Comparative performance of local and introduced cultivars of taro (*Colocasia esculenta* (L.) Schott) in Vanuatu

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Taro, according to FAO:

- approx. 2 millions ha & 10 millions tons, but…
- many countries do not give statistics
- orphan crop
- very low yields (approx. 5 t/ha)


- Taro is a vegetatively propagated root crop species
- Araceae family characterised by the structure of the inflorescence and by protogyny
- Very polymorphic species: dasheen and eddoe



Traditional food of great cultural and economic importance in the Pacific:


in Vanuatu, the population is going to double over the next 20 years

Traditional food of great cultural and economic importance in the Pacific:

- strong desire to safeguard taro production by breeding for improved quality and performance

- taro breeding started in the Pacific in the 80's without much success because of Taro Leaf Blight: *Phytophthora colocasiae*

Pacific taros:

- tremendous variation
- dasheen types
- diploids
- high quality
- high yield
- improved architecture
- very susceptible to TLB

taro is vegetatively propagated but highly polymorphic

the main challenges for breeders are:

-genetic sources for major traits, and

- international access to selected germplasm

… in this presentation:

1- brief review of molecular studies,

2- comparative performances,

3- future directions for taro breeding.

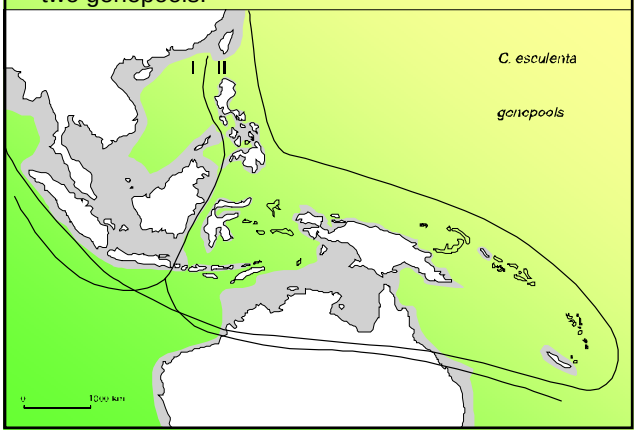
1- Genetic diversity & molecular markers

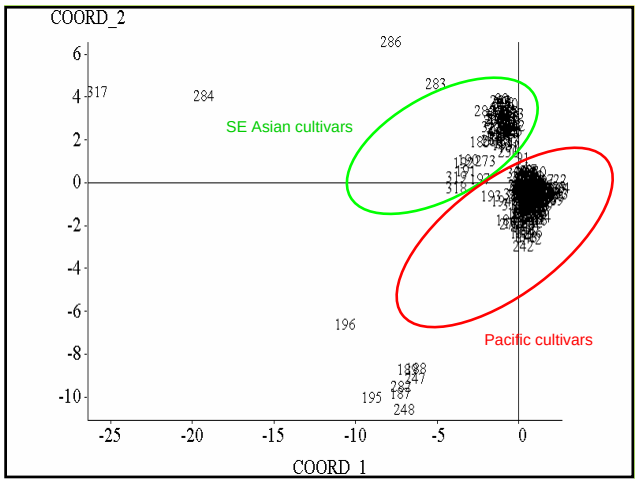
Isozyme studies:

(Lebot & Aradhya, 1991): **1417** acc. from (SE Asia) and Oceania
(Lebot *et al*., 2004): **2081** acc. from SE Asia (and Oceania)

- two distinct genepools, in S.E. Asia and the Pacific
- where independent domestication has occurred
- the genetic base of diploid cultivars is narrow in most countries
- except in Indonesia
- wild taros assemble most of the allelic diversity

two genepools:





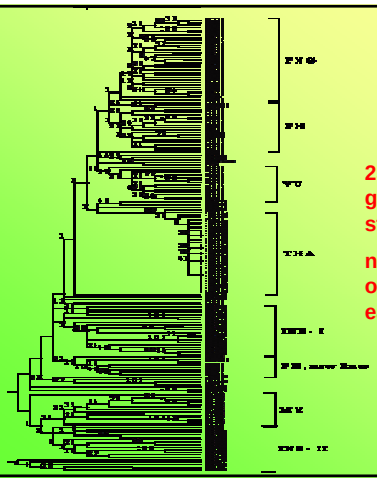
DNA markers have confirmed isozyme studies:

Kreike *et al*. (2004): 255 acc x 3 AFLP primer pairs

a) AFLP diversity is greater in S.E. Asia than in the Pacific,

b) within each country, cultivars are genetically closer to each other than they are to cultivars from other countries,

c) highest diversity being, again, found in Indonesia where the two genepools overlap.



255 acc. X 3 AFLPs = geographical structure

narrow genetic base of cultivars within each country

TARO NETWORK FOR SOUTHEAST ASIA AND OCEANIA

Indonesia
Malaysia
Papua New Guinea
Philippines
Thailand
Vietnam
Vanuatu

TANSAO:

- 2298 acc. collected and described
- core sample of 170 elite cultivars
- tissue cultured and indexed in Wageningen and Bogor
- indexed for DMV, distributed *in vitro* to 7 countries + SPC, Fiji
- released in the field in Nov. 2000

2 - Comparative performance of local and introduced cultivars

- results biased by heterogeneity of the clonal material
- significant genotype × environment interactions
- corm yield correlated to the weight of the propagule
- performance is difficult to assess at early clonal stage
- simple methods needed for rapid screening
- numerous seedlings but very slow growth

a **selection index**
which could take into consideration:

the vegetative traits of a genotype and which could

indicate the yield potential of that genotype

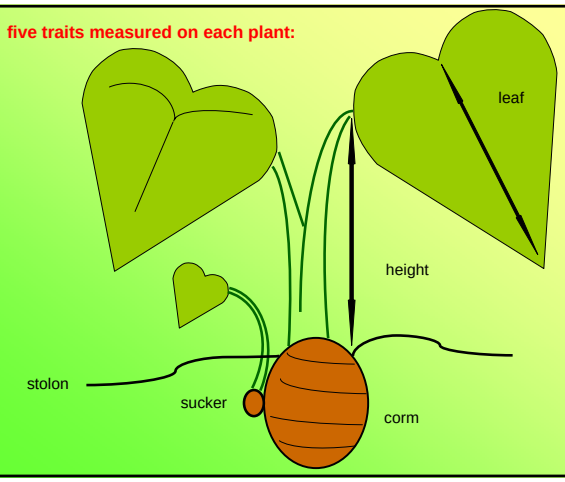
after years of vegetative propagation,

would represent useful practical implications

- 43 elite cvs from VU selected from 452 acc.
- 53 introduced (28 ID, 7 MY, 12 PH, 4 TH, 2 VN)
- only calibrated headsetts of 500 g
- planted on 44 lines (110 m), spacing (1 x 1m)
- 4733 plants measured for five traits

Calibration of headsetts of 500 g

Trial one month after plantation



Vegetative Growth Index (VGI):

[*((leaf length / 1.4) x leaf length) x 5) x h/100] - (suckers + stolons)*^{2}

hypothesis:

high VGI translates a good architecture of the plant and its aptitude to stock energy in its corm:
tall cultivars with large leaves and wide canopy can store energy if low number of stolons and suckers avoid useless translocation into vegetative growth

Trial in the vegetative phase, 5 months after plantation

Trial in the maturity phase, 8 months after plantation

intraclonal variation within and between countries:

Country	cvs no	*n plants*	height (cm)	*cv %*	leaf (cm)	*cv %*	stolons (no)	*cv %*	suckers (no)	*cv %*	corm (g)	*cv %*
Vanuatu *(i-cl)*	43	*1024*		*16.9*		*16.4*		-		*77.7*		*23.4*
Vanuatu *(b-cv)*			70.0	*18.3*	32.9	*19.3*	0	-	3.0	*57.7*	1015	*17.6*
Indonesia *(i-cl)*	28	*1830*		*18.8*		*15.6*		*125.2*		*61.5*		*24.5*
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Malaysia *(i-cl)*	7	*598*		*12.8*		*10.1*		*123.7*		*40.5*		*10.4*
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Total *(i-cl)*	96	*4733*	77.6	*17.8*	35.0	*16.8*	1.5	*118.2*	5.6	*69.1*	1094	*20.8*
Total *(b-cv)*			*21.4*		*18.0*		*158.6*		*72.9*		*23.6*	
Between countries			*16.4*		*11.1*		*94.0*		*35.0*		*13.2*	

intraclonal variation (inter plant) :

- limited for plant height, from 11.7% to 18.8%

- limited for leaf length, from 7.4% to 16.4%

- highly variable for no. of stolons, from 49.8% to 125.2%

- variable for no. of suckers, from 26.5% to 77.7%

- low for corm yield, from 10.4% to 29.7%

- **intraclonal variation is lower than between cultivars variation**

- within countries, between cultivars variation is greater than between countries

- in Vanuatu, several varieties introduced from Asia perform better than local ones

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comparative performance of best fifteen varieties:

Acc.	*Name*	*n plants*	height (cm)	*cv %*	leaf (cm)	*cv %*	stolons (no)	*cv %*	suckers (no)	*cv %*	*VGI*	corm (g)	*cv %*
ID497	*Paco kebo*	*13*	87.6	*16.8*	56.5	*15.9*	3.1	*143.2*	10.0	*40.2*	*9816*	2044	*24.7*
VU239	*IRCC 3*	*4*	99.5	*3.1*	51.3	*8.9*	0.0	-	6.8	*32.8*	*9306*	1750	*6.4*
PH055	*Kalpao*	*108*	108.7	*13.8*	45.9	*11.6*	1.8	*83.4*	2.3	*98.4*	*8162*	1736	*26.5*
PH049	*Hinagnaya*	*82*	116.9	*16.9*	42.2	*16.3*	6.6	*68.7*	3.8	*67.0*	*7327*	1702	*47.9*
PH004	*Inarugon.*	*70*	93.3	*16.7*	37.6	*12.7*	4.2	*93.4*	4.5	*98.6*	*4635*	1649	*40.1*
VN050	*Phualanh*	*93*	106.2	*14.1*	47.1	*5.3*	0.0	-	9.7	*64.1*	*8320*	1548	*29.1*
TH001	*Muang*	*97*	97.7	*18.2*	39.3	*16.7*	1.5	*130.5*	4.3	*76.9*	*5356*	1506	*27.5*
PH014	*Pontevedra*	*52*	123.4	*13.5*	48.5	*11.1*	1.9	*115.8*	10.1	*42.6*	*10223*	1504	*29.0*
ID392	*n.a.*	*10*	80.7	*13.9*	49.1	*16.9*	0.3	*225.0*	9.5	*54.4*	*6852*	1459	*42.3*
ID054	*Keladi*	*163*	93.3	*33.8*	28.1	*22.8*	1.9	*136.8*	7.4	*91.9*	*2545*	1450	*22.8*
ID280	*Lampunsel*	*95*	92.5	*18.5*	41.1	*16.4*	0.6	*156.0*	6.4	*62.9*	*5531*	1417	*17.4*
ID316	*Bolang*	*45*	83.2	*24.4*	35.8	*23.0*	0.2	*300.7*	0.6	*154.3*	*3808*	1413	*41.2*
PH023	*Fernando*	*36*	116.5	*15.7*	46.8	*14.9*	1.9	*120.6*	10.6	*51.9*	*8957*	1413	*27.6*
ID245	*Pakem*	*48*	93.5	*17.3*	39.4	*13.7*	0.0	-	2.3	*74.7*	*5178*	1412	*24.2*
PH054	*Tsina*	*129*	113.1	*16.1*	41.8	*12.7*	2.1	*120.2*	9.0	*48.7*	*6934*	1397	*33.2*

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none of the selected cvs from Vanuatu presented stolons and most of them were clearly differentiated from asian morphotypes

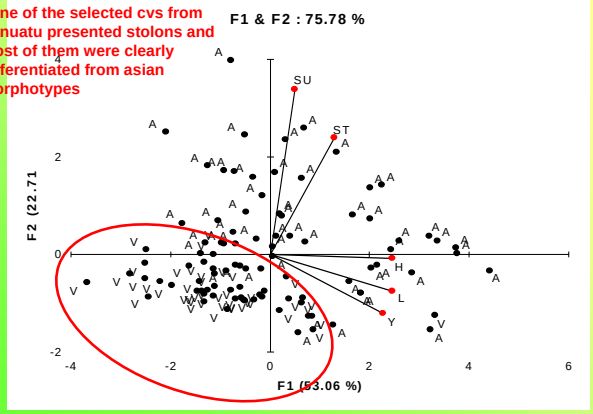

Figure 1: Principal components analyses (96 cvs × 5 traits)

correlation coefficients computed on 96 means:

+ *0.8*** between height and leaf

+ *0.7*** between height and corm

+ *0.8*** between leaf and corm

low and non significant between other traits

0.1 ns between *n* and intra clonal variation (cv%)

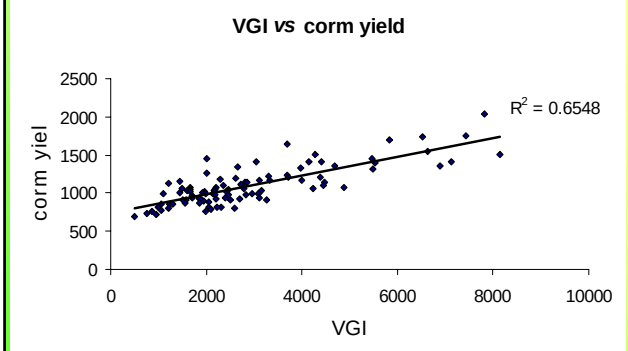

Figure 1: VGI *vs* mean corm yield per plant for 96 cultivars and predicted regression.

conclusions:

- the low intra clonal variation values obtained for plant height, leaf length and corm yield indicate that simple field design can be use to screen numerous genotypes if propagules have been calibrated

- *VGI* is positively correlated with corm yield and can therefore be used to screen numerous genotypes in breeding programmes (only 4 traits measured)

- best genotypes present tall plants, large leaves, few suckers, no stolons and no inflorescences which deform corms

- molecular markers cannot prelude the agronomic performances of genotypes introduced in another country

- if taro cultivars share a narrow genetic base within their countries of origin, their agronomic performance is variable and greater within than between countries

3 - future directions for taro breeding

- select parents based on their wide genetic distances (markers) and therefore from distant geographic origins

- produce numerous seedlings (thousands) based on numerous crosses between distant genotypes (population-0 with wide genetic base)

Infrutescences at different stages of maturity

Young germinated seeds in 'jiffy' pots

Nursery of hybrids

- apply high selection pressure on few traits

- capture additive effects via recurrent selection

- use multi-population approach: few traits selected in each population to accelerate progress

- develop new chemotypes with attractive properties, *i.e.,* antioxydants, carotenes, anthocyanins…

Exemples of variability within hybrids




F1 hybrid selected from a cross between a hybrid (VuxVu) and an Indonesian cultivar

Other F1 hybrids showing hybrid vigour


- exchange true taro seeds between populations

- participatory evaluation of chemotypes (on-farm) to decrease on-station work load and accelerate adoption

Distribution of F1 hybrids to farmers

‘On farm’ evaluation of chemotypes

-Ex: of Vanuatu breeding programme: creation of a wide genetic base for the population-0 to try to create hybrids of multi-origin composition
(PH x THA x IND x MAL x VN x VU)

⇨ pyramiding of interesting genes (R alleles to TLB)

Many thanks for your attention!!