The Sweetpotato Production-Postharvest Use System in Vietnam: Participatory Needs and Opportunity Assessment

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A participatory needs assessment on root crops production-postharvest use systems was conducted in eight major root crop production provinces of Vietnam in 1998/99 as a collaborative effort of six Vietnamese institutions, International Potato Center, and UPWARD. Sweetpotato (*Ipomoea batatas* (L.) Lam) production data showed that the greatest opportunity for increased profitability from sweetpotato was in more effective and efficient use of existing technologies. That implied the development of farmer learning methods and mechanisms rather than technology development research. A follow-up workplan for the development and institutionalization of adapted integrated crop management (ICM) farmer field school (FFS) protocols for sweetpotato resulted from the study. Moreover, research and extension organizations committed themselves to implement the workplan. The participatory nature of the study has been instrumental in achieving the final output.

CIP's 1998-2000 Medium Term Plan identified Vietnam as a priority country within the program framework for sweetpotato research (Walker and Collion, 1997). Vietnam ranks third in cultivated area after China and Uganda among the world's sweetpotato producing nations. Workplans of individual CIP projects also emphasized the continuation of existing work or implementation of new research activities, especially in genetic resources conservation and breeding, integrated pest management (IPM), and postharvest use. During a meeting between CIP scientists and national agricultural research systems partners in 1998, the lack of comprehensive, reliable, and updated information on root crop production-postharvest use systems in Vietnam was identified as a key issue. A needs and opportunity assessment was recommended as a key step toward planning and undertaking action-oriented research. A collaborative study was designed involving scientists from four International Potato Center (CIP) research areas (IPM, breeding, postharvest utilization, and canna germplasm), and from the six Vietnamese national research institutions represented by the authors of this paper. This study was supported by CIP and UPWARD (The Users' Perspectives for Agricultural Research and Development (UPWARD) is a CIP-affiliated network of Asian researchers conducting participatory research and development projects in root crop systems).

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The overall objective of the study was to establish a baseline of root crop systems in key production areas in Vietnam and to identify opportunities and mechanisms for improvement of root crop enterprises. The specific objectives were:

- to document and analyze root crop systems in selected provinces of Vietnam, with an emphasis on sweetpotato;
- to determine root crop farmers' variety requirements, cultivation and postharvest constraints and practices, and needs and opportunities for improvement; and
- to identify and prioritize relevant research and development interventions and mechanisms for root crop technology development, promotion, and institutionalization.

This paper outlines the methods of the study, presents the major findings with a focus on sweetpotato production, and discusses how the participatory and integrative nature of the exercise contributed to research planning and implementation of CIP's sweetpotato IPM activities in Vietnam.

Methods

The study emphasized two key types of baseline information, i.e., 1) production and crop management, and 2) postharvest use in both sweetpotato and canna systems. Study sites represented key sweetpotato or canna production areas, and included eight provinces across the country.

- Northern Vietnam: Vinh Phuc and Ha Bac provinces (sweetpotato), and Hoa Binh (canna).
- Central Vietnam: Thanh Hoa Province (sweetpotato and canna), and Quang Nam Province (sweetpotato).
- Southern Vietnam: Ba Ria-Vung Tau and Vinh Long provinces (sweetpotato), and Dong Nai Province (canna).

Data are reported only for the six provinces considered key sweetpotato production areas. Hoa Binh and Dong Nai provinces, which were studied only for canna production, are not included in the analysis.

Data collection was done in four villages per province (except Ba Ria-Vung Tau in which only three were studied) during the 1998/99 winter-spring and spring-summer seasons by teams of one researcher and one field assistant per province. The team members were involved in pretesting and revising the data collection methods. For data collection the following methods were employed.

- Analysis of secondary data.
- Village profiling using participatory rural appraisal methods including transect walks; informal discussions with farmers, traders, retailers, processors, and consumers; participatory mapping using production criteria; and focus group discussions using ranking exercises, seasonal calendars, gender analysis, and open discussion on technology and learning needs.
- Season-long record-keeping of sweetpotato/canna production by 10 randomly selected farmers per study village per crop, or 40 farmers per site (except Ba Ria-Vung Tau that had only 25).
- Observation in sweetpotato fields of record-keeping farmers once every other week.
- Individual interviews, midway in the season and at harvest, with record-keeping farmers about qualitative aspects of sweetpotato/canna production.
- Individual interviews on root crop postharvest use focusing on pig feed and starch with approximately 10 processing families per village, mostly not the same as the production respondents.
- End-of-season analysis meetings in each village to interpret results and prioritize research needs.

Results were analyzed statistically to determine whether there is a linear relationship between fertilizer rates and vine or storage root yield. Additionally, a prediction model for vine and storage root yield was studied by multiple regression analysis. A nationwide seminar was conducted in October 1999 to present the needs assessment method and results to stakeholder group representatives. The seminar was followed by a workshop with existing and potential partners in the sweetpotato IPM project to determine future program strategies and to plan follow-up activities.

Results

Characterization of sweetpotato cultivation areas and systems

Sweetpotato cultivation in the various regions in Vietnam varies by agroecology and climate. In all study sites, sweetpotato is typically grown as a field crop in rotation with rice and other crops such as maize, groundnut, cassava, and vegetables. Winter and spring constitute the major cultivation season in northern and central Vietnam. In southern Vietnam sweetpotato is grown year-round, but preferably during the dry season, which coincides with the winter-spring season in the North. Women have a major role in sweetpotato cultivation, particularly in northern and north-central Vietnam. Further to the south the average proportion of work done by women is smaller (Table 1), which is consistent with results of Tuyen (1999). Sweetpotato ranks first among major field crops in Ha Bac, Thanh Hoa (one district), Ba Ria-Vung Tau, and Vinh Long provinces, and either second, third, or fourth (depending on a specific community) in Vinh Phuc, Quang Nam, and Thanh Hoa. Sweetpotato is favored because of its high productivity and low management and input requirements, which makes it an easy and potentially profitable enterprise. Additionally, seed is readily available, and in some areas sweetpotato is one of the few crops adapted to prevailing soil conditions. Disadvantages include unreliable marketing opportunities and a generally low market price. In some areas, farmers face low productivity or low product quality.

A majority of farmers perceive their soils as moderately to fairly fertile; only in Quang Nam do a substantial number of farmers rate their sandy soils as fairly infertile (Table 1). Eighty-three percent of all farmers, although relatively fewer in Vinh Long (50%), are aware that they could improve the fertility of their soils with applications of organic fertilizer, whereas 55% believe that inorganic fertilizer could do the job. A majority of farmers rate their water supply as unreliable. The water supply in Ha Bac is considered moderately to fairly reliable. Only in Vinh Long, which is located in the Mekong Delta, do all farmers rate their water availability as fairly reliable. Major constraints to sweetpotato cultivation vary across provinces and seasons. They include sweetpotato weevils, stem borers, soil nutrient deficiencies, the lack of suitable varieties, and abiotic factors such as cold, drought, or floods.

Both vines and storage roots are used in the northern and central provinces, whereas in the South the deliberate use of vines is rare. Vine production accounts for an average of 62% of the total gross income from sweetpotato in Thanh Hoa and is equally important for use on-farm as animal feed or for market (Table 2). In Vinh Phuc, Ha Bac, and Quang Nam, approximately one third of total gross income from sweetpotato comes from vines, with a focus on home consumption by farm animals (mainly pigs). Storage roots find a variety of uses in northern and central Vietnam, whereas in the South the bulk is sold to the fresh market (Table 2).

Sweetpotato production

In all study sites, farmers plant sweetpotato on ridges, although the width and height, and accordingly plant population, vary by soil type, water supply, and local

Table 1. Sweetpotato (SP) production and postharvest use characteristics in six needs assessment sites in Vietnam, 1998/99.

Characteristic	Northern Vietnam		Central Vietnam		Southern Vietnam	
	Vinh Phuc	Ha Bac	Thanh Hoa	Quang Nam	Ba Ria-Vung Tau	Vinh Long
Labor ratio, women:men (h/ha)	1:0.4	1:0.6	1:0.3	1:1.1	1:1.4	1:1.6
Rank of SP among other major crops	3, 4, After rice, maize, sugarcane, mulberry, soybean	1, Before rice, maize, groundnut	1, Before rice, beans, groundnut. 2, 3, after groundnut, rice	2, 3, or 4, After cassava, rice, groundnut	1, Before rice	1, Before rice, maize, vegetables
Typical cultivation pattern[1]	Rice or maize - rice - SP or vegetables	Rice - SP or vegetables - rice or groundnut	Rice or beans - SP, or Maize or vegetables - SP or beans	Rice - SP - Vegetables or cassava/ sesame	Rice - SP	Rice or SP - Rice - SP or vegetables
Most serious production constraints	SP weevil Low soil fertility Lack of suitable varieties	Soil fertility	SP stem borer SP weevil Unreliable water supply	SP stem borer Viruses Drought, cold	Lack of suitable varieties Lack of capital	SP weevil Lack of capital Heavy rain
Soil fertility						
Fairly fertile	38%	63%	73%	3%	-	100%
Moderately fertile	50%	38%	28%	53%		0%
Fairly infertile	13%	0%	0%	45%		0%
Water availability						
Fairly reliable	0%	58%	0%	23%	0%	100%
Moderately reliable	25%	43%	3%	15%	0%	0%
Fairly unreliable	75%	0%	98%	63%	100%	0%

[1] Spaced hyphen indicates followed by. For example: rice crop followed by a sweetpotato crop indicated as rice - sweetpotato.

Table 2. Contribution to gross income of the various uses of vines and storage roots, as average percent of total gross income (including opportunity value for in-kind products) from sweetpotato. Vietnam, 1998/99.

Use	Northern Vietnam		Central Vietnam		Southern Vietnam	
	Vinh Phuc (n=40)	Ha Bac (n=40)	Thanh Hoa (n=40)	Quang Nam (n=40)	Ba Ria-V. Tau (n=25)	Vinh Long (n=40)
Vines:	38.5	31.5	62.5	29.6	0.0	0.2
Animal feed	24.0	18.7	29.7	23.2	0.0	0.0
Sold to market	10.7	12.7	28.6	4.2	0.0	0.2
Seed	2.9	0.0	4.2	2.1	0.0	0.0
Give away/ other uses	0.8	0.0	0.0	0.1	0.0	0.0
Storage roots:	61.5	68.5	37.5	70.4	100.0	99.8
Sold to market	10.2	39.4	13.6	11.3	99.3	97.5
Animal feed	25.4	21.3	7.8	17.0	0.1	0.1
Family consumption	13.0	5.8	5.8	19.1	0.1	1.6
Used for processing	1.0	0.0	10.4	22.9	0.0	0.0
Discarded[1]	3.9	2.0	0.0	0.0	0.1	0.0
Give away/ other uses	8.1	0.0	0.0	0.0	0.5	0.6

[1] Due to weevils, rot and other causes.

habits. The widest ridges, containing two rows of plants instead of one, are found in Quang Nam and Ba Ria-Vung Tau (Table 3). Over time, farmers appear to have developed the most appropriate planting system under the prevailing conditions in the various areas. Almost all farmers in the northern and central provinces, and a majority in Vinh Long, practice seed selection mainly by discarding cuttings with symptoms of pests and diseases, and the selective use of tip cuttings or the use of vines from healthy mother plants. None of the farmers in Ba Ria-Vung Tau are reported to practice seed selection (Table 3). Fertilization practices vary widely among and within provinces. Farmers commonly use organic fertilizer, except in Vinh Phuc (Table 3). The average amounts applied seem adequate to maintain soil fertility in Ha Bac, Thanh Hoa, and Quang Nam, but are suboptimal in Ba Ria-Vung Tau and Vinh Long. Inorganic nitrogen fertilizer is commonly applied. Average doses in all provinces except Thanh Hoa are excessive and, considering the relatively low yields, seemingly highly inefficient, as illustrated by a nonsignificant ($P > 0.05$) correlation between the dose of total inorganic fertilizer and vine yield (Pearson product moment correlation coefficient as low as 0.132) or storage roots (0.122). Phosphate and potassium fertilizer applications are widely practiced, mostly in excess, in Thanh Hoa and Ba Ria-Vung Tau, but variably in Ha Bac, Quang Nam, and Vinh Long, and not at all in Vinh Phuc.

Pesticides are used only by farmers in Quang Nam, where the majority practice one or two applications a season, and in Vinh Long where all farmers in one study district used pesticides excessively (on average four applications a season) (Table 3). Field observation is commonly practiced by farmers in Vinh Phuc, Ha Bac, and Ba Ria-Vung Tau, but only occasionally by most farmers in the other provinces (Table 3). Only in Quang Nam and Ba Ria-Vung Tau do substantial numbers of farmers understand natural enemies and their role in the ecosystem and identify especially ants, frogs, and dragonflies as examples of natural enemies. That might be an effect of intensive IPM training that has taken place in rice in these provinces.

Table 3. Sweetpotato production practices, farmer knowledge and skills in the six needs assessment sites (% farmers reporting unless specified otherwise).

Variable	Northern Vietnam		Central Vietnam		Southern Vietnam	
	Vinh Phuc (n=40)	Ha Bac (n=40)	Thanh Hoa (n=40)	Quang Nam (n=40)	Ba Ria-Vung Tau (n=25)	Vinh Long (n=40)
Soil preparation and planting:						
Avg. width of ridge (cm)	80	67	107	199	133	100
Avg. height of ridge (cm)	40	34	54	58	70	57
Avg. planting density ('000 plants/ha)	67	48	47	54	64	40
Practice seed selection	98	100	98	100	0	68
Apply organic manure	8	100	100	100	100	100
Apply fertilizer						
Inorganic N	95	100	100	100	100	98
Inorganic P	0	13	95	8	100	48
Inorganic K	0	88	100	33	100	0
Apply pesticides	0	0	0	85	0	53
Practice field monitoring:						
Occasionally	0	18	80	98	0	98
Routinely	100	83	20	3	100	3
Understand the concept of natural enemies	8	0	13	70	100	3
Can assess root yield within reasonable range	35	45	15	38	28	18
Market prices						
For vines (D[1]/kg) (avg.)	348	216	505	400	-	1000
For roots (D/kg) (avg.)	624	534	503	716	1100	1435
Store sweetpotato roots	85	100	43	100	0	0

[1] D = dong, Vietnamese currency unit; 14,000 dong = US$1.

Storage root yields ranged from an average of 9.2 t/ha in Thanh Hoa to 17.2 t/ha in Quang Nam, whereas vine yields averaged from 10.7 t/ha in Vinh Phuc to 18.6 t/ha in Quang Nam (Figure 1A). Despite the relatively poor soils in Quang Nam compared with the relatively rich soils in Vinh Long, Quang Nam farmers achieve equally high yields through suitable management (Figure 1B). Analysis of cultivation practices shows that no variable possibly contributing to yield (i.e., plant density, crop growth duration, labor, fertilization rate, or pesticide application frequency) strongly predicts vine or storage root yield across sites (Table 4). This is the result of the high variability of practices among farmers, possibly due to lack of adequate information to increase production efficiency, and among areas due to varying ecological and utilization conditions. Only the data for Quang Nam and Vinh Long resulted in a fairly strong prediction model. In Quang Nam, optimization particularly of plant density, but also of labor and N-fertilizer application rates, is likely to improve both vine and root yields. This may be related to the soil quality in this province, which is very sandy and hence requires adapted crop care. In Vinh Long, crop growth duration occurred as a relatively strong determining factor with a positive correlation to both vine and root yield. The average growth duration is relatively short in this province. Farmers might increase their production levels significantly by allowing the crop a few more weeks in the soil, although this will depend on the market price at the time of harvest and the opportunity cost of land and time during that particular season. The significant values for various other variables in the models, albeit at low coefficients, indicate that there is room for improvement in the production systems but also that a location specific approach will have to be applied.

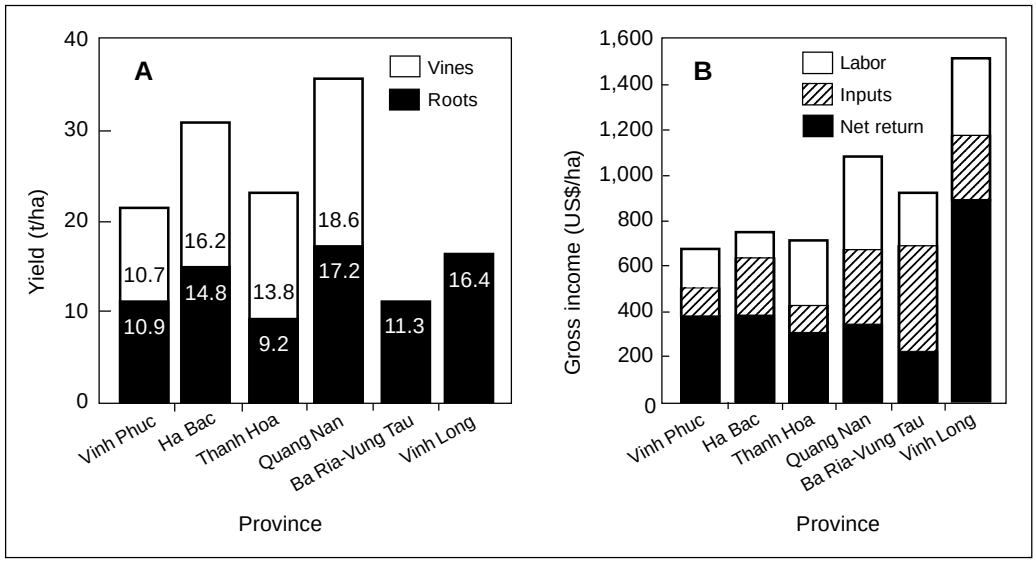

Figure 1: (A) Average total yield broken down into average storage root yield and vine yield (left). (B) Average gross income broken down into net income and cost for inputs and labor.

Table 4. Multiple linear regression of cultivation variables possibly accounting for sweetpotato vine and storage root yield (dependent variable). Independent variables include plant density, labor, crop growth duration, doses of organic manure and inorganic (N, P, K, and others which is mainly NPK composite) fertilizers, and pesticide application frequency. Values per entry are standardized coefficient and probability P (in parenthesis). Only values for independent variables with a probability of $P<0.10$ are displayed.

		Independent variables						
	Adjusted R^2	Density (plants/ha)	Growth duration (days)	Labor (hr/ha)	Fertilizer			Pesticide application frequency
					N (kg/ha)	K (kg/ha)	Organic (kg/ha)	
Vines								
Vinh Phuc	0.225		0.514 (0.006)					
Ha Bac	0.198				-0.354 (0.068)		0.365 (0.059)	
Thanh Hoa	0.032						0.303 (0.094)	
Quang Nam	0.773	-0.914 (<0.001)		0.223 (0.022)	0.239 (0.013)			
Roots								
Vinh Phuc	0.162		0.389 (0.040)					
Ha Bac	0.213			-0.538 (0.009)	0.329 (0.086)	0.440 (0.008)		
Thanh Hoa	0.015						0.383 (0.038)	
Quang Nam	0.816	-0.883 (<0.001)		0.007 (0.240)	0.188 (0.028)			
Ba Ria-Vung Tau	-0.043							
Vinh Long	0.869		0.773 (<0.001)				-0.122 (0.062)	0.301 (0.018)

The majority of farmers in the northern and central provinces store sweetpotato roots in their houses before selling them, whereas in southern Vietnam farmers sell their crop immediately (Table 3). The prices farmers receive vary considerably, with the lowest prices for vines in the northern provinces of Vinh Phuc and Ha Bac, and the lowest prices for roots in the more remote areas of Ha Bac and the central province of Thanh Hoa (Table 3). Average storage root price is relatively high in the two southern provinces, Ba Ria-Vung Tau and particularly in Vinh Long. As a result of relatively high yield and high market price, the gross income from sweetpotato roots in Vinh Long is significantly higher than in all other provinces (Figure 1). In Quang Nam, where root yield was the same as in Vinh Long, farmers benefit from the additional value of the vines, resulting in an average total gross income from sweetpotato that is not significantly lower than in Vinh Long. Because of high expenditures for inputs and labor, net return from sweetpotato in Quang Nam is not significantly different from that in other provinces, and is lower than in Vinh Long. Farmers in the northernmost provinces, Vinh Phuc, Ha Bac, and Thanh Hoa in central Vietnam have a low net income from sweetpotato, despite relatively low expenditures, as a result of low yields and low prices. But in Ba Ria-Vung Tau, despite a high market price, low net income resulted from low yield and high expenditures.

Follow-up research agenda and activities

During the needs assessment analysis workshop, the major opportunity areas and actions needed for improvement of the production system were defined and ordered as listed below.

Marketing. Develop and implement FFSs to enhance farmers' bargaining power.

Soil and nutrient management. 1) Review existing information on soils to develop broad fertilization guidelines for each area, 2) conduct participatory field studies to test and adapt guidelines, and 3) develop and implement FFS activities on crop nutrient requirements and on experimental skills needed to adapt fertilization guidelines.

Major pests and diseases (including weevils, stem borers, and root rot). 1) Conduct applied research on the use and production of the entomopathogen *Beauveria bassiana* to manage weevils in field and storage, 2) conduct large-scale testing of storage techniques in pilot FFSs, and (3) develop and implement FFSs on weevil and stem borer management.

Workshop participants concluded that the sweetpotato ICM-FFS approach in Indonesia (Van de Fliert and Braun, 1999) would have potential for Vietnam after being adapted to local conditions. It covers all aspects of sweetpotato cultivation, from soil preparation to marketing to postharvest use, with ecological and economic sustainability an underlying principle. Vietnam has a very strong IPM program applying the FFS model to training in rice and other crops. With relatively little investment, the Indonesian sweetpotato ICM-FFS protocols could be adapted for the Vietnamese conditions; and, the skills of Vietnamese FFS facilitators could be upgraded so they could conduct sweetpotato ICM field schools. The analysis workshop brought about a commitment from the national IPM program to follow up on the research and development phase of the project. The follow-up work plan contains activities to review, field-test, and revise the sweetpotato IPM-FFS protocols; to train master trainers; and initiate a larger-scale program by the local institutions.

Discussion

Sweetpotato productivity in Vietnam is generally low. But in the study sites, where one would expect the crop to be well suited to local conditions, average storage root yields were higher than the national average of 6.5 t/ha (FAO, 2000). Low

yields were mainly due to stress factors such as low soil fertility, low temperature in the short winter growing season, and insect pests (sweetpotato weevil and stem borer). Whereas in the late 1980s the unavailability of fertilizers was a major constraint (Bottema et al., 1991), chemical fertilizer use is now common. Even though use has more than tripled over the past decade (FAO, 2000), it is often inefficient as illustrated by the correlation and regression analyses done in this study. Balanced nutrient management and effective pest management are expected to increase profitability.

The team members evaluated the study methods and implementation process positively. All but one felt the three objectives were fully or for the most part achieved. They were particularly positive about having achieved the third objective, identifying and prioritizing relevant research and development interventions and mechanisms for root crop technology development, promotion, and institutionalization. All methods except secondary data analysis were considered instrumental in achieving the objectives. The study provided a valuable learning experience for the research team members, many of whom had mainly done conventional, disciplinary research work before. The interdisciplinary composition of the study team favored the integrative approach of the study. Farmers' active involvement in the needs assessment is expected to result in increased farmer interest in the study sites in future training.

Conclusions

The integrated needs assessment reported here is the most comprehensive study done to date in Vietnam on root crop production-postharvest use systems. Containing as it does production, post-production, and socioeconomic elements, it provides a fairly complete picture of the constraints and opportunities of root crop enterprises in various parts of the country. The study served as a foundation for further production and use technology and extension development, and resulted in an operational workplan for the sweetpotato IPM research group. Needs and opportunities identified were directed more toward farmer learning than research, and more to crop cultivation in general than pest management in particular. Consequently, the follow-up workplan concentrated on the development of an adapted, flexible ICM-FFS protocol to suit the various production-postharvest use systems across the country. Involvement of all stakeholder groups in the final needs assessment analysis was instrumental in reaching conclusions and developing a workplan, including the commitment from the national extension system to follow up research efforts on a nationwide scale.

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