Deutscher Tropentag 2003
Göttingen, October 8-10, 2003

Conference on International Agricultural Research for Development

Status of under-utilised tuber legumes *Pachyrhizus erosus* (Yam Bean) and *Vigna vexillata* (Wild Cowpea) in Indonesia

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Abstract

The yam bean (*Pachyrhizus* spp.) was introduced to South East Asuia in the 16th century from America. It has received more interest since the Amazonian yam bean 'Chuin' cultivar group has been found which is used and processed like cassava. The wild cow pea (*Vigna vexillata*) is used in Asia, Africa and Central America for its tuberosus roots. The objectives of this study were to record the cultivation status as well as the use and processing knowledge of these species in Indonesia. In a collection trip a questionnaire was used to record these information. In total 110 yam bean (*P. erosus*) and 7 culitvated *V. vexillata* accessions were collected. The yam bean – local names: Bengkuang, Uas or Bose – is cultivated on all major Indonesian islands. Molecular marker analysis (RAPDs) revealed that the Indonesian *P. erosus* germplasm is clearly different from American *P. erosus* accessions, however the genetic distance was not large. Cultivated *Vigna vexillata* – local names: Jempirang Kamberiti or Fanuatufui – has been found only in Bali, Timor and pers. comm. Indicate also cultivation in Papua. The yam bean is known as a vegetable crop rather than as a root crop. Owing to high moisture content the tuber is consumed raw as salad or as refreshing tuber fruit. The Jempirang is considered as a root crop – tubers are always steamed or boiled before consumption and seeds are additionally used. Yam bean yields are 10 to 70 t ha^{-1} in West Indonesia (Sumatra, Java) and 10 to 50 t ha^{-1} in East Indonesia (Sulawesi, Timor Flores, Sumba). In East Indonesia the yam bean is predominantly intercropped with maize and cassava due to poor soil conditions. The Jempirang tuber yields are 20 to 30 t ha^{-1}. It is cultivated after rice (*Oryza sativa*) in the dry season. A part of the *V. vexillata* material could be made available by the National Botanic Garden of Belgium. In conclusion the cultivated *V. vexillata* should consider more attention as a legume root crop and merits further investigation e.g. crossings with *V. vexillata* var. *lobatifolia* from the Namibian desert might be of interest for dry land agriculture. Furthermore, the yam bean may be an additional option for intercropping systems. A higher dry matter Amazonian yam bean (the 'Chuin' cultivar group) are lending themselves as a protein rich starchy stable as well as to incorporate high dry matter into the South East Asian yam bean genepool.

Introduction

The yam bean (P. erosus (L.) Urban) and the wild cowpea (Vigna vexillata (L.) A. Rich.) are legumes which are used for their tuberous roots (NRC 1979). Both legume root crops are cultivated in Indonesia. The yam bean has been introduced into South East Asia in the 16th century via the Acapulco – Manila trade route and the crop is today cultivated in nearly all South East Asian countries (Prosea 1994, Sørensen 1996). However, details about the cultivation of the yam bean in Asia is very limited (Ratanadilok & Thanisawanyangkura 1998). *V. vexillata* is pantropical distributed and close related to the cowpea (V. unguiculata (L.) Walp.) (Garba & Pasquet, 1998). It is usually found wild, often on poor soil conditions including lateritic soils (NRC, 1979). The cultivation of *V. vexillata* as a root crop has been reported by (Sasikumar. & Sardana, 1988) in North East India. The use of *V. vexillata* tubers as food - particularly in times of scarcity due to drought - has been reported for Africa from Senegal to South Africa – as well as Australia. Hanelt (2001) noted sporadically or experimentally cultivation in Africa, SE Asia, Australia and Cuba. Moreover, there is information that *V. vexillata* is cultivated in Papua New Guinea (R. Pasquet, pers. comm. - Henty in Verdcourt 4960A (K) PNG, New Guinea, Henty's plantation, 1976) and in Bali, Indonesia (F. Iseman, pers. comm. – photo of tubers, 1997). However, so far *V. vexillata* is not considered as a cultivated plant and no germplasma of culivars is available.

Materials and Methods

A field survey and collection trip was carried out and a questionnaire (Ørting et al., 1996) was used to record information. Out of the total collection for yam bean (110 accessions) 39 accessions from Indonesia and 6 accessions from America (available by Sørensen , KVL University, Kopenhagen, Denmark) were analysed by RAPD markers.

Results

In total 110 yam bean (*P. erosus*) and 7 cultivated *V. vexillata* accessions were collected (two *V. vexillata* accessions were made available by the National Botanical Garden of Belgium, Vanderborght pers. comm.) and 81 field interviews were made.
The yam bean was always found as a vegetable root crop (consumed raw or in salads) for ist moisture and refreshing taste. In West Indonesia (Sumatra and Java) the yam bean was mainly cultivated as a monocrop (25 of 35 observations), whereas in East Indonesia (Timor, Sumba, Sulawesi, Kalimantan) the yam bean was often found inter-cropped with maize or cassava as well as teak trees(15 of 20 observations) (Fig. 1). Cultivation practices are given in Table 1. *V. vexillata* was found cultivated in Bali and Timor and the tuberous roots of theses cultivars are always boiled or steamed before consumption (Fig. 2). The crop was found to be sown after the rice harvest at the beginning of the dry season (Table 2).
The RAPD marker analysis revealed that the Indonesian *P. erosus* germplasm was clearly different from the American *P. erosus* accessions, however the genetic distance was not large (Fig. 3).

Table 1. Cultivation practices for the yam bean (*P. erosus*) in Indonesia

Traits	Eastern regions				Western regions			
	N	Mean	Min	Max	N	Mean	Min	Max
Yam bean cultivation area (m^2)	14	910	100	5000	35	880	65	500
Plant distance between row (cm)	23	30	10	100	35	25	10	100
Plant distance within row (cm)	23	20	10	50	35	20	5	30
N fertilisation (kg Urea ha^{-1})	5	81	30	150	29	86	0	400
P fertilisation (kg TSP ha^{-1})	16	16	0	100	29	67	0	357
K fertilisation (kg KCl ha^{-1})	16	0	0	0	29	7	0	180
Organic fertilisation (kg dung ha^{-1})	15	400	0	2000	31	600	0	6670
Reproductive pruning (freq.)	15	1,5	0	3	13	2	0	4
Cultivation period (months)	29	4,5	4	6	35	4,5	4	6
Tuber yield (t ha^{-1})	6	25	10	50	31	35	10	70
Tuber sold to local market (%)	20	67.5	10	90	12	80	70	100

Table 2. Cultivation practices of *Vigna vexillata* in Timor and Bali islands

Traits	West Timor	Bali
Number of informants (N)	2	5
Seed origin	Local	Local
Planting distance within rows (cm)	45-50	50 - 60
Planting distance between rows (cm)	20-30	30 - 40
Number of seed per planting station	3-4	3 - 5
Time to tuber harvest (days)	110 – 115	115 - 120
Major pests	Wild pigs, rats	Ants, larvae, rats
Estimated tuber yield (ton ha^{-1})	18 – 20	20 - 30

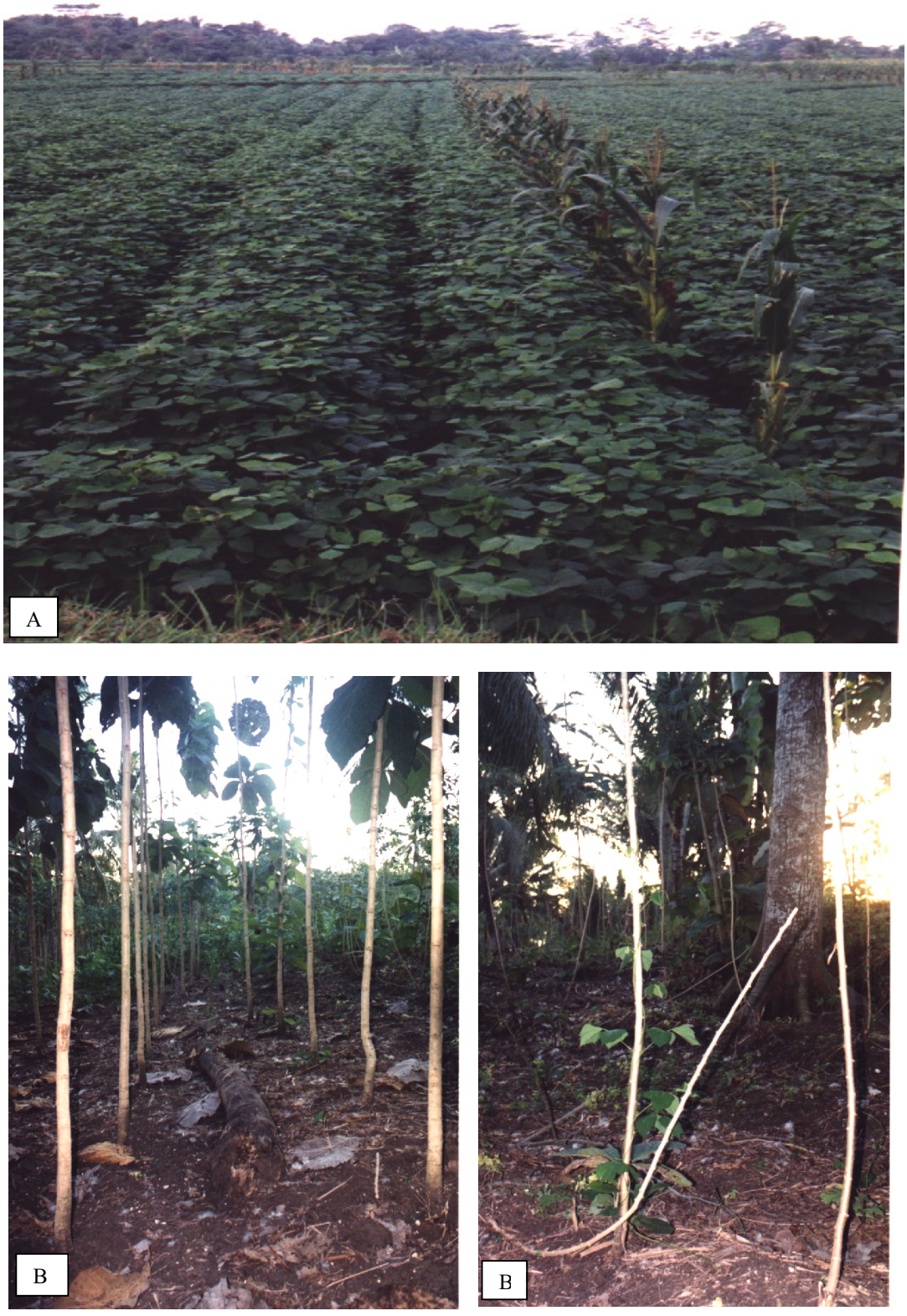

Fig. 1. The yam bean (*P. erosus*); commercial production in West Indonesia (A), intercropping with young teak trees in East Indonesia (B).

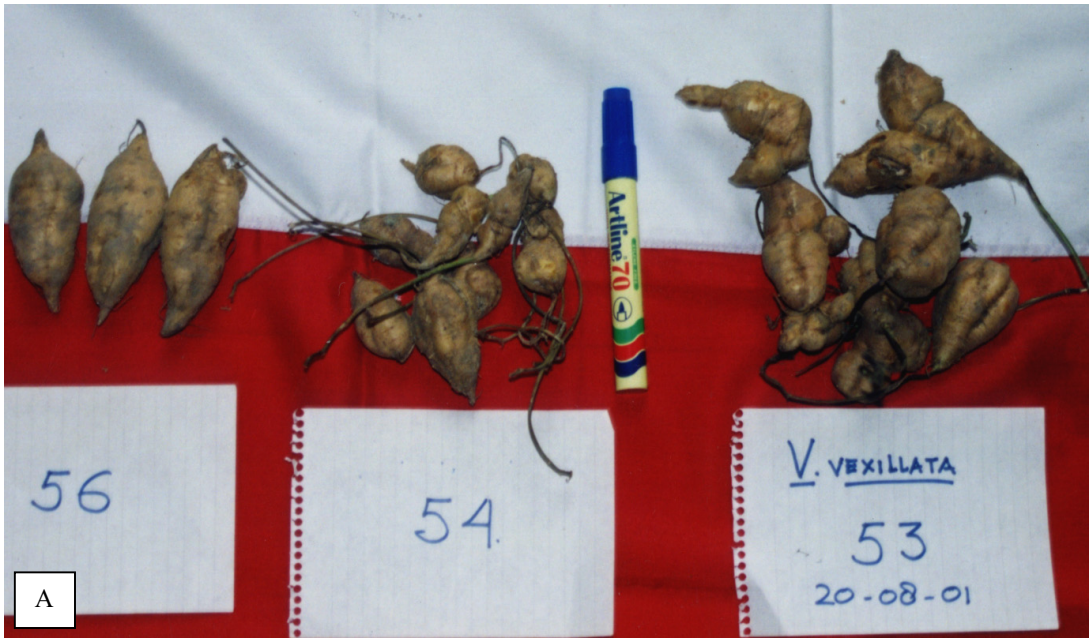

Fig. 2. Tubers of cultivated *Vigna vexillata* from Bali (A), cooked tubers of *Vigna vexillata* in a market in Bali (B)

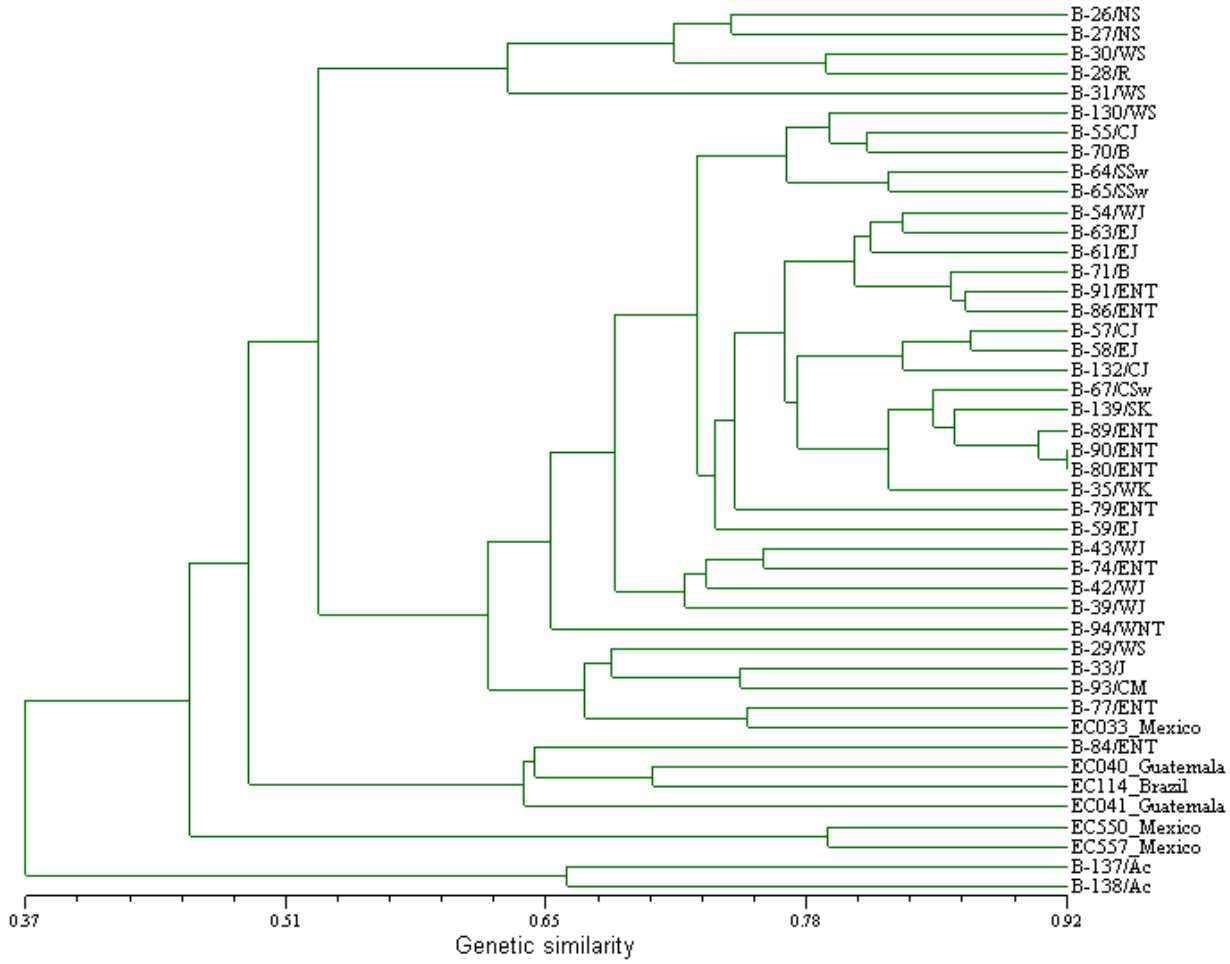

Figure 3. Grouping of 39 yam bean accessions from Indonesia and 6 yam bean accessions from America based on 100 RAPD markers using Jaccard‘s coefficient of similarity and UPGMA clustering.

Discussion and Conclusion

- The yam bean is well established in Indonesia. Under poor soil conditions it is used as an N-input plant in inter-cropping systems. Further studies should aim at incorporation of high dry matter from 'chuin' cultivars (Grüneberg et al., 2003) which are used and processed like cassava (available by CIP, Lima, Peru) into the Indonesian germplasm which might give the yam bean new forms of food and processing use in Indonesia.
- The present study confirmed that *V. vexillata* has been transformed into a cultivar in some parts of Indonesia and that it is adapted to the dry season. Since wild *V. vexillata* is found and used in many tropical and subtropical countries the new material may of interest to transfer cultivar characteristic (i.e. into *V. vexillata* var. lobatifolia from the Namibian desert - available by botanical garden Meisen, Belgium).
- Both crops should provide higher food quality compared to traditional root crops and a option to enrich soil fertility of marginal land.

Acknowledgements

This research was funded by the Deutscher Akademischer Austauschdienst (DAAD) and Volkswagen Stiftung. Moreover, we thank Dr. Vanderborght (Vanderborght@BR.fgov.be) for making part of the cultivated *V. vexillata* material available by the National Botanic Garden of Belgium long term seed conservation.

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