

CASSAVA BREEDING AND VARIETAL DISSEMINATION IN VIETNAM FROM 1975 TO 2000

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ABSTRACT

Cassava breeding and varietal dissemination in Vietnam initiated in 1975 after Vietnam was unified. The cassava program in Vietnam began to cooperate closely with CIAT and became part of the Asian Cassava Research Network in 1988. Thanks to the introduction of new high-yielding varieties from Thailand and the adoption of improved cultural practices, cassava production in Vietnam has made remarkable progress. Before 1985, Gon, H34 and Xanh Vinh Phu were the most popular cassava varieties. Between 1986 and 1993, HL20, HL23 and HL24 were selected from a local germplasm collection by Hung Loc Agricultural Research Center (HARC) and these varieties have been grown extensively in South Vietnam, with areas of about 70,000 to 80,000 ha planted annually to these varieties. More recently, the Vietnam Cassava Research and Extension Network, working in close collaboration with CIAT, Vedan Vietnam Enterprise Corp. Ltd. and other cassava processing factories, obtained further achievements, especially in the area of breeding and varietal dissemination. Six new high-yielding varieties were recommended and disseminated for production during 1993-1999; these are KM94, KM60 and SM937-26 (three high-starch and high-yield varieties for industrial processing), and KM98-1, KM95-3 and KM95 (three multipurpose varieties suitable for food, feed and processing, with early harvestability and an extended harvest time). The growing areas of KM94 and other new improved varieties were about 60,000 ha in the crop year 1999/2000. The high-yield/high-starch varieties have brought to the producers additional benefits of about 787 billion Vietnamese dong (US\$ 60.78 million) during the six years from 1994 to 1999 in five provinces: Dong Nai, Binh Phuoc, Binh Duong, Tay Ninh and Ba Ria-Vung Tau. More than one half of the additional benefits went directly to cassava farmers; the rest was shared among cassava processing factories and traders.

At present, Vietnam has a large and promising cassava germplasm collection. In the future, new varieties will be developed in order to satisfy the demand for higher production and additional processing. The present research direction is to develop high-starch and high-yield varieties by introducing new breeding materials, crossing and applying biotechnology in breeding; to multiply planting material of new varieties; and to enhance the adoption of sustainable cassava production practices.

1. INTRODUCTION

Vietnam has become one of the major cassava producing countries in Asia. The total capacity of cassava processing factories is about 1,080 tonnes of dry starch/day (**Figure 1**). With the development of the processed food, feed and pharmaceutical

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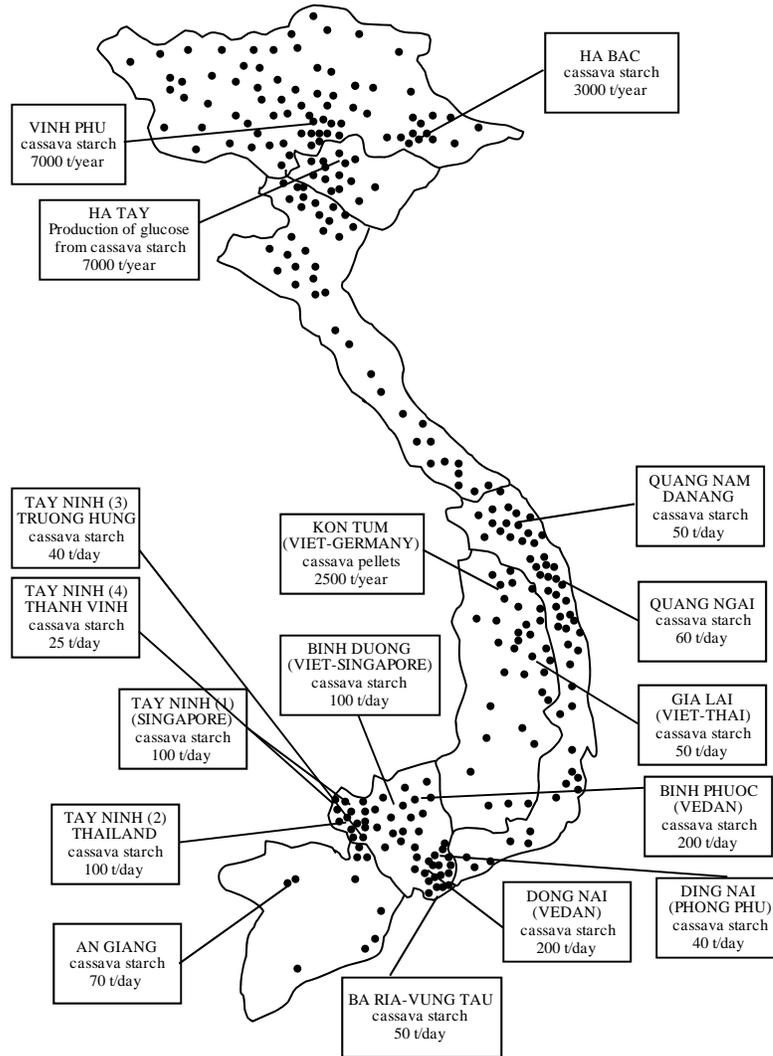


Figure 1. Cassava production and processing areas in Vietnam; each dot represents 1000 ha of cassava in 1997.

Source : Adapted from General Statistical Office 1998 and Projects under Promotion by the State Committee for Cooperation & Investment (SCCI) 1986-1998.

industries, cassava is rapidly changing its role from a traditional food crop to an industrial crop.

Recently, the breeding and dissemination of new cassava varieties have contributed to major improvements in cassava yield and production, especially in South Vietnam. Cassava selection began in 1975, soon after the unification of the country, by collecting and evaluating local germplasm. In 1988, Vietnam began cooperation with CIAT and began taking part in the Asian Cassava Research Network. This cooperation gave Vietnam new opportunities of germplasm material introduction for the cassava varietal improvement program. The objectives of cassava breeding in the last decade were:

1. Selection and development of high starch yield varieties for industrial processing, and
2. Selection of sweet cassava varieties with short duration and having an extended harvest time and high starch yield for human consumption.

Toward the 21st century, the Vietnam cassava breeding program will focus on crossing and introducing promising materials as well as applying bio-technology in breeding.

2. MATERIALS AND METHODS

2.1 Materials

Vietnam cassava breeding activities have been conducted mainly at Hung Loc Agricultural Research Center (HARC), belonging to IAS in Ho Chi Minh city; by the Root Crop Research Center (RCRC), belonging to VASI in Hanoi; and by Agro-forestry College of Thai Nguyen Univ. (TNU), Thai Nguyen city. About 128 accessions of cassava germplasm are maintained at VASI (Nguyen Thuc Nhan *et al.*, 1996) and about 72 accessions at HARC (Hoang Kim *et al.*, 2000). A total of 74,718 F₁ hybrid seeds were introduced, 48,895 seeds from CIAT/Colombia and 23,180 seeds from the Thai-CIAT program. The Vietnam Cassava Program also produced 2,643 seeds (**Table 1**).

At present, KM94 (the Thai variety Kasetsart 50) is the most popular new variety. Two other varieties that can be used for industrial processing are SM937-26 and KM60 (Rayong 60). Three varieties for multipurpose use are KM95, KM95-3 and KM98-1. Besides the good varieties that have been selected and released, other promising breeding materials are continuously being introduced in the form of sexual seed from CIAT/Colombia and the Thai-CIAT program, in order to strengthen the Vietnam National Cassava Breeding Program.

2.2 Methods

Establishment of the National Cassava Research and Extension Network

At HARC in Dong Nai province there are ten cassava breeding experiments conducted every year, including two Standard Yield Trials (SYT₁ and SYT₂), three Preliminary Yield Trials (PYT₁, PYT₂ and PYT₃), three Observational Yield Trials (OYT₁, OYT₂, OYT₃), one F₁ Seedling Trial (F₁ST) and one trial to maintain the cassava germplasm. At RCRC in Hanoi and in TNUAF in Thai Nguyen city, similar trials are

being conducted. In addition, 18-25 Regional Yield Trials (RYT) are conducted every year in different cassava producing provinces in collaboration with provincial and district extension offices (**Figure 2**). Results of these experiments are presented and discussed during the annual Vietnam Cassava Workshops that have been held in Ho Chi Minh city since 1991.

Table 1. Cassava germplasm of Vietnam in 1999.

| Cassava germplasm | Number of clones |
|---|--|
| <i>Collection of cassava germplasm</i> | |
| - at VASI | 128 |
| - at IAS | 72 |
| <i>Number of cassava F1 hybrid seeds received between 1975 and 1999</i> | |
| - from CIAT/Colombia | 74,718 |
| - from the Thai-CIAT program | 48,895 |
| - from Vietnam cassava program | 23,180 |
| - from Vietnam cassava program | 2,643 |
| <i>Varieties released</i> | |
| - varieties for industrial processing | KM94 SM937-26; KM60 |
| - varieties for direct human consumption | KM95, KM95-3, KM98-1 |
| <i>Promising varieties being tested in regional yield trials</i> | |
| - varieties for industrial processing | OMR34-11-43 OMR34-18-11 OMR34-35-34 |
| - varieties for direct human consumption | KM98-5, KM98-6 SM1447-7; SM1717-12 SM2220-11; SM1862-6 SM1868-1; SM2060-7 |

Methods of evaluation. These were standardized for the whole network: the SYT are conducted with plots of 50 m² and 4 replications in RCBD; the PYT with plots of 40 m² and 3 replications in RCBD. The planting density is 10,000 plants/ha (1x1 m) and fertilizers are applied at the rate of 80 kg N + 60 P₂O₅ + 80 K₂O/ha. CIAT and IBPGR methods are used for data collection and evaluation. Starch content is measured by the Reihmann scale. The IRRISTAT statistical program is used for data analysis.

Establishment of Demonstration Fields and On-Farm Research (OFR). The methods used were presented at the 5th Regional Cassava Workshop (Hoang Kim *et al.*, 1998). Funding for those activities was provided by: 1) the provincial Agricultural Extension budget; 2) Investment of processing factories for expanding the areas producing raw material; 3) Agricultural and Rural Development Programs; and 4) the network of advanced cassava farmers.

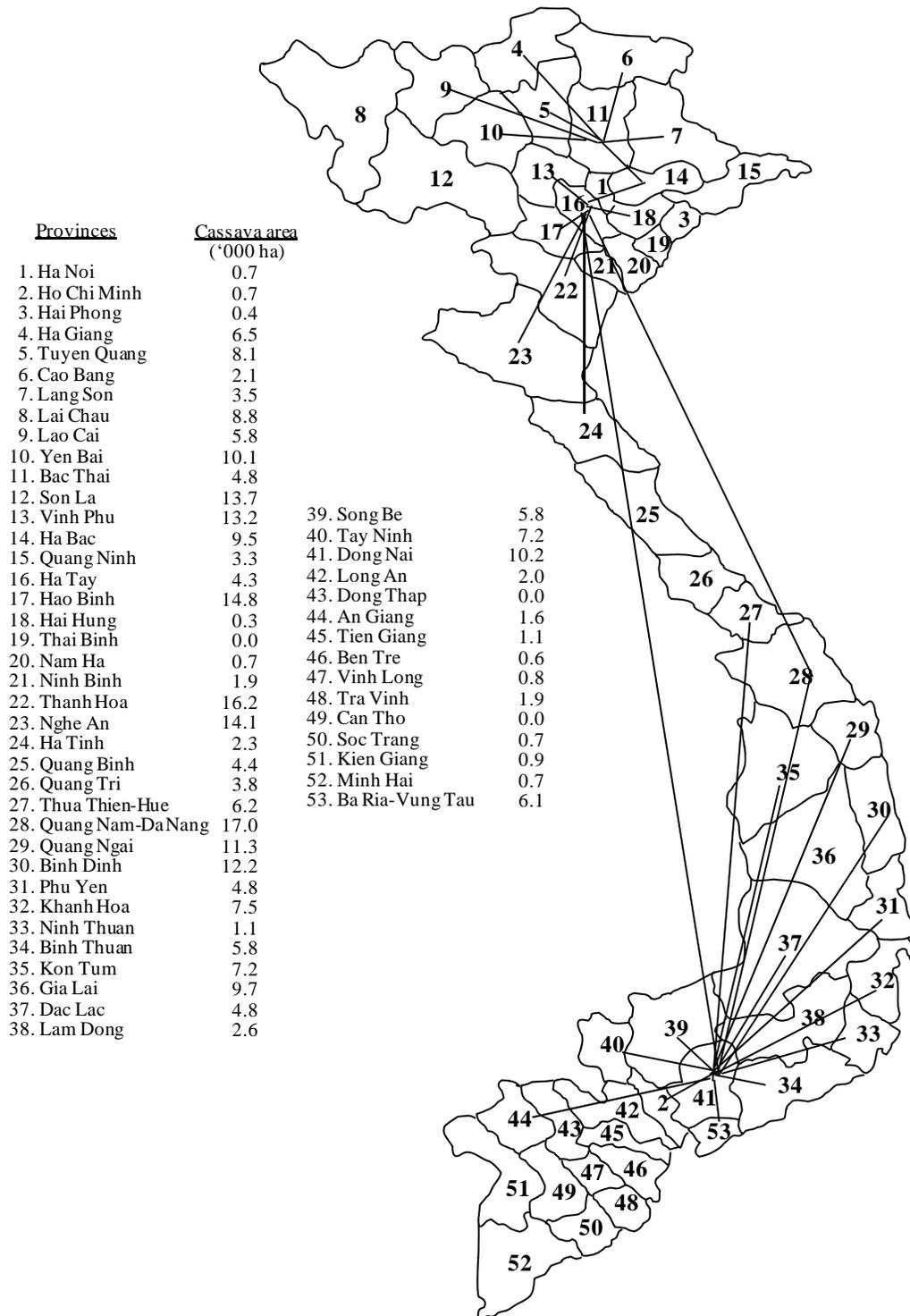


Figure 2. The research and technology transfer network for cassava development in Vietnam.

Applying Ten Mutual Link-up Extension Activities (ten Ts) with investment of processing factories, especially Vedan Vietnam Enterprise Corp. Ltd., for the expansion of areas that will produce raw materials. The extension methodology used by IAS can be summarized by the following ten words starting with the letter T (in Vietnamese):

- | | |
|---|-----------------------------------|
| 1) Thu nghiem | (Trials) |
| 2) Trinh dien | (Demonstrations) |
| 3) Tap huan | (Training) |
| 4) Trao doi | (Exchange) |
| 5) Tham vieng | (Farmer tours) |
| 6) Tham quan hoi nghi dau bo | (Farmer field days) |
| 7) Thong tin tuyen truyen | (Information, propaganda) |
| 8) Thi dua | (Competition) |
| 9) Tong ket khen thuong | (Recognition, price and reward) |
| 10) Thanh lap mang luoi nguoi nong dan gioi | (Establish good farmers' network) |

Using the above mentioned approach, new cassava varieties were quickly accepted by farmers and were widely adopted.

Vedan Vietnam Enterprise Corp. Ltd., the biggest cassava processing company in Vietnam, has contributed the following: 1) Investment in the production and dissemination of new planting materials of high-yield varieties and of liquid fertilizer (Vedagro) to farmers; 2) Establishment of a support price (for example: factory gate price of fresh roots with 25% starch content: 300 VND/kg in 1998-2000); 3) Sponsorship of the Vietnam annual cassava workshops and the publishing of cassava documents; 4) Support of cassava breeding activities and cassava sustainable production techniques in raw material producing areas.

3. RESULTS AND DISCUSSION

3.1 Progress in Cassava Breeding and Varietal Development

Before 1985, Gon, H34 and Xanh Vinh Phu were the most popular cassava varieties in Vietnam (Tran Ngoc Ngoan *et al.*, 1996). From 1986 to 1993, HL20, HL23 and HL24 were selected from the local variety collection by Hung Loc Agricultural Research Center (HARC) and these varieties were grown extensively in South Vietnam with annual areas of about 70,000 to 80,000 ha.

In recent years, the Vietnam Cassava Research and Extension Network has been closely collaborating with CIAT, Vedan Vietnam Enterprise Corp. Ltd. and other cassava processing factories to improve its development of cassava, especially in breeding and varietal dissemination. Six new high-yield varieties were recommended and disseminated for production during 1993-1999 (**Table 2**).

Three high-yield and high-starch varieties for industrial processing are KM94, KM60 and SM937-26. Three multi-purpose use varieties suitable for food, feed and processing, with early harvestability and having extended harvest times are KM98-1,

KM95-3 and KM95 (**Table 2**). These varieties were extensively tested and selected mainly for their high yields and high dry matter and starch contents (**Tables 3 and 4**).

The growing area of KM94 and other new improved varieties was about 60,000 ha in the crop year 1999/2000.

Table 2. Background and outstanding characteristics of six released varieties

| Variety | Year released | Background and outstanding characteristics |
|----------|---------------|---|
| KM60 | 1993 | Originally named Rayong 60, was introduced from the Thai-CIAT program in 1989. High fresh yield. Recommended for early harvesting. Excellent agronomic traits. Good root shape, but flesh color is slightly yellow. |
| KM94 | 1995 | Originally named MKUC 28-77-3 (Kasetsart 50), was introduced from the Thai-CIAT program in 1990. High yield and high starch content. Good root shape and white flesh. Good stake quality. Tolerant to major pests and diseases. Well adapted to unfavorable conditions. |
| SM937-26 | 1995 | Originally named SM937-26, was introduced from the Thai-CIAT program in 1990; High fresh yield and high starch content. Good root shape and white flesh. Good plant type. Good stake quality. |
| KM95 | 1995 | Selected from F ₁ hybrid seeds introduced from the Thai-CIAT program in 1991 (originally named OMR33-17-15). High fresh yield. Early harvestability. Multi-purpose use for direct human consumption, feed and processing. Good root shape and white flesh. |
| KM95-3 | 1998 | Selected from F ₁ hybrid seeds introduced from the Thai-CIAT program in 1992 program (originally named SM1157-3). High fresh yield. Early harvestability. Multi-purpose use for direct human consumption, feed and processing. Good plant type. Good stake quality. |
| KM98-1 | 1999 | Selected from F ₁ hybrid seeds introduced from the Thai-CIAT program in 1995 (pedigrees Rayong 1 x Rayong 5). High fresh yield. Early harvestability. Multi-purpose use for direct human consumption, feed and processing. Good root shape and white flesh. Good plant type. |

Table 3. Results of Regional Yield Trials conducted by Hung Loc Agricultural Research Center in Central and South Vietnam (1997-1998).

| No. of trials | Variety | Growing period (months) | Dry root yield (t/ha) | Fresh root yield (t/ha) | Root dry matter content (%) | Root starch content (%) | Harvest index |
|---------------|---------|-------------------------|-----------------------|-------------------------|-----------------------------|-------------------------|---------------|
| 18 | KM94 | 9-11 | 15.9 | 39.6 | 40.2 | 28.9 | 0.58 |
| 15 | KM98-1 | 7-10 | 14.9 | 38.4 | 38.8 | 27.8 | 0.66 |
| 14 | KM60 | 7-10 | 11.7 | 30.2 | 38.7 | 27.4 | 0.56 |
| 18 | HL23 | 8-12 | 8.6 | 23.7 | 36.3 | 25.4 | 0.53 |

Source: Hoang Kim et al., 2000.

Table 4. Comparison of average root yields of new cassava varieties with those of local variety in FPR trials¹⁾ at Thai Nguyen province in 1998.

| Variety | Dry root yield (t/ha) | Fresh root yield (t/ha) | Root dry matter content (%) | Relative dry root yield (%) |
|---------------|-----------------------|-------------------------|-----------------------------|-----------------------------|
| SM1717-12 | 10.00 | 25.44 | 39.5 | 154 |
| CM4955-7 | 9.60 | 24.62 | 39.0 | 148 |
| KM94 | 9.10 | 21.91 | 41.5 | 140 |
| KM60 | 8.26 | 20.40 | 40.5 | 128 |
| KM95-3 | 7.28 | 18.45 | 39.5 | 112 |
| Xanh Vinh Phu | 6.50 | 16.89 | 38.5 | 100 |

¹⁾14 farmers x 6 varieties

Source: Tran Ngoc Ngoan and Kawano, 2000.

The high-starch yield varieties have provided the producers with higher benefits of about VND 787.50 billion (US\$ 60.78 million) during six years (1994-1999) in five southern provinces of Dong Nai, Binh Phuoc, Binh Duong, Tay Ninh and Ba Ria-Vung Tau (Table 5). More than one half of the additional benefits went directly to cassava farmers' income. The rest was shared among cassava processing factories and traders.

3.2 Recent Results of Cassava Breeding 1998-1999

HARC has recommended two sets of cassava varieties, i.e. SYT₁ and SYT₂ for national evaluation in 1998/99 (Tables 6 and 7). In addition, KM98-1 was released as a new variety for production in 1999 by the Ministry of Agriculture and Rural Development (MARD). Other new promising varieties/lines are being tested and selected (Hoang Kim et al., 2000).

Table 5. Estimated monetary gains from the adoption of new cassava varieties in five provinces of Dong Nai, Binh Duong, Binh Phuoc, Tay Ninh, Ba Ria-Vung Tau during six years from 1994 to 1999.

| Year | Total area of new cassava varieties ('000 ha) ¹⁾ | Increases in yield and starch content vs HL23 | | Monetary gain (million VND/ha) | | Total monetary gain ⁶⁾ from planting new varieties (billion VND) |
|--------------|---|---|---------------------------------------|--|--|---|
| | | Fresh root yield (t/ha) ²⁾ | Root starch content (%) ³⁾ | From higher fresh root yield ⁴⁾ | From higher starch content ⁵⁾ | |
| 1994 | 2.75 | + 8.0 | + 2.5 | 2.67 | 1.59 | 11.71 |
| 1995 | 9.68 | + 9.5 | + 3.0 | 4.55 | 1.58 | 60.45 |
| 1996 | 27.36 | + 10.3 | + 3.3 | 2.84 | 1.86 | 128.59 |
| 1997 | 24.57 | + 9.6 | + 2.9 | 3.80 | 1.83 | 138.33 |
| 1998 | 36.68 | + 10.5 | + 3.0 | 4.18 | 1.75 | 217.50 |
| 1999 | 42.45 | + 9.8 | + 3.2 | 3.57 | 1.87 | 230.92 |
| Total | | | | | | 787.50 |

¹⁾Provincial Statistics Office (1994-1999).

²⁾Means from survey on large plot trials in South East Region Fresh root yield of local varieties about 12 t/ha, KM60 about 20 t/ha, KM94 about 22-24 t/ha.

³⁾Root starch content of cassava varieties at Vedan factory: HL23 about 24-25%; KM60 about 27-28%, KM94 about 28-30% (Yeh Fang Ten, 1999).

⁴⁾Price of fresh roots (at Vedan factory): 11/1994-5/1995:334 VND/kg; 9/1995-5/1996: 479 VND/kg; 9/1996-6/1997: 276 VND/kg; 9/1997-6/1998: 396 VND/kg; 9/1998-6/1999: 398 VND/kg; 9/1999-2/2000: 345 VND/kg (Yeh Fang Ten, 1999; Tran Vien Thong, 2000).

⁵⁾Cassava starch price (1994-1999): about 240 USD/tonne.

⁶⁾Exchange rate: 1USD=11,040VND (1994); 10,980VND (1995); 11,210VND (1996); 13,170VND (1997); 13,860VND (1998); 13,950VND (1999); 14,030VND (2/2000).

TNU recommended cassava line SM1717-12, which has given a high yield and has a high dry matter content (**Table 8**). This line has been evaluated in FPR trials at Thanh Ba district (Phu Tho province) and Luong Son district (Hoa Binh province) (Tran Ngoc Ngoan and Kawano, 2000). This has now been released under the name KM98-7.

RCRC selected and recommended four new cassava lines SM1862-6, SM1868-1, SM2201-11 and SM2060-7 for on-farm trials and regional yield trials (**Table 9**) (Trinh Phuong Loan *et al.*, 2000).

At present in Vietnam the genetic base of cassava is widening and the yield potential of the breeding population is increasing. **Figure 3** shows the change in the mean of the breeding population (all entry mean in standard yield trials) in terms of fresh root yield and root dry matter content at Hung Loc Agricultural Research Center in Dong Nai province of South Vietnam.

Table 6. Results of the Standard Yield Trials (SYT₁) at HARC in 1998/99.

| Variety | Fresh root yield (t/ha) | Dry starch yield (t/ha) | Root starch content (%) | Root dry matter content (%) | Harvest index |
|------------|-------------------------|-------------------------|-------------------------|-----------------------------|---------------|
| KM98-1 | 43.1 cd | 12.41 | 27.8 cd | 38.1 | 0.74 |
| KM98-2 | 39.6 bc | 11.09 | 28.0 cd | 38.3 | 0.59 |
| KM98-3 | 46.9 d | 11.53 | 24.6 b | 36.1 | 0.59 |
| KM98-4 | 42.5 bcd | 9.05 | 21.3 a | 33.7 | 0.58 |
| KM98-5 | 46.0 d | 13.02 | 28.3 cde | 38.8 | 0.58 |
| KM98-6 | 46.9 d | 13.69 | 29.2 de | 39.4 | 0.59 |
| KM94 | 43.5 cd | 12.26 | 28.2 cde | 40.0 | 0.57 |
| KM60 | 38.0 b | 11.25 | 29.6 e | 38.2 | 0.59 |
| HL23 | 25.4 a | 6.98 | 27.5 c | 37.8 | 0.45 |
| CV (%) | 8.1 | | 3.9 | | |
| LSD (0.05) | 4.9 | | 1.6 | | |

Source: Hoang Kim et al., 2000.

Table 7. Results of the Standard Yield Trials (SYT₂) at HARC in 1998/99

| Variety | Fresh root yield (t/ha) | Dry starch yield (t/ha) | Root starch content (%) | Root dry matter content (%) | Harvest index |
|------------|-------------------------|-------------------------|-------------------------|-----------------------------|---------------|
| KM99-1 | 38.3 d-g | 11.45 | 29.9 bc | 40.7 | 0.55 |
| KM99-2 | 41.7 b-e | 12.05 | 28.9 bcd | 39.0 | 0.54 |
| KM99-3 | 39.7 c-g | 12.26 | 28.4 bcd | 38.8 | 0.55 |
| KM99-4 | 42.2 bcd | 11.20 | 28.0 bcd | 38.5 | 0.59 |
| KM99-5 | 37.1 e-h | 11.50 | 31.0 ab | 40.9 | 0.50 |
| KM99-6 | 41.4 b-f | 12.17 | 29.4 bc | 39.7 | 0.49 |
| KM94 | 43.8 abc | 12.74 | 29.1 bcd | 39.1 | 0.56 |
| KM60 | 35.8 gh | 10.63 | 29.7 bc | 40.7 | 0.54 |
| HL23 | 24.1 k | 6.39 | 26.5 b-e | 37.1 | 0.43 |
| CV (%) | 9.01 | | 12.79 | | |
| LSD (0.05) | 4.72 | | 5.12 | | |

Source: Hoang Kim et al., 2000.

Table 8. Results of three Standard Yield Trials conducted at TGUAF in Thai Nguyen province in 1996, 1997 and 1998.

| Variety | Fresh root (t/ha) | | | | Relative root yield (%) |
|---------------|-------------------|------|------|------|-------------------------|
| | 1996 | 1997 | 1998 | Av. | |
| KM94 | 36.7 | 25.8 | 25.7 | 28.3 | 142 |
| SM1717-12 | 31.6 | 24.7 | 26.3 | 27.5 | 139 |
| KM60 | 33.3 | 22.5 | 23.0 | 26.3 | 132 |
| KM95-3 | 23.9 | 21.8 | 22.3 | 22.7 | 114 |
| Xanh Vinh Phu | 22.2 | 17.5 | 19.8 | 19.8 | 100 |

Source: Tran Ngoc Ngoan and Kawano, 2000.

Table 9. Results of the Standard Yield Trials conducted in Thach That district, Ha Tay province in 1998.

| Variety | Fresh root yield (t/ha) | Dry starch yield (t/ha) | Root starch content (%) | Root dry matter content (%) | Harvest index |
|---------------|-------------------------|-------------------------|-------------------------|-----------------------------|---------------|
| SM1862-6 | 19.78 | 8.17 | 23.4 | 41.3 | 0.64 |
| SM1868-1 | 19.17 | 7.46 | 21.7 | 38.9 | 0.57 |
| SM2220-11 | 20.74 | 7.45 | 19.6 | 35.9 | 0.66 |
| SM2060-7 | 18.39 | 6.69 | 18.7 | 36.4 | 0.66 |
| KM95-3 | 22.70 | 8.83 | 21.7 | 38.9 | 0.64 |
| KM94 | 20.56 | 8.70 | 24.1 | 42.3 | 0.71 |
| KM60 | 21.18 | 8.03 | 21.0 | 37.9 | 0.66 |
| Xanh Vinh Phu | 18.90 | 7.01 | 20.4 | 37.1 | 0.60 |
| CV (%) | 12.96 | | | | |
| LSD (0.05) | 2.94 | | | | |

Source: Trinh Phuong Loan et al., 2000.

3.3 Future Research Direction of Cassava Breeding and Varietal Dissemination

Selection and development of high-starch yield varieties are the primary objectives of the global strategy of cassava development (Hershey, 1999). The cassava breeding program is one of the major programs in the Crop and Animal Breeding Project of MARD for 2000-2005 (MARD, 1999).

The future research direction of cassava breeding in Vietnam aims to select varieties with high yield and high starch content and to promote more sustainable production systems by introducing new breeding materials, cross breeding and applying biotechnology to crop improvement.

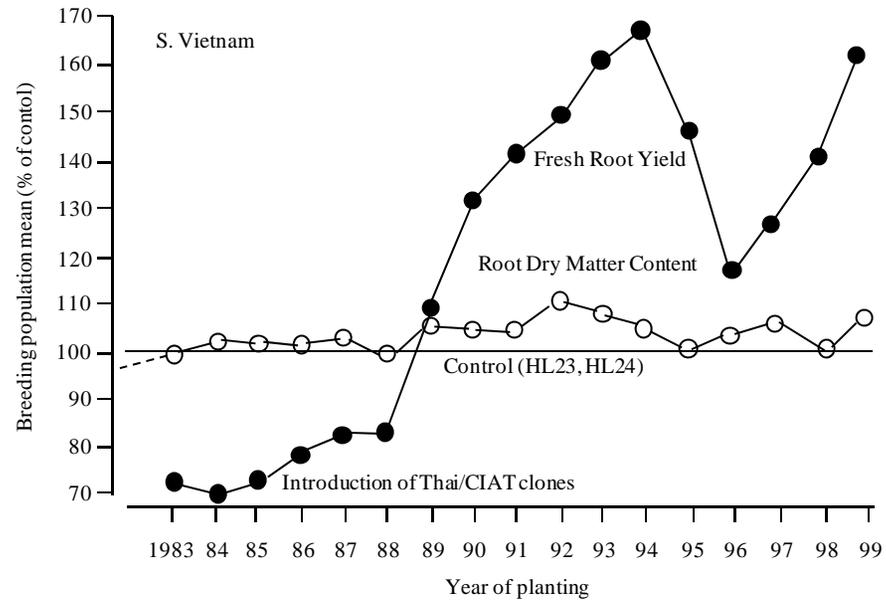


Figure 3. Change in the mean of breeding population (all entry mean in yield trials) in fresh root yield and root dry matter content at Hung Loc Agric. Research Center, South Vietnam.

4. CONCLUSIONS AND SUGGESTIONS

4.1 Conclusions

1. *Cassava breeding and varietal dissemination in Vietnam made considerable progress during the past decade.* In recent years (1993-1999), the Vietnamese Cassava Program (VNCP) cooperated closely with CIAT, Vedan Vietnam Enterprise Corp. Ltd. and other cassava processing factories. The activities of the network were effective in recommending and widely disseminating new cassava varieties. KM94, KM60, SM937-26, KM95, KM95-3, KM98-1 were recommended and released for production.
2. *The contribution of VNCP in the development of cassava production and processing has been significant.* The area planted to KM94 and other new improved varieties reached about 60,000 ha in the crop year 1999/2000. The high starch yield varieties have provided the producers benefits of up to VND 787.50 billion (US\$ 60.78 million) during the past six years (1994-1999) in five provinces, i.e. Dong Nai, Binh Phuoc, Binh Duong, Tay Ninh and Ba Ria-Vung Tau. More than half of the additional benefits went directly to cassava farmers' income. The rest was shared among cassava processing factories and traders.
3. *At present, the cassava germplasm base is widening and new varieties are quite promising.* New varieties will be selected and developed to meet the demand of production and processing in the future.

4.2 Suggestions

1. Continue to cooperate closely with CIAT in the introduction and evaluation of breeding materials and the application of biotechnology in cassava breeding.
2. Find research funding from different sources (MARD, CIAT, Vedan, local and provincial governments, NGO's etc.).
3. Organize workshops, training courses and study tours and exchange germplasm and information with other members of the Asian Cassava Research Network.

5. ACKNOWLEDGEMENTS

The authors wish to express their thanks to MARD, IAS, CIAT, VEDAN, VASI, TNU for helping us carry out the Vietnam Cassava Program. Our thanks are also due to the Department of Science, Technology and Environment of the Department of Agriculture and Rural Development, to Provincial Governments, the Agricultural Extension Centers, Districts and Communes for their assistance in developing the Cassava Breeding Program from 1988 to 1999.

REFERENCES

- Hershey, C. 1999. Report of a Regional Consultation on the Global Cassava Development Strategy, held in Bangkok and supported by the International Fund for Agricultural Development (IFAD), Nov 23-25, 1998. 11 p.
- Hoang Kim, Tran Ngoc Quyen, Pham Van Bien and K. Kawano. 1998. Cassava varietal dissemination in Vietnam. *In*: R.H. Howeler (Ed.). Cassava Breeding, Agronomy and Farmer Participatory Research in Asia. Proc. 5th Regional Workshop, held in Danzhou, Hainan, China. Nov. 3-8, 1996. pp. 82-100.

- Hoang Kim, K. Kawano, Tran Hong Uy, Tran Ngoc Quyen, Vo Van Tuan, Tran and Cong Khanh. 2000. Cassava variety KM 98-1. *In: Progress in Cassava Research and Extension in Vietnam. Proc. Vietnamese Cassava Workshop, held in Ho Chi Minh city. March 16-18, 1999. pp. 62-80. (in Vietnamese with English abstract)*
- Ministry of Agric. and Rural Development (MARD). 1999. The Crop and Animal Breeding Projects of MARD for 2000-2005. (in Vietnamese)
- Nguyen Thuc Nhan, Hoang Kim, Truong Van Ho, Nguyen Thi Sam, Tran Duc Hoang and Nguyen Phung Ha. 1996. Collection of root crops germplasm in Vietnam. *In: Enrique Chujoy (Ed.). Root Crops Germplasm Research in Vietnam. pp. 1-11.*
- Tran Ngoc Ngoan and K. Kawano. 2000. Result of cassava varietal deseminatation and cassava breeding in the Northeast Region of Vietnam. *In: Progress in Cassava Research and Extension in Vietnam. Proc. Vietnamese Cassava Workshop, held in Ho Chi Minh city. March 16-18, 1999. pp. 81-86. (in Vietnamese)*
- Tran Ngoc Ngoan, Tran Ngoc Quyen, Hoang Kim and K. Kawano. 1996. Cassava cultivars and breeding research in Vietnam. *In: R.H. Howeler (Ed.). Cassava Production, Processing and Marketing in Vietnam. Proc. Workshop, held in Hanoi, Vietnam. Oct 29-31, 1992. pp. 49-57.*
- Tran Vien Thong. 2000. Present situation and future potential of cassava in Tay Ninh province of Vietnam. *In: Progress in Cassava Research and Extension in Vietnam. Proc. Vietnamese Cassava Workshop, held in Ho Chi Minh city. March 16-18, 1999. pp 62-80. (in Vietnamese)*
- Trinh Phuong Loan, Tran Ngoc Ngoan, Hoang Van Tat, Dao Huy Chien. 2000. Cassava breeding and varietal improvement in North Vietnam. *In: Progress in Cassava Research and Extension in Vietnam. Proc. Vietnamese Cassava Workshop, held in Ho Chi Minh city. March 16-18, 1999. pp. 86-96. (in Vietnamese)*
- Yeh Fang Ten. 1999. Present situation and future potential of cassava processing and utilization in Vedan Vietnam Enterprise Corp. Ltd. *In: Progress in Cassava Research and Extension in Vietnam. Proc. Vietnamese Cassava Workshop, held in Ho Chi Minh city. March 16-18, 1999. pp. 73-87. (in Vietnamese)*