether extract	0.26
HCN	0.02
Crude fiber	0.85
Starch	27.65
Other N.F.E	5.04
Calorific value/kg	1,403.00

Cedillo (1952) studied the possibility of preparing "landang" or cassava rice from the fresh roots. He found that "landang" compares favorably with corn and rice as to food constituents and calorific value. Although rice and corn contain more proteins (Table VII), "landang" has a greater amount of carbohydrates from the nutritive point of view. "Landang" can very well become a good substitute of corn or rice during hard times.

Table VII. Food value of "landang" as compared with corn and rice

Item	"Landang" %	Yellow Corn (Air-dry) %	Rice (Lowland) %
Moisture	14.2	13.88	11.39
Crude fat (ether extract)	0.26	4.47	1.10
Crude proteins	2.41	8.90	8.35
Carbohydrates	80.79	67.28	76.74
Crude fibers	1.68	2.86	0.92
Ash	0.65	2.61	1.50
Cal. value per 100 grams	335.00	353.91	359.09

RESEARCH ON SWEET POTATO

Sweet potato is the most important root crop in the Philippines. It may yet become one of our important industrial crops. Many varieties are grown and they vary in yield and quality. It is necessary, therefore, that yield trials be conducted to discover the best varieties.

Variety test

Cadiz (1944) found that Centennial, Phila, Seedling 47, BNAS 51 and Batanes were the promising varieties as a result of the yield trial at U.P. College of Agriculture. Previous to this were such varieties as Samar Big Yellow, Kadali, Tamisang Puti and Isabelang Pula (Alcantara, 1946; Zamora, 1947; Calma and Zamora, 1949; Calma and Paningbatan, 1950).

Propagation

The most common practice of propagating sweet potato in the Philippines is the vine cuttings. Some claimed that the highest yield is obtained when cuttings are planted in a slanting position. Others believed that either the bent or twisted one gives the best results.

Tenebro (1935) compared the positions of planting on two varieties and found that the bent position was the best in the production of roots (Table VIII). The others are slanting and twisted positions

Table VIII. Yield of vines and roots of sweet potatoes as influenced by positions of planting

Position	Vines kg/ha	Roots kg/ha
1. Slanting	40,224	19,144
2. Bent	53,556	22,752
3. Twisted	50,060	16,756

The Philippines farmers used 'camote' cuttings from different portions of the vine for planting. In some cases cuttings from sprouting tubers were used. Roque (1924) conducted an experiment to find out the relation between growth and yield of the plants grown from different outings. He observed that the tip cuttings gave the faster growth and the higher yield than the basal cuttings.

Intercropping and topping

Lawas (1947) tried to intercrop corn with sweet potato. He stated that the stand of corn was affected when sweet potato was planted at the same time with the former in the row or between hills. However, if sweet potato was not planted until after corn had been hilled up, the latter was not affected at all (Table IX).

Table IX. Yield of corn as influenced by intercropping with sweet potato

Treatment	Sweet Potato	Marketable ears	Non-marketable ears
Ordinary Upland Field			
1. Corn alone	—	2355.64	2855.81
2. Intercropped between the hills of corn	363.86	2067.79	3473.02
3. Intercropped between the rows of corn	343.08	1592.60	2558.40
Bulldozed Field			
1. Corn alone	—	2319.33	5202.12
2. Intercropped between the hills of corn	1797.09	1677.51	3770.04

Morales (1956) determined the effect of topping on root yield of sweet potato. He found that severely topped plants (all shoots acceptable for greens were removed) gave lower yield than the moderately topped (approximately one-half of the shoot acceptable for greens was removed). This was due to the reduction of the leaf area for the manufacture of plant food.

Fertilization

Lantican and Soriano (1961) reported that the yield of roots, leaves and vines increased with the rate of nitrogen applied. The highest amount of potassium increased the vegetative growth but did not increase the yield of roots. The response to the minor elements was inconsistent and phosphorus gave no response. The combinations of 100-90-90 and 100-90-0 were consistently the best for root yield; 100-90-90 and 50-90-180 for growth of leaves and vines (Table X).

Table X. Yield of roots and vines in tons per hectare of sweet potato in two seasons of tests

Treatment	Storage roots		Vine	
	Dry season	Wet season	Dry season	Wet season
N-P-K	1956	1957	1956	1957
0-90-0	4.98	11.20	1.87	1.71
50-90-0	5.75	12.93	1.97	1.88
100-90-0	8.78	15.04	1.64	2.00
0-90-0	6.83	12.19	1.87	1.98
50-90-90	5.13	11.38	2.30	2.23
100-90-90	9.75	16.80	3.07	3.51
50-0-90	6.62	13.32	2.21	2.34
50-90-90	6.05	14.94	2.05	2.36
50-90-180	6.48	13.08	3.23	3.04

Cadiz and Abbigay (1964) found that the application of fertilizer at the rate of 100-90-100 kilos of N-P-K, respectively, per hectare generally promotes vigor and production of uniform roots. Closer spacing yielded more than wider spacing but better vigor and more uniform roots were obtained in wider spacing. In general, 20 cm. spacing fertilized at the rate of 100-0-0 and 200-0-0 was shown to be the best combination of greater and heavier roots.

Cadiz and Hermano (1964) determined the effect of starter solution and age of cuttings on the recovery and yield performance of three varieties of sweet potato, namely Phila, Batanes and Seedling 47. They noted that delaying planting of cuttings for a day or two seems to favor better recovery. Generally the use of starter solution (5 lbs. of 12-24-12 fertilizer for every 50 gal. of water) promotes greater survival and total yield, better vigor, better yield of marketable roots.

OTHER ROOT CROPS

Taro, or gabi, yam or ubi and arrowroot are other sources of food. Research involving cultural practices with these crops has been rather limited. A few of them are herewith presented.

Paguirigan (1950) opined that gabi required 500 to 600 kg. per hectare of a mixture of 6% N, 6% P_2O_5 and 12% K_2O for a food yield of corms.

Banaag (1958) determined the effects of individual and combined application of N, P, and K on the yield of corms and vegetative parts. The highest level of N (150 kg/ha) mixed with 90 kg of P and 90 kg of K increased the yield of corms and vegetative parts. Coligado (1964) on the other hand, recommended the application of 180, 90, and 90 kg. per hectare of N, P, and K respectively.

An experiment is in progress on the effect of poles in the yield of ubi or yam at varying hill spacing. This was conceived because of the general practice of the farmers to use support for this crop without considering the distance between plants.

There is no distinct variety of arrowroot in the Philippines, as the plant is grown only in semi-cultivated condition.

UTILIZATION OF ROOT CROPS FOR FORAGE

Chemical analysis represents the starting point determining the nutritive value of feeds. Mendiola (1931) in an article on the growing of cassava in the College of Agriculture, U.P. gave the quality of roots of the different varieties of cassava found in the Philippines (Table XI).

Although roots cannot replace legume hay in stock feeding, they can be used as a substitute for a considerable part of grain customarily fed to swine or poultry. Feeding trials conducted at the College of Agriculture have shown that cassava may be utilized to great advantage by feeding it to hogs. There are however, some varieties grown in the Philippines, some of which are more or less poisonous. The substitution of one feed for another is an important and ever present factor in swine feeding. Some feeds become scarce, others become unavailable. Feed prices change from time to time.

Alba (1937) studied a number of casssava varieties for hog feeding purposes. He used four varieties and observed that all varieties did not produce fatal effect on pigs fed with them (Table XII). From the point of view of the rate of gain, the replacement of from 5-15% of the basic concentrate ration by cassava in proportion of 3 parts of cassava roots to be one part of concentrate proved to be most practical and economical.

Aipin Valenca was consistently superior to those from other lots. It is not poisonous and with good flavor and not fibrous (Mendiola, 1931). The replacement of 5% of concentrate ration by cassava roots is practical in a dry-lot system of feeding.

Table XI. Quality and flavor of different varieties of cassava

Variety	Quality	Flavor
Mandioca Sao Pedro Preto*	VP	not edible
Mandioca Tapicuro*	NP	fair
Mandioca Basiorao	NP	fair
Mandioca Itaploica	NP	good
Mandioca Criolinha	P	not edible
Aipin Valenca*	NP	good
Aipin Mangi*	NP	very good
Aipin Trapecuma	NP	good
Aipin Manteiga*	NP	good
Casjave Singkong Manis	NP	very good
Kapo White	NP	good
Kapo Colorado	NP	fair
Rough Intermediate	NP	good
White Smooth Intermediate	NP	good

VP — very poisonous
NP — not poisonous
P — poisonous
* — included in the present collection of cassava varieties of FCD, Department of Agronomy, U.P.C.A.

Table XII. Feeding value of cassava tubers on pigs

Items	Lot I (Control)	Lot II (5% Mandioca Tapicuro)	Lot III (5% Aipin Valenca)	Lot IV (5% Mandioca Itaparica)	Lot V (% Mandioca Basiorao)
Average initial weight (kg.)	7.12	7.16	7.20	7.16	7.08
Average final weight (kg.)	25.28	22.68	26.04	23.36	25.80
Average daily gain per pig	0.26	0.22	0.27	0.23	0.27
% of ration to live weight	3.14	3.04	2.96	2.96	2.91
Feeds consumed per kg gain	2.80	2.95	2.62	2.79	2.56

Mondonedo (1928) compared the feeding value of corn and cassava for hogs. One lot of 8-month old pigs was fed with a ration containing 20% corn, and the other lot was replaced by twice its weight of peeled, chopped raw cassava. The cassava lot made an average daily gain per pig of 0.40 kg; corn lot, 0.36 kg. The former required 0.44 kg more feed to make a kg gain than the latter.

Mondonedo and Bayan (1927) fed for 70 days two lots of 3-month old pigs on 'camote' pasture, one on a ration containing 30% corn and the other on the same ration with corn replaced by cassava on the basis of one part corn to 2 parts cassava in cooked form. In producing gain, ground corn proved to be slightly better than either the whole corn or 3 parts cooked cassava. Three parts of peeled cooked cassava, which is equivalent to 2 parts of raw cassava had approximately the same feeding as one part flint corn grain.

Mondenedo and Alonte (1931) reported that cassava or sweet potato is a good substitute for corn in the ration of pigs when fed in dry lot. Two parts by weight of cassava or sweet potato are about 87% as one part corn in feeding value and 2 parts 'pongapong' are equivalent to 75%. In other words 2.3 parts of cassava or sweet potato and 2.67 parts of 'pongapong' are equivalent to 1 part corn.

Penuliar (1940) studied the value of casava refuse meal and rice bran as feeds for growing and fattening pigs. In rate of gain, cassava refuse was only 52% efficient when substituted for rice grain in the College standard ration during the 210-day feeding period. As to the amount of feed required to make a kilogram gain, cassava refuse meal was 61% efficient as compared with rice bran.

Gaplek meal is a good substitute for corn in the ration for growing and fattening pigs (Asico, 1941). He compared gaplek meal and corn as basal feed for growing and fattening pigs. He observed that with the amount of feed required for a given unit of gain as the basis of comparison, gaplek meal was 90% as efficient as corn for the 210-day feeding test (Table XIII).

Table XIII. Feeding value of gaplek as a substitute for corn in pigs

Items	Lot I	Lot II
Average initial weight per pig	17.71 kg.	12.71 kg.
Average final weight per pig	75.29 kg.	70.49 kg.
Average daily gain in weight	0.30 kg.	0.27 kg.
Feed consumed per kg. gain	5.39 kg.	5.68 kg.

Tabayoyong (1935) used cassava refuse meal in the ration for growing chicks. The rice bran fed chicks grew faster than those fed with cassava refuse meal. Those fed with a combination of cassava and rice bran were intermediate in size between those fed with rice bran and cassava with a tendency to approach those of rice bran. The cassava refuse meal fed chicks had the slightest percentage of mortality 59.4% those fed with rice bran, 41.5% and those with combination, 42.5%.

Some years ago it was considered nearly essential to supply succulent feeds to livestock to secure maximum growth from any rations. Some of these are leaves of sweet potato, 'ipil-ipil', young shoots of Centrosema and Calopogonium. Swine can be raised on concentrates alone, but experiments have shown that through the use of suitable forage and pasture crops pork may be produced at a much lower cost than when pigs are maintained in dry lots on expensive concentrates.

Rodriguez and Kohmson (1927) observed that pigs on pastures did considerably better when given 'camote' vines in the form of soilage in addition to the concentrate alone.

When rapid growth and development is the object sought, full feeding with dry ration with access to a good pasture like sweet potato is a better practice than limiting the ration (Soriano, 1932). Sweet potato has a marked superiority over Calopogonium as pasture for hogs, full fed or on limited ration.

Dingayan and Fronda (1950) compared Centrosema, 'ipil-ipil' and sweet potato vines as green feed to chicks. Either finely cut green leaves and young shoots of 'ipil-ipil' and Centrosema are much better than sweet potato leaves and young shoots as green feed for growing chicks (Table XIV).

There were no significant differences in digestion coefficients for organic matter, fat and protein in sweet poato tubers and vines, cassava roots and green papaya fruits by different breeds of pigs. Philippine native pigs had the highest digestion coefficient (Zarate, 1956).

Table XIV. The average proximate analysis of three green feeds

Constituent	Ipil-ipil	Centrosema	Sweet potato
Moisture	74.89	74.63	89.63
Crude Protein	0.36	0.22	0.24
Crude fats	2.77	2.02	0.45
Carbohydrates	17.69	15.23	6.39
Crude Fibre	2.25	5.86	1.48
Ash	2.04	2.04	1.81
Calorific value/100 grams	97.00	80.00	31.00

Castillo, *et al.* (1964) confirmed that corn can be entirely replaced by either camote or cassava silage in the swine ration. Their test showed that when camote or cassava silage replaced corn in growing and fattening swine ration, the gain in weight is the same as in corn (Table XV).

Table XV. Proximate analysis of camote and cassava tuber silage

	Proximate						
Silage	Dry Matter %	Ash %	Crude Protein %	Ether extract %	Crude fiber %	NFE %	HCN mg/100 grams
Camote tuber:							
before ensiling	30.88	1.24	0.50	0.30	1.05	27.79	—
1st sampling	38.03	1.48	0.76	0.39	1.47	33.93	—
2nd sampling	30.03	1.57	0.82	0.21	1.49	25.94	—
3rd sampling	39.17	1.51	0.74	0.20	1.57	35.15	—
Cassava tuber:							
before ensiling	36.07	1.16	0.98	0.99	1.28	31.66	10.71
1st sampling	43.45	1.88	0.61	0.30	2.10	38.56	9.72
2nd sampling	46.46	2.08	0.82	0.19	2.78	40.59	9.72
3rd sampling	41.19	1.57	0.68	0.23	1.57	37.14	9.40

REFERENCES

Acena, B. (1953). The status and future of the Philippine cassava industry. **Proc. Soc. Tob. Conf.:** 28-38.

Adrinano, F.T., H.T. Ramos, and L.A. Tualvey (1932). The proximate chemical analysis of Philippine foods and feeding stuffs. III. **Phil. Agric.** 20: 530-534.

Alba, M.G. (1937). A study of different varieties of cassava for hog feeding purposes. **Phil. Agric.** 25 (9): 782-796

Alcantara, M. (1946). Performance test of early maturing varieties of sweet potato. **U.P.C.A. Bi-weekly Bull.** 11 (9): 1-2.

Anonymous. (1966). **The Statistical Reporter.** 10 (1): 15.

———— (1958). **Annual Report, Dept. of Agronomy, U.P.C.A.** (Unpublished).

Asico, P.M. (1941). A comparative study of gaplek meal and corn as basal feed for growing and fattening prior. **Phil. Agric.** 29: 706-712.

Banaag, L.V. (1958). Fertilizer requirement of gabi. (Unpublished) **Undergraduate Thesis,** U.P.C.A.

Baybay, D.S. (1922). Storage of some root crops and other perishable farm products. **Phil. Agric.** 10: 423-440

Cadiz, T.G. (1964). Let's grow more sweet potato. **Agriculture at Los Banos.** 3 (4): 14-15.

———— and Agbigay, (1964). Fertilizer and spacing test on sweet potato. (Unpublished) **Undergraduate Thesis.** U.P.C.A.

———— and F. Hermano. (1964). The effect of starter solution and age of cuttings on the recovery and yield performance of three varieties of sweet potato. (Unpublished) **Undergraduate Thesis,** U.P.C.A.

Calma, V.C. and E.S. Paningbatan (1950). Field tests of six varieties of sweet potato. **Phil. Agric.** 34 (2): 84-89

———— and F.S. Zamora (1949). The yield and varietal characters of some varieties of the sweet potato. **Phil. Agric.** 32 (3): 215-222.

Castillo, L.S., F.B. Aglibut, T.A. Javier, A.L. Gerpacio, Puyaoan (1964). Camote and cassava tuber silage as replacement for corn in swine growing-fattening rations.**Phil. Agric.** 47 (9-10): 460-474.

Cedillo, V.C. (1952). Cassava rice or "landang". **Phil. Agric.** 35 (8): 434-440

Coligado, B.C. (1966). Response of gabi to different levels of N, P and K and their combinations. (Unpublished) **Undergraduate Thesis, U.P.C.A.**

Dingayan, A.B. and F.M. Fronda. (1950). A comparative study of the influence of the leaves and young shoots of Centrosema, ipil-ipil sweet potato as green feed in the growth of chicks. **Phil. Agric.** 34: 110-115.

Galang, C.F. (1931). Experiment on cassava at Lamao Experiment Station, Bataan. **Phil. Journ. Agric.** 2: 179-188.

Guanzon, G.A. (1927). The possibilities of cassava production in the Philippines. **Phil. Agric.** 16: 433-440.

Huertas, A.S. (1940). A study of the yield of cassava as affected by age of cuttings. **Phil. Agric.** 28 (9): 762-770.

Lantican, R.M. and P.M. Soriano. (1961). The response of sweet potato to different fertilizer treatment. **Phil. Agric.** 45 (5): 258-263.

Lawas, C.M. (1947). A study on the intercropping of corn with sweet potato **U.P.C.A. Bi-weekly Bull.** 12 (5): 1-2.

Martinez, J.T. (1947). A study on intercropping corn with cassava. **U.P.C.A. Bi-weekly Bull.** 12 (7): 1-2.

Mendiola, N.B. (1931). Cassava growing and cassava starch manufacture. **Phil. Agric.** 20: 447-476.

Mondonedo, M. (1928). A comparative study of corn and cassava as feeds for hogs: II. Ground corn vs. raw chopped cassava. **Phil. Agric.** 17: 105-107.

——————— and P.V. Bayan (1927). A comparative study of corn and cassava feeds for hogs **Phil. Agric.** 15: 523-532.

——————— and F. Alonte (1931). A comparative study of corn, cassava, sweet potatoes and ponga-pong as feeds for swine. **Phil. Agric.** 20: 113-119.

Paguirigan, D.B. (1950). Outline of the Philippine crops. **Agric. and Ind. Life** 12 (5): 30.

Palis, F.O. (1938). Entire stalk versus ordinary cutting for cassava. **U.P.C.A. Bi-weekly Bull.** 7 (4): 1-2.

Penuliar, S.P. (1940). A comparative study of cassava refuse meal and rice bran or feeds for growing and fattening pigs. **Phil. Agric.** 29: 611-615

Rodriguez, Jr. E. and G. Khomson. (1927). Preliminary experiments on the use of camote (**Ipomoea batatas** Linn.) as pasture and soiling crop for growing breeding pigs. **Phil. Agric.** 15: 605-613

Roque, D.O. (1924). The growth and yield of sweet potato started from different cuttings. **Phil. Agric.** 13 (3): 143

Roxas, M.L. and R.V. Mario (1921). Industrial alcohol from cassava. **Phil. Agric.** (10) 2: 75-84.

——————— (1921). Starch from cassava. Phil. Agric. 10 (2) 73-74.

Sison, D.L. (1921). Variety test of cassava based on production. **Phil. Agric.** 10 (5): 255-256.

Soliven, F. (1921). The chemical changes of cassava preceeding and following harvesting. (Unpublished). **Undergraduate Thesis** U.P.C.A.

Soriano, A.V. (1952). Sweet potato (**Ipomoea batatas** Linn.) vs. **Calopogonium muconoides** Desv., a legume as pasture crop for growing pigs. (Thesis abstract by A.D. Pablo). **Phil. Agric.** 22: 157-158.

Tabayoyong, T.T. (1935). The value of cassava refuse meal in the ration for growing chicks. **Phil. Agric.** 24 509-518.

Tenebro. M.T. (1935). The effect upon the yield of sweet potato of planting cuttirgs in three different positions. **U.P.C.A. Bi-weekly Bull.** 3 (15): 1-2.

Tolentino, J.S. (1953). A field test of six varieties of sweet potato. **U.P.C.A. Bi-weekly Bull.** 18 (10): 1-2.

Uichanco, L.B. (1959). **Phil. Agric. Vol. 1** (Field Crops) pp. 449-450

Zamora, F.S. (1947). A preliminary test of eleven varieties of sweet potato. **U.P.C.A. Bi-weekly Bull.** 11 (17): 1-2.

Zarate, J.J. (1956). Digestibility by swine of sweet potato vines and tubers of cassava roots and green papaya fruits. **Phil. Agric.** 40: 78-83.