17. Breeding improved sweetpotato varieties in Indonesia

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Abstract

Before 2000, sweetpotato breeding programs in Indonesia were directed at improving yield and tolerance to stress environments, scab diseases, and sweetpotato weevil. From 1970 to 1995, the Central Research Institute for Food Crops (CRIFC) only released six sweetpotato varieties, namely Daya (1978), Prambanan (1982), Mendut (1989), Borobudur (1982), Kalasan (1991), and Muara Takus (1994). The roots of these varieties were of poor quality (wet type) and as such, these varieties were poorly adopted by farmers.

Sweetpotato has long been used for food, industrial purposes, and feed in Indonesia. Production, however, is stagnant due to relatively low consumer demand. Recently, swetpotato's use as food has decreased, while its use in industrial processes and as feed has increased. By increasing its use in agroprocessing, the crop can become a value-added commodity that will benefit farmers, rural enterprises, and consumers. Most varieties now cultivated have a low dry matter (DM) content (22-30%), too low for them to be used as a raw material in the processing industry, which prefers root DM content above 35 percent. To this end, breeding for higher dry matter content, good eating quality, and early maturity began in 1995. Aside from these characteristics, farmers now look for new varieties that have uniformly large roots, attractive shape and color, and good storage qualities.

From 1996 to 2000, CRIFC and the regional office of the International Potato Center for East, Southeast Asia and the Pacific (CIP-ESEAP) released a two new varieties of sweetpotato. One, named Sewu (1998), is moderately resistant to swetpotato weevil and the other, named Cangkuang (1998) is resistant to leaf scab. Anticipating the consumer demand for high DM and good eating quality, CRIFC and CIP-ESEAP released five sweetpotato varieties in 2001: Sukuh, Jago, Kidal, Sari, and Boko. Most of these varieties have DM contents above 30 percent and have good eating quality.

Research work in breeding in the future should pay more attention to the different uses of sweetpotato varieties. There is a comprehensive literature in Indonesia on the use of sweetpotato, but it is mostly theoretical. Very little reflects concrete research or practical results and conflicting data are often shown. This shows that, as a whole, sweetpotato has not been given the priority it should have.

Introduction

Sweetpotato is a minor rootcrop traditionally grown by small farmers in Indonesia. Its status is still very much a crop grown for home consumption or for the fresh food market. The area under sweetpotato cultivation yearly in the country is approximately 200,000 ha. Fresh roots are cooked in various ways: boiled, steamed, coated with butter then fried, and used in a variety of local dessert or snack preparations. There is no accurate information regarding the proportion used in processing, but sweetpotato is believed to be used in certain food industries as a thickener (e.g. in sauces). It is also used in making fried crisps (locally known as *kripik*) and a confectionery called *kremes* made from fried matchstick-sized sweetpotato cuts coated with liquid brown sugar.

The sweetpotato root is primarily an organ for storing starch. As such, CRIFC recognized the crop's potential for wider industrial applications in the future. Starch is important for the textile industries and in the manufacture of flavor enhancers such as monosodium glutamate (MSG), sweeteners such as glucose and high-fructose syrups, and fermentation products such as lactic and acetic acids.

Indonesia is a net importer of large quantities of wheat flour for bakery products and grains like maize for livestock feed. Sweetpotato can help save valuable foreign exchange by partially substituting for these imports. The research priorities for sweetpotato in CRIFC, particularly in the fields of breeding and selection, production system, and end-use development reflect this move away from just the traditional fresh food market to more industry-based applications.

Varietal improvement is very important in achieving increased production, considering the importance of this crop. Several programs are under way in the country targeting high tuber yield, good cooking quality, early maturity, wider adaptability, resistance to diseases and pests, drought tolerance, better storage and maintaining quality, processing attributes, and nutritional value.

The improvement programs are taken up on short- and long-term projects using various breeding methods such as interspecific and intervarietal hybridization, population improvement through open pollination, polycross, polyploid, and mutation breedings. The immediate breeding need in Indonesia is to enhance the national productivity from 8 to 20 t/ha by developing short duration lines.

So far, bred using different approaches, 14 cultivars with yield potentials of 20 to 25 t/ha have been released since 1980 for commercial cultivation in different agroecological zones (tables 1 and 2).

Breeding Objectives

The objectives of the national sweetpotato breeding program are:

1. To improve sweetpotato productivity, tuber quality, and maturity for food, feed, and industrial purposes.
2. To improve tolerance of sweetpotato clones to major biological constraints (sweetpotato weevil and leaf scab disease).
3. To improve tolerance of sweetpotato clones to major environmental stresses (drought and shading).

Since 2002, higher priority has been given to a number of specific breeding objectives, including drought and cold temperature tolerance, scab and nematode resistance, and breeding for the development of sweetpotato varieties for specific uses and traits (table 3). High dry matter content is among these specific traits, which also include high beta carotene and anthocyanin.

Breeding Strategy

For the fresh market, food processing, and industrial uses, traits required are more diverse than before. Simple methods to evaluate quality must be established. The proposed strategy for sweetpotato breeding is to: collect, conserve, evaluate, and use sweetpotato genetic resources; develop new technology to enlarge genetic variation; develop breeding lines with highly general and specific combining abilities; establish efficient selection methods; and develop simple evaluation techniques for quality.

Several government agencies have eagerly pursued breeding and improvement of sweetpotato. Since its establishment, the Research Institute for Legume and Tuber Crops (RILET)[1] is actively doing breeding work to increase yield and improve component characters such as dry matter, starch content, good eating quality, resistance to pests and diseases, and tolerance to problem soils.

Since 1980, 14 sweetpotato varieties have been released for cultivation. The majority of these are products of polycross and the rest were developed through biparental crossing. Selected superior germplasm accessions were used in the polycross breeding. However, farmers' adoption of these varieties has been slow. Slow adoption was partly attributed to the absence of farmers' field trials prior to the release of the variety that led to:

1. Shortcomings of new varieties in terms of eating quality, storability, and adaptability to marginal environment;
2. Limited access of farmers to planting materials of new varieties, no distribution program for sweetpotato cuttings;
3. Difficulty in distribution of sweetpotato seedpieces because of their high perishability, bulk, and problems in maintaining/multiplying quality seedpieces in the field; and
4. No stable market for increased production.

The track record of the recommended varieties taught sweetpotato researchers many lessons such as the following:

1. Farmers' and consumers' preferences must be considered in screening and evaluating a variety.
2. Breeding must be directed towards developing varieties for marginal areas where sweetpotato is grown.
3. Farmers' participation in certain stages of variety selection is very necessary.
4. Intensify breeding and selection using biotechnology to meet current market demands.
5. Clean planting materials of recommended varieties need to be multiplied and distributed to growers.
6. The demand for varieties with high dry matter, good eating quality, and high yield has not been met.

Farmers often determine varietal preference by taste, texture, or color and not necessarily by yield. A farmer's decision to select a particular sweetpotato cultivar or variety is based on a combination of technical and socioeconomic factors. Yield, root characteristics, growth duration, plant morphology, and agroecological suitability are theprimary biophysical concerns. Socioeconomic factors, particularly culinary factors, consumer acceptance, and market price for commercial sale are integral. Most farmers weigh the combination of these factors in justifying their varietal selections in relation to their particular situation.

Screening for weevil and scab resistance identified resistant lines. Stable resistance was observed only for scab but not for weevil. Screening of sweetpotato suited for processing is ongoing, and some promising cultivars for various food products have been identified.

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[1] RILET is one of the commodity institutes under CRIFC.

The future direction of breeding must be geared towards selection of varieties adapted to specific growing conditions, and with specific uses. Moreover, it must be farmer-participatory and oriented towards market driven demands.

Use of Sweetpotato in Indonesia

Sweetpotato has a wide variety of uses in Indonesia. As a fresh food, it is highly nutritious and an important source of Vitamin A (Woolfe 1992). It is usually consumed in boiled form (Watson et al. 1992). Indigenous snack foods made of sweetpotato have been very common especially in Java. Fried and sweetened snacks is usually the product of household industries. Small and traditional markets sell their products together with other traditional snack foods. In Java these snack foods include *kremes* and fried sweetpotato chips.

The market for sweetpotato snack is not large. A food store in Cianjur, for example, sells fried and sweetened sweetpotato chips for Rp 3,000/kg. On average, according to the shop owner, the daily sales are less than 3 kg. Market for sweetpotato-derived sweetened snack foods is low. With poor packaging and performance, they face fierce competition with other modern processed food. Large demand for sweetpotato comes from large-scale processing industries and exporters. PT Siantar Top, for example, can process 80-100 of sweetpotato per day. Sweetpotato crackers, cubes, chips, and flour seem to be the most important products of this company. Some of these products are exported to Japan. But some of these are also available in the domestic market (Gunawan, Wheatley and Irfansyah 1995).

Estimates of the total demand for sweetpotato by food industries vary widely, from 2,000 t/year by Damardjati et al. (1990) to 500,000 t/year by Gunawan, Wheatley and Irfansyah (1995). Damardjati et al. (1990) attempted to carry out a comprehensive survey of sweetpotato processors, but may have under-estimated total processing demand by missing some important sources of processing demand, especially by small- and medium-scale processors. Furthermore, processors are often reluctant to divulge accurate information on their processing capacity and costs (Heriyanto 1995). Gunawan, Wheatley and Irfansyah (1995) estimated sweetpotato processing use by taking the difference between the quantity of sweetpotato food availability estimated in national food balance sheets (approximately 2 million t/year) and the quantity of at-home fresh sweetpotato consumption reported in national household consumption surveys (approximately 1.5 million t/year). However, this approach is likely to overestimate the quantity available for processing because: 1) the estimates are sensitive to assumption underlying the food balance sheets; and 2) consumer surveys may tend to underreport fresh sweetpotato consumption (Woolfe 1992). Thus, there is a lack of reliable statistics on sweetpotato use in Indonesia.

New Product Development for Sweetpotato

Sweetpotato is a versatile crop with significant potential as a raw material in the food, non-food and animal feed industries. Sweetpotato is the world's leading crop in dry matter production per unit area per unit time (Woolfe, 1982). Practically every part of the crop can be used. Its roots can be processed into animal feed ingredients and industrial raw materials such as starch and flour: products with a large and rapidly expanding local and international market. Its leaves can also be processed into feedstuff. China, the world's biggest sweetpotato producer, currently processes 60 percent of its sweetpotato production.

For animal feed, the nutritional content of sweetpotato roots and vines are as good as or better than other feed crops such as cassava and corn. But up to now, sweetpotato is not commonly used as feed in Indonesia because feed costs are lower using other feed crops.

Flour for bread and bakery products is one of the most promising products of sweetpotato in the future. Uses of sweetpotato flour are becoming more diversified and broader, including those for the export market. Sweetpotato flour can be used as composite flour in making cakes, pies, breads, etc. So far, there are several promising sweetpotato clones that have great potential for flour or starch production, such as AB 94001.8, Binoras Op 95-2, and Cangkuang for their high yield potentials (> 25t/ha) and high dry matter contents (> 30% DM) (Jusuf et al. 1999 and table 6).

Starch for food and industrial products is another growing market for sweetpotato. Sweetpotato starch can be used to make cookies, cakes, jam, sweets, and desserts, and extruded products such as noodles and snack foods. Starch may be further processed to improve the texture of food products.

Various products that may not be derived from sweetpotatoes can use sweetpotato starch as a source of carbohydrate for the hydrolysis process. In this process, sweetpotato starch is transformed into sugar, alcohol, and acid. The products from this process include glucose, alcohol, citric acid beverages, and ice cream. Other sources of starch can be used equally well for this process and as such, the demand for sweetpotato starch for hydrolysis depends on the relative cost of starch among crops such as sweetpotato, cassava, and maize. Studies on sweetpotato starch processing technology have been carried out.

Based on current export-oriented processing factory (Thailand, Philippines) buying prices, it is estimated that sweetpotato roots must be produced at a cost lower than US$ 40/ton if its use for starch processing can be achieved on an internationally competitive basis against other raw materials such as maize and cassava. With improved varieties that yield high dry matter, this optimum production cost can be achieved in Indonesia. There is potential to select varieties with specific starch properties for particular end uses.

Selection for early maturity

Thirteen clones were evaluated in low and medium elevations in Blitar and Malang in 2001 to select sweetpotato clones which can be harvested in less than four months at low elevation and in less than five months at medium elevation (table 4). This trial was a collaborative research project with CIP-ESEAP. Results indicated that at low elevation, clones BB 97020-1 and BB 96001-2 produced significantly higher yields compared with Sukuh and Jago. The yield of BB 97020-1 months at low elevation (Blitar) at 3, 4 and 5 months was 15.7, 19.2, and 22.3 t/ha, respectively. BB 96001-2 produced tuber yields of 12.8, 17.2, and 26.0 t/ha respectively at 3, 4 and 5 months.

At medium elevation (Tumpang), clone BB 97020-1 outyielded Sukuh and Jago varieties BB 97070-5 at 4 and 5 months. The fresh tuber yield of BB 97020-1 was 17.3 and 18.6 t/ha at 4 and 5 months, respectively. Clone BB 97070-5 produced 16.5, 19.0, and 31.6 t/ha at 4, 5, and 6 months, respectively.

From an organoleptic taste test it was found that clone BB 97020-1 was better accepted than Sukuh or Jago. BB 97070-5 had a similar to the two checks.

Evaluation of sweetpotato clones for drought

Fifteen sweetpotato clones were evaluated for yield and drought tolerance at three locations (Muneng, Ngale, and Kendalpayak) in 1999 (table 5). Results indicated that Sari (improved variety) and Ir. Melati (Local variety) produced good yields under limited water resources.

The average yields of the varieties at limited drainage in Muneng, Ngale, and Kendalpayak were 0.59, 10.57, and 12.38 t/ha, respectively, while under optimum drainage, their yields were 3.79, 14.17, and 14.04 t/ha, respectively. The average yields of Sari variety at limited drainage were 1.15, 17.82, and 24.63 in Muneng, Ngale, and Kendalpayak, while under optimum drainage, its average yields in the three locations were 11.02, 25.92, and 25.60 t/ha respectively.

Evaluation for flour production of sweetpotato clones/varieties

Four sweetpotato varieties/clones were evaluated for their flour production in Malang (700 m asl) at 4, 4.5, and 5 months (table 6). Results indicated that the highest flour production was achieved by Sukuh variety at five months. Flour production of the other varieties were 7.41, 7.32, and 7.17 for Binoras Op 2, Jago, and Cangkuang, respectively. The average flour production at 4, 4.5, and 5 months were 4.18, 6.54, and 8.12 t/ha, respectively. Sukuh produced more flour than the other four varieties because of its higher yield and dry matter content.

Promising sweetpotato clones

Regional yield trials were conducted in five sweetpotato central production areas in East Java during the dry season of 2001 to determine the adaptation and yield stability of 13 promising clones. Results indicated that four clones outyielded the improved variety (Cangakuang) and the local check. Of the four clones, two of them produced average yields of more than 30 t/ha. These two clones are MSU 163-9 and MIS 547-22. Clones MSU 163-9 had a yield range of 23.2 - 39.5 t/ha, with a yield average of 31.6 t/ha and tolerance to scab disease. MIS 547-22 had a yield range of 22.8 - 40.7 t/ha, with a yield average of 31.8 and tolerance to drought.

Improving nutritional quality

Carotene and protein

Initially, RILET scientists emphasized the development of dessert type cultivars, with high carotene and protein contents, and are adapted to the tropical environment. Clones were subsequently developed with over 9 mg carotene/100 g fresh weight and more than 7 percent protein on a dry weight basis.

Dry matter content

High dry matter content is required in the yellow- or white-fleshed clones for staple, feed, and industrial uses. Swetpotato cultivars with high dry matter content have better marketing appeal for feed and starch extraction. Progress has been attained to raise the dry matter content and yield of new RILET selections.

Screening for processing quality

The important root characteristics that are used to screen varieties for processing are root yield, flesh color, root texture, and dry matter, starch, sugar, and protein contents. For sweetpotato processed into catsup and dehydrated sweetpotato (Delicious SP), color and texture of the roots are the important selection criteria. Yellow orange to dark orange roots with texture close to VSP 1 (check variety) are considered in the selection. For starch and flour processing, varieties will be selected based mainly on dry matter and starch contents.

Several clones have already been selected for specific processing uses. Many clones introduced from CIP were found to be suitable raw materials for sweetpotato-based products.

Improving sweetpotato scab tolerance

Scab resistance research was initiated because of the importance of the disease and the requirement for resistant lines in tropical countries. Several screening tests have confirmed some resistant cultivars. Cultivars Cangkuang and Muara Takus have been used as sources of resistance in the RILET program. AVRDC pathologists have already developed a suitable method for *in vitro* propagation of the disease scoring method. Seedling screening techniques and screening of segregating populations are being improved further. The current pedigree emphasizes recombination between indigenous cultivars and exotic progenitors. With high dry matter as a prerequisite, secondary traits dealing with biotic and abiotic stresses are being incorporated during the selection process in target agroecological areas.

Few countries in the target areas have a well-established sweetpotato research program. It is essential to implement and strengthen the regional trial system and sweetpotato network among these countries. The network has to integrate regional multidisciplinary sweetpotato research activities involving national agricultural research systems, non-government organizations, and international research centers.

Screening for resistance to weevil and scab

Two polycross nurseries with 26 and 16 parents, respectively, were established for screening for weevil and scab resistance. From 1996 to 2001, a total of 12,154 seeds were collected and 25,794 genotypes were evaluated in the field for resistance to weevil and scab. Under field conditions, a total of 60 genotypes were rated as moderately resistant to weevil. In the forced feeding experiment however, all were susceptible. Results of the field screening and forced feeding experiments showed that the available resistance from the germplasm is very low. This available resistance may prove useful when used with other IPM components for weevil.

For scab resistance screening, a high level and relatively stable resistance was observed in F1 progenies even under high inoculum pressure. Entries rated resistant in the field remained resistant under artificial inoculation and this proves the stability of resistance.

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Table 1. Sweetpotato varieties officially released in Indonesia since 1980

No	Official variety name	Year of Release	NARS breeder and institution	Source of material Country/institution	Year of first use in NARS	Related to CIP Yes or No	CIP number
1	Sukuh	2000	M. Jusuf, RILET	Indonesia, CIP	1996	Yes	AB 94001-8
2	Jago	2000	M. Jusuf, RILET	Indonesia, CIP	1996	Yes	B 0053-9
3	Kidal	2000	M. Jusuf, RILET	Phillipines, SAPRAD	1993	No	
4	Sari	2000	Rahayuningsih, RILET	Indonesia, RILET	1995	No	
5	Boko	2000	Rahayuningsih, RILET	Indonesia, RILET	1995	No	
6	Cangkuang	1998	M. Jusuf, RILET	Indonesia, CIP	1994	Yes	
7	Sewu	1998	M. Jusuf, RILET	Indonesia, SARIF	1994	No	
8	Muara Takus	1994	M. Jusuf, RILET	Indonesia, BORIF	1990	No	
9	Kalasan	1989	Sriwidodo, MARIF	Taiwan, AVRDC	1983	No	
10	Mendut	1987	Yudi Widodo, MARIF	Nigeria, IITA	1982	No	
11	Prambanan	1984	Wargiono, BORIF	Not Known	1978	No	
12	Borobudur	1984	Wargiono, BORIF	Not Known	1978	No	
13	Daya	1982	Wargiono, BORIF	Not Known	1976	No	
14	Gedang	1982	Wargiono, BORIF	Not Known	1976	No	

Table 2. Characteristics of some sweetpotato varieties released in Indonesia

Variety	Cangkuang *)	Sewu *)	Kidal	Sukuh *)	Jago *)	Sari	Boko
Promising clones	SRIS 226 Op 95	I 1186 = Daya-6	Inaswang Op 95-6	AB 94001-8	B 0053-9	MIS 104-1	MIS 146-1
Year released	1998	1998	2000	2000	2000	2000	2000
Skin color	Red	Dark Yellow	Dark Yellow	Yellow	Light Yellow	Red	Dark Red
Flesh color	Light Yellow	Orange	Red	White	White	Orange	Light Yellow
Dry matter (%)	30.7	27.7	31.0	35.0	33.0	31.6	32.5
Fiber content (%)	1.13	1.03	1.07	0.85	1.09	-	-
Protein content (%)	1.32	1.59	1.62	1.62	1.50	1.91	1.73
Total sugar (%)	4.56	4.5	4.82	4.56	4.26	5.23	4.69
Vitamin C (mg/100 gr)	22.31	27.3	20.22	19.21	20.65	21.52	30.89
Beta carotene (mkg/100 gr)	14.6	14.05	347.84	36.59	84.99	380.9	108.1
Fresh yield (t/ha)	30 - 31	28.5 - 30	25 - 30	25 – 30	25 - 30	30 - 32	25 - 30
Specification	High yield, good root shape, R to scab, MR to Cercospora	High yield, good root shape, MR to scab, MR to Cercospora	High yield, high beta carotene, R to scab, R to Cercospora, fresh consumption	High yield, high dry matter, for starch/flour, MR to scab, MR to Cercospora	High yield, high dry matter, for starch/flour, MR to scab, MR to Cercospora	High yield, high beta carotene, R to scab, MR to Cercospora	High yield, good root shape, R to scab, MR to Cercospora

*) Involvement of CIP - ESEAP

Table 3. Sweetpotato breeding activities and priorities in Indonesia

Breeding activities	Before 2002	After 2002
A. Breeding for tolerance to abiotic stress		
a. Drought	****	*****
b. Acid soil	*	**
c. Shading	***	***
d. Cold temperature	*	****
e. Low radiation	*	*
B. Breeding for tolerance to biotic stress		
a. SP Weevil	****	***
b. Scab	***	*****
c. Viruses	*	**
d. Nematodes	*	**
C. Breeding for developing SP varieties for specific uses and traits		
a. Dry matter	****	****
b. Beta carotene	*	****
c. Anthocyanin	*	*****
d. Protein	*	***
e. Vitamin C	*	*
f. Early maturity	**	***
g. Plant type	*	**

* = Lower Priority ***** = Highest Priority

Table 4. **Organoleptic test scores of early maturing sweetpotato clones in advanced yield trials in Blitar, East Java, during dry season 2001**

No Plot	Clones / Varieties	SCORE						
		Flesh color	Texture	Fiber	Taste	Sweetness	General Acceptability	Rata-rata
1	BB 97020-1	4.1	4.5	4.1	4.1	3.5	3.5	4.0
2	BB 97019-7	3.9	4.2	3.8	3.3	3.1	3.6	3.7
3	BB 96621-6	3.5	3.5	3.5	3.4	3.7	3.5	3.5
4	BB 97063-9	2.8	3.2	3.6	3.8	3.9	3.7	3.5
5	BB 97026-1	3.0	2.5	2.6	2.1	2.5	2.5	2.5
6	BB 96609-7	4.8	4.5	4.8	4.9	4.7	4.9	4.8
7	BB 97019-6	3.4	3.5	3.1	3.3	3.3	3.3	3.3
8	BB 96618-4	2.7	2.0	1.5	2.1	2.2	2.1	2.1
9	BB 97011-3	3.1	3.4	3.5	3.7	3.8	3.6	3.5
10	BB 96001-2	2.4	3.1	3.1	3.4	3.3	2.8	3.0
11	BB 97070-5	3.8	4.0	3.6	3.5	3.5	3.6	3.7
12	BB 96611-4	4.1	3.3	3.5	3.6	3.5	3.6	3.6
13	BB 97017-5	3.7	3.5	3.7	3.4	3.2	3.5	3.5
14	CIP 2	3.4	3.5	3.6	3.5	3.5	3.5	3.5
15	CIP 1	3.4	3.5	3.9	3.9	3.9	3.7	3.7
Mean		3.47	3.48	3.46	3.47	3.44	3.43	-
CV (%)								
LSD 0.05								

Note: Score 1 = least preferred. 2 = less preferred. 3 = moderately preferred. 4 = preferred. 5 = most preferred.

Table 5. Fresh root yields of drought-tolerant sweetpotato clones in three locations during dry season 1999

No	Clone/varietas	Produksi Umbi Segar (t/ha)						Rata-rata	Rasa
		Muneng		Ngale		Kendalpayak			
		A	B	A	B	A	B		
1	AB 94001-8	1.30	6.54	18.66	18.83	11.34	24.84	13.59	Enak
2	Binoras-2	1.44	3.75	10.24	17.63	8.38	15.10	9.18	Sedang
3	Inaswang Op 95-6	0.85	4.26	11.73	17.05	12.55	13.37	9.95	Enak
4	B 0053-9	0.23	0.74	6.25	9.78	4.64	5.19	4.47	Sedang
5	MLG 12588-1	1.35	6.51	11.94	15.37	7.65	5.94	9.12	Sedang
6	MIS 104-1	1.15	11.02	17.82	25.92	24.63	25.60	17.69	Sedang
7	MIS 110-1	0.18	5.91	10.86	17.03	10.59	12.32	9.48	Sedang
8	MIS 159-3	0.41	0.73	12.87	17.23	13.20	16.05	10.00	Sedang
9	IR Melati	1.58	9.74	12.93	15.57	20.93	28.58	14.88	Kurang enak
10	Muara Takus	0.26	2.08	6.35	7.73	11.67	8.39	6.08	Enak
11	MIS 146-1	0.17	3.11	10.40	12.49	10.19	13.35	8.29	Enak
12	Cangkuang	1.06	5.16	11.60	17.57	15.90	19.32	11.76	Enak
13	ST 18	0.65	1.16	5.94	5.89	9.28	7.69	5.10	Sedang
14	MLG 12659-4	0.45	4.18	4.64	5.75	-	-	3.75	Sedang
15	Ungu Kawi	0.45	2.90	6.43	8.73	-	-	4.65	Enak
	Rata-rata	0.59	3.79	10.57	14.17	12.38	14.04	9.19	-

A: Limited Water Application
B: Optimum Water application

Table 6. Fresh yield,. dry matter content and flour production of sweetpotato clones at different maturity periods in Tumpang, East Java (700 m asl) in 1998

Remarks	Clone/variety				Mean
	AB 94001-8	Binoras Op 95-6	B 0053-9	Cangkuang	
Maturity = 4 months					
Fresh yield (t/ha)	12.3	10.9	15.4	11.5	12.5
Dry matter content (%)	36.0	35.5	32.0	30.5	33.5
Flour yield (t/ha)	4.43	3.86	4.93	3.50	4.18
Maturity = 4.5 months					
Fresh yield (t/ha)	18.8	17.2	22.1	21.2	19.8
Dry matter content (%)	37.5	35.0	30.0	30.5	33.3
Flour yield (t/ha)	7.05	6.02	6.63	6.47	6.54
Maturity = 5 months					
Fresh yield (t/ha)	28.2	22.8	24.0	23.1	24.5
Dry matter content (%)	37.5	32.5	30.5	31.0	32.9
Flour yield (t/ha)	10.58	7.41	7.32	7.17	8.12