

ASSESSING IMPACTS OF PATHOGEN-TESTED SWEETPOTATO PLANTING MATERIALS IN CENTRAL LUZON, PHILIPPINES

Carlos S. Basilio, Rizalina M. Tablarin, Fe L. Porciuncula, and Lolit M. Dolores¹

ABSTRACT

Sweet potato production in Central Luzon, Philippines has been plagued by a virus disease complex locally known as “camote kulot.” Aside from causing more than 50% reduction in yield, the disease was also responsible for the loss of an important variety with good and well-accepted agronomic characteristics. Interagency efforts resulted in a technology in the production of clean planting materials through thermotherapy and meristem culture. A sweetpotato variety has been cleaned up, reproduced and multiplied for farmers use.

CIP-UPWARD supported the use of participatory R&D approaches to adapt CPM in sweetpotato-associated livelihood systems in the region. The program implemented livelihood systems analysis, farmer field schools and farmer participatory researches. Several technical and socio-economic evaluation activities were also conducted to determine the contribution of these projects and CPM in livelihood systems.

The results indicated the role of participatory approaches in facilitating project outputs and outcomes. PR&D approaches intensify awareness of research and development institutions about “kulot” and the potential of CPM in solving it leading to their provision of resources and other support to its solution. CPM were produced and used by 117 farmers in 19 villages of the provinces of Tarlac and Bataan. Local government units provided their own resources to so that their constituents will benefit from the technology. They build nethouses, finance FFS and mobilize communities leading to establishment of enterprises out of CPM technology. Unfortunately, there are a number of technical, socio-economic and policy issues that limits more widespread use of CPM and improvements in contributions of sweetpotato to the livelihood systems of households in the region.

The paper also looks at the various elements of participatory research and development, how they have been operationalized within the project context and how they have contributed to achieving project outcomes and impacts. These elements evolved from UPWARD’s own field-based experiences and from efforts by other organizations to develop a wide range of participatory approaches. The paper explores the use of the following elements - problem-based agenda, impact-driven objectives, field-based action, user responsiveness, household orientation, livelihood systems framework, integration of scientific and local knowledge, interdisciplinary mode and inter-institutional partnerships, as touchstones for assessing PR&D processes.

¹ Research Fellow- International Potato Center, Instructor – Tarlac College of Agriculture, Associate Professor, Central Luzon State University and University Researcher – University of the Philippines at Los Banos

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Introduction

Central Luzon is a major commercial sweet potato growing area in the Philippines. Although it is not considered as a major sweetpotato producing region, it is the main supplier of sweet potato in Metro Manila and other nearby cities and municipalities. The region provides a year round supply of sweetpotato mainly coming from Tarlac during the dry season and from Bataan and other provinces during the wet season (Table 1).

Table 1. Areas planted/harvested to sweetpotato in Central Luzon (1995-2001)

Province	Area (has)						
	1995	1996	1997	1998	1999	2000	2001
Bataan	340	340	344	330	558	580	510
Bulacan	74	44	45	47	58	56	55
Nueva Ecija	81	117	109	94	162	150	173
Pampanga	454	594	610	628	626	561	561
Tarlac	3,780	3,876	4,800	5,730	6,450	5,800	6,215
Zambales	193	135	110	68	76	79	72
TOTAL	4,922	5,106	6,018	6,897	7,930	7,226	7,586

Source: http://bas.gov.ph/stats/csd/01_0695.html

“Camote Kulot”

Sweet potato production in the region however, has been plagued by a complex virus disease locally known as “camote kulot” (curled-leaf sweetpotato). It is the term used by farmers to describe a diseased plant that shows physical deformities such as curling of leaves, mottling, yellowing of leaves and stunted growth. Infected plants were observed to dry up if it express symptoms at one week after planting and produce few and small roots

The disease has been causing more than 50% yield reduction and is reported to be responsible for the loss of “Bureau” – an important local variety with good and well-accepted agronomic characteristics. Yield reduction was attributed to the reduced production, translocation and absorption of photosynthates caused either by reduced leaf area (due to curling) hardening of stems and other still unknown physiological and biochemical disorders. The disease devastated large production areas and caused great economic losses to many farmers in the region.

¹ Research Fellow- International Potato Center, Instructor – Tarlac College of Agriculture, Associate Professor, Central Luzon State University and University Researcher – University of the Philippines at Los Banos .

Through collaborative efforts of Tarlac College of Agriculture (TCA), Central Luzon State University (CLSU), and Department of Agriculture-Central Luzon Integrated Agricultural Research Center (DA-CLIARC) and with financial support from Philippine Council for Agriculture National Resources and Forestry Research and Development (PCARRD), a technology in the production of clean planting materials (CPM) through thermotherapy and meristem culture has been developed. The “Super Bureau” (VSP 6) a popular sweetpotato variety in the region was cleaned up, multiplied and sold to farmers.

CPM Research and Development

Sweetpotato is propagated by vegetative means. Farmers obtain cuttings from their previous planting from the field and further multiply them for their next cropping. Following this practice repeatedly over time continuously spreads the disease and aggravates the “camote kulot” problem. The use of clean planting materials (CPM) is considered as a good, immediate and feasible control measure for “camote kulot”. Results of on farm trials indicated the ability of CPM to reduce disease incidence resulting to higher yield and income from sweetpotato production.

Before receiving support from the Users Perspectives with Agricultural research and Development program of the International Potato Center (CIP-UPWARD), exploratory studies on the nature and extent of “kulot” were conducted by TCA. PCARRD supported improvement in the facilities of the tissue culture laboratory and nethouses for RMT as well as further verification of CPM technology in lahar and non-lahar laden farms in Tarlac. CIP provided support for construction of a nethouse, training of the researcher on tissue culture and rapid multiplication technique (RMT) and identification of viruses using ELISA kits

Attempts to validate and promote the use of CPM were also undertaken by TCA. It collaborated with the local government unit of Sta. Ignacia, Tarlac to produce and sell CPM. The LGU funded the construction of two nethouses and provided PhP15,120/ha credit support to 13 farmers that will produce and sell CPM. TCA conducted a one-day training for the farmers and provided regular technical assistance. Initial planting materials were also given to the farmers at subsidized cost. Unfortunately, the venture did not prosper because of the delay in planting of sweetpotato farms in Sapang, Moncada. The target market for the CPM was waterlogged and flooded and planting materials were not paid, bought or harvested.

Creating Impacts through PR&D

CIP-UPWARD started working on sweetpotato livelihood systems in Central Luzon by organizing a multi-agency project development workshop. The workshop attended by TCA, CLSU, DA-CLIARC and R&D institutions recommended the conduct of livelihood

systems analysis to determine the status of sweetpotato industry in the region and come out with a relevant research agenda.

Livelihood Systems Analysis

LSA was implemented in Central Luzon to determine status and assess sustainability of sweetpotato-associated livelihood systems and determine contributions of sweetpotato in the system at the household and community level. The analysis untangles the different issues associated with sweetpotato production, marketing, processing and consumption and determines their relevance to the existing livelihood systems.

LSA results show that sweetpotato is grown in diverse agro-ecological systems, either as a primary or secondary crop in the region. It is part of a livelihood portfolio that consists of crop, livestock and off-farm related enterprises (Adion, 1999). The diversity in livelihoods and the different strategies pursued by the various stakeholders and households involved, offer an array of research and development opportunities that need careful consideration, evaluation and prioritization.

The results identified camote kulot, lack of quality planting materials, low soil fertility and lack of control of the market as the priority problems of households involved in sweetpotato associated livelihoods. They highlighted the need for Farmer Field Schools (FFS), Farmer Participatory Research (FPR) and other more participatory learning and action approaches. LSA also identifies sweetpotato producing areas in Bataan as the more appropriate sites for PR&D activities because of the key roles that they play in the planting materials distribution system in the region.

Farmer Field Schools

The FFS approach in learning sweetpotato planting materials production was piloted in Bataan in 2000 and was later adapted in Tarlac. The field schools used a draft manual developed by the facilitators and some resource persons. They were used as venues for farmer learning on clean planting materials production and also control and prevention of “kulot”.

The curriculum focused on the propagation and management of CPM inside and outside nethouses and on cultural management of CPM for root and planting materials production. Special topics such as experimentation, farm record keeping, financial analysis, etc that were found necessary were also discussed. Participatory research methodologies used in aid of learning such as farmer- managed experiments, field observations, discussions, cross visits, field trips and group dynamics were conducted. Project launching, field days, end of season evaluations, and review and planning workshops were used to increase awareness of other actors and stakeholders about learning process and CPM. All activities were designed and implemented according to farmers’ needs and situations making the project flexible and adaptive to local situations.

Farmer Participatory Research

Farmer Participatory Research (FPR) was conducted to compare the yield and level of virus infection of CPM and non-CPM, with or without disease management and determine percent decline in yield at each level or stage of multiplication.

CPM gave both increased yield and better quality plants because of its greater rooting ability, more rapid growth and earlier tuber formation than non-CPM plants. On farm trials showed higher yield of CPM from TCA (27%) and from FFS nethouses (13%) respectively as compared to cuttings from farmers' fields. Kulot incidence using the same materials is also rated very low and low and observed at later stages of crop growth in fields planted with CPM as compared to moderate at earlier stages observed in farmers' cuttings

Table 2. Root yield of CPM and non CPM with or without disease management in on farm trials conducted in Bataan and Tarlac, Philippines

Treatment	Root Yield (tons/ha)			
	Year 1		Year 2	
Sites	Bataan	Tarlac	Bataan	Tarlac
CPM+DM	11.22a	13.67a	9.92a	24.56a
CPM only	10.50a	13.20a	9.20a	23.84a
FPM+DM	10.44a	13.00a	6.83b	16.09b
FPM only	7.61a	11.28a	6.00b	14.21b

In a column, values followed by the same letter are not significantly different at LSD (0.05)

However a serious drawback remains – the plants have no resistance to virus. After plants were transferred into the fields, beneficial effects disappeared over a three to four year period due to re-infection. The integrity of planting materials can not be maintained for a long time. Re-infection is bound to occur upon field exposure.

Table 3. Degree of virus infection of CPM and non CPM with or without disease management in on farm trials conducted in Bataan, Philippines

Treatment	Virus Infection (%)							
	Year 1				Year 2			
	Initial	3WAP	6WAP	8WAP	Initial	3WAP	6WAP	8WAP
CPM+DM	0.00	0.25	0.5	2.25	15.18	18.89	12.22	9.44
CPM only	0.00	0.75	3.5	7.00	15.18	27.22	16.11	14.45
FPM+DM	0.00	1.50	1.50	4.25	12.00	11.6	10.92	28.33
FPM only	0.00	1.00	4.00	9.25	12.00	15.11	12.22	43.33

The viruses that were detected in both CPM and non-CPM plots were SPFMV, SPCFV and SPCSV, SPFMV being the predominant virus type. The absence of “kulot” in FPM can be due to the uneven distribution of the virus within the plant or the virus concentration in parts sampled may not be high enough for the assay to detect. It could

also be due to good farmers' management and/or low intensity of virus disease of planting materials production area. Disease management (hilling-up, rouging of symptomatic plants, spraying of insecticides, weeding) also helped reduce virus infection and allow better crop growth and yield.

Table 3 shows that the yield of sweetpotato for Year 2 on all treatments are much lower compared to that of Year 1 at the same experiment site. CPM yield reduction due to re-infection is 12.38% without disease management and 11.57% with disease management. The Non-CPM or the farmers' planting materials on the other hand was reduced by 34.58% and 21.15% respectively. The decrease in yield can be attributed to the use of planting materials from previously grown less-infected crop but now with higher initial virus infection.

Table 4. Yield reduction due to reinfection of CPM and non-CPM with or without disease management in Balanga, Bataan, Philippines.

Treatment	Root Yield (tons/ha)		% Yield Reduction
	Year 1 (Sept.-Dec. 2003)	Year 2 (Aug.-Nov.2004)	
CPM+DM	11.22	9.92	11.57
CPM only	10.50	9.20	12.38
FPM+DM	10.44	6.83	34.58
FPM only	7.61	6.0	21.15

Generating Outputs and Outcomes

Interest on CPM picked up after the high profile piloting of FFS-SPPMP. The regional office of the Department of Agriculture (DA-RFU 3) and local government units (LGUs) of sweetpotato producing municipalities initiated, coordinated, facilitated and funded succeeding activities. DA-RFU provided 1.5 million pesos to support intensification of sweetpotato CPM production and distribution. LGUs of Sta. Ignacia in Tarlac and Bagac and Balanga in Bataan have conducted FFS in other villages using their own staff, facilities and funds. UPWARD was requested to provide capacity building, monitoring and evaluation and other technical support. Table 2 list the outputs of PR&D activities conducted.

Capacity Building

Field schools were implemented in three locations in Bataan and in six locations in Tarlac covering 22 villages and 8 municipalities (Table 2). The schools trained 170 farmers and 17 agricultural technicians in CPM production and utilization. Farmers appreciated the nature of viral diseases and understood dynamics of disease transmission including concepts of vectors, reinfection and alternate hosts. More importantly, they acquired skills necessary to not only to produce CPM for their own farms but also in making an enterprise out of it. Agricultural technicians who were only previously exposed to rice

production not only acquired knowledge on sweetpotato planting materials and root production but also skills in managing and facilitating farmer field schools. In addition, facilitators and resource persons involved in the process also strengthened their capacities in managing and facilitating PR&D approaches such as LSA, FFS, FPR and PM&E.

Farmers association and cooperatives increased their confidence and competence in dealing with individuals and institutions to access resources and leverage policies supportive of their need to improve their livelihood system. They were able to access financial support to finance research and development activities, micro-credit support to undertake CPM production and amend policies of the Land Bank of the Philippines to accommodate costs of CPM for sweetpotato production loan.

Technology Adaptation

CPM was produced and used by 117 farmers from 16 villages in Tarlac and 8 villages in Bataan. As of 2003, there were only 4 who are classified as SP CPM producers, 53 users and 60 producer-users. Majority (60 or 51% of 117) of the adaptors were producer-users who also undertake staggered production of roots to sustain their needs. Some farmers prefer to produce and use CPM to be on the safe side especially that market for CPM is not yet well established. They also gain additional income from the roots produced by the crop. Others produce CPM for planting in their own root production farms but also sell CPM.

Forty percent of the farmers first learned about CPM from TCA while others learned it from DA-RFU, LGU's, Coops, co-farmers/relatives in the area, CLSU and BSU. Majority of farmers in Tarlac learned about CPM in 2001 (30%) and 2003 (27%) while most farmers in Bataan learned about it in 2000 (35%) and 2002 (40%).

Table 5. Outputs and outcomes of PR&D activities on pathogen-tested sweetpotato planting materials production.

Activities	Outputs		
Livelihood Systems Analysis	research agenda		
	appropriate project site		
	research team		
FFS –SPPMP Piloting (Bagac, Bataan)	15 farmers trained	1 semi-permanent nethouse 3 improvised nethouses 5 multiplication farms	
	3 technicians trained		
	3 TCA facilitators mentored		
	Draft FFS Manual		
	Increased awareness	3 FFS	2 mosquito net-type nethouses
		1 LGU nethouse	

		DA Support (PhP1.5 M)	25 tunnel type nethouses 8 FFS conducted 115 farmers trained
		Credit Support to farmers (PhP 418,490) PhP16,000/ha	1 farmers association 20 has multiplication farms 20 CPM producers 16 mosquito net-type nethouses
	1 Training of Trainers (TOT) conducted	8 technicians trained 1 farmer trained	2 LGU nethouses 6 FFS conducted
	PTD Agenda	2 PTD seasons	

Table 6. Coverage and outputs of Farmer Field Schools on Sweetpotato Planting Materials Production (FFS-SPPMP) conducted in Central Luzon, Philippines

Location	Coverage	Number of participants trained	
		Farmers	Technicians
Brgy. Dangcol, Balanga, Bataan	3 villages	14	3 OMA staff 3 OPA staff
Brgy. Sto Nino, Bamban, Tarlac	2 villages	29	2
Brgy. Sta. Juliana Capas, Tarlac	3 villages	21	1
Brgy. Tagumbao, Gerona, Tarlac	2 villages	20	1
Brgy. Aduas. Paniqui, Tarlac	3 villages	19	1
Brgy. Sapang, Moncada, Tarlac	2 villages	26	1
Brgy. Cataning, Balanga, Bataan	3 villages	20	1
Brgy. Saysain, Bagac, Bataan	1 village	13	1
Brgy. Baldios, Sta Ignacia, Tarlac	3 villages	22	3
Total	22	170	17

Some farmers in Tarlac started planting CPM as early as 1998, two years earlier than that of Bataan. It is mainly because the project team who initiated the clean up of the widely grown variety (Super Bureau) was from Tarlac. However, majority of farmers in Tarlac (36%) and Bataan (60%) start utilizing CPM in 2002 and 2003 respectively. These findings show that farmers immediately adapted/utilized SP CPM after undergoing experiments through the FFS or upon learning from other farmers' experiences.

Majority (57%) used CPM because of its perceived high quality, free from "kulot" and higher yield. Furthermore, 65% claimed that they continuously use CPM. Seventy five percent claimed that they continuously use CPM because of its good benefits (higher yield), good quality (disease free), early maturity and better accessibility. On the other hand, around 19 or 25% farmers did not continuously use CPM due to the unavailability of CPM (13) and lack of capital (3). Four farmers from Tarlac complained about the quality of harvested roots (elongated and non-marketable) that discouraged them to continuously use CPM.

CPM Production and Utilization

As of 2003, CPM production covers 60 hectares of nurseries and multiplication farms while 415 hectares were used for sweetpotato production utilizing CPM in Tarlac and Bataan. CPM production and use were spearheaded by FFS graduates and/or members of farmer organizations. In Tarlac, CPM production is being pursued vigorously by the Sta Ignacia CPM Producers Association while CPM utilization is being promoted by the Sapang Primary Multipurpose Cooperative, Inc. In addition, there are individual farmers who are also engaged in CPM production and/or utilization.

In Bataan, farmers who have undergone FFS on ICM and sweetpotato planting materials production are also producing clean planting materials. The three groups of participants who have constructed their own nethouses produce mainly for their own planting material requirements. However, stem cuttings from their storage root production farms were sold to traders from Tarlac or given away to friends and relatives.

Table 7. CPM Production in Central Luzon in 2001-2002

Year	Producers	Source of CPM	Area (has)	No. of Farmers	No. of Cuttings
2001	TCA	TCA	1 nethouse 0.30	NA	120,000
	Sta Ignacia	TCA		4	100,000
	Moncada	TCA, LGU(Moncada) Nethouse Sta Ignacia	36.55	9	1,850,000
	Paniqui	LGU (Paniqui) Nethouse	3.00	4	150,000
	Gerona	LGU(Moncada) Nethouse	7.40	9	370,000
Sub-Total			47.25	26	2,590,000
2002	TCA	TCA	2 nethouses 1.2	NA	214,000
	Sta. Ignacia	TCA	7	18	455,000
	Bamban	TCA	4.75	8	250,000
	Moncada	TCA/Sta Ignacia Bagac, Bataan	78.3 18	12 12	3,915,000 900,000
	Paniqui	LGU (Paniqui) Nethouse	7.00	5	350,000
	Gerona	LGU(Moncada) Nethouse TCA	24	36	1,200,000

Sub-Total	140.25	91	7,424,250
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Nethouse Innovations

One of the important structures in the propagation and/or maintenance of quality of clean sweetpotato planting materials are the nethouses. Clean materials are propagated inside these structures to prevent insect vectors from transmitting the disease. TCA has received financial support from various institutions for the construction of nethouses. It has four nethouses measuring 5 x20 m with funding support from TCA and PCARRD in 1998, CIP in 1999, and DA-RFU3 High-Value Commercial Crops Program in 2001.

Nethouses at the municipal level were constructed either as a project counterpart of the LGU or provided by the project as learning venues for the technology and for the community to start propagating clean planting materials. In Tarlac, the municipality of Sta. Ignacia was the first to build nethouses followed by the municipalities of Moncada and Paniqui, the two biggest sweetpotato producing municipalities in the province. Likewise, the Bilad Multipurpose Cooperative in Camiling put up its own nethouse with the intention of going into the business of sweetpotato planting materials production. Nethouses built by these municipal governments measure 5x5-m with either steel or wooden frames.

DA-RFU 3 funded the construction of cheaper and more manageable tunnel-type nethouses that were distributed to participating municipalities. Twenty farmers constructed nethouses from their own funds or from production loans provided by local governments. These were either bamboo-frame type or mosquito net-type nethouses. The types, location and owners of constructed nethouses are in Table 4.

Table 8. Nethouse innovations as encouraged by PR&D process

Nethouse Type	Institutional Management			Subtotal
	R&D Centers	LGU	Private	
Semi-permanent (5x20m; steel frame; double door)	TCA -5	Balanga-1	Domingo-1	16
	DA-CLIARC-2	Moncada-1	BMPCI-1	
	CLSU-1	Paniqui-1		
		Sta. Ignacia-1		
Improvised (5x20m; wood or bamboo frame; double door)	TCA-1	Moncada-1	Bagac-4	6
Tunnel-type (2x8m; collapsible steel frame; zip door)	TCA-4	Gerona-4 (Bamban-4)		25
		Moncada-4 (Sta Ignacia)		
		Paniqui-4		
		Bamban-4		
		Capas-4		

		Bagac-1		
Mosquito-net type (2x6m; pole support; zip door)		Balanga-1	Bagac-1	20
			Balanga-2	
			Sta Ignacia-16	

Assessing Impacts

Knowledge Enhancement

PR&D approaches are based on learning by doing principles in which farmers and other actors conduct field activities to test and learn about crop management options under realistic conditions. Knowledge were gained through field experimentations, observations and discussions and supplemented with scientific and socio-economic explanations.

During the research and development process, farmers were able to confirm that *camote kulot* is partly caused by water stress and low soil fertility and disprove that longer vines produce better yield. They have acknowledged that it is a transmissible viral disease that posed a grave threat to their livelihood, if not managed effectively. Farmers also had better appreciation of CPM's economic value and thus motivated them to cooperate in mitigating the disease. This was exhibited in their willingness to build nethouses and use CPM when available.

They also claimed that after attending the FFS they were able to understand and learn more about different CPM production activities (from production of single node cuttings to production of planting materials and roots and their marketing). They became more aware of the cost incurred along with the benefits derived in the said undertaking. The knowledge encouraged them maximize scarce resources around them.

Farmers appreciated value of experimentation as they hop from one experiment to another during field schools. They even proposed to validate results of these experiments through farmer participatory research as they wanted to the results from bigger experimental plots

Livelihood Improvement

The economic gains of propagating clean sweetpotato planting materials was demonstrated in the pilot test conducted in Baldios, Sta. Ignacia, Tarlac. Based on the group's experience, CPM production is an economically viable source of livelihood. The association members revealed that during the 2003 planting season, they were able to generate an estimated average net income of PhP14,215 per hectare of their CPM production farms. An average of 118, 458 cuttings were harvested per hectare at PhP 0.12 per cutting (if the buyer harvest the cuttings) and PhP 0.15 per cutting (if the owner harvest the cuttings).

The total cost of production for one hectare CPM amounted to PhP 78,096.50. This cost included the non-cash cost of PhP 43,997.90 for the land charge/rent and an interest of 24% on capital. The average production cost per cutting is PhP 0.12. With a stem cutting yield of 672,500 and a storage root yield of 90 bags, the total gross income that can be realized from a hectare of sweetpotato planting material production farm is PhP 136,875 if the price of stem cutting is PhP 0.15 and the price per bag of storage root is PhP 400, the net income will be PHP58,778.50.

Sweetpotato root producers especially members of Sapang Multipurpose Cooperative, (SMPCI) also benefit from the use of CPM due to reduced cost planting materials and also on reduced disease incidence leading to better yields. At first, the coop bought CPM mother plants directly from TCA. They assume the responsibility of multiplying the CPM before it was utilized for root production. The coop also took charge of marketing and distribution. Farmers who bought CPM cuttings and multiply them to produce planting materials enough for his entire root production area save 33% on the cost of planting materials if they will be buying them all.

Farmers claimed lower and much later incidence of camote kulot and relatively higher yield. On farm trials conducted in the area showed higher yield of CPM from TCA (27%) and from FFS nethouses (13%) respectively as compared to cuttings from farmers' fields. Kulot incidence using the same materials is also rated very low and low and observed at later stages of crop growth in fields planted with CPM as compared to moderate at earlier stages observed in farmers' cuttings

Enterprise Development

CPM production provided farmers in the municipality of Sta Ignacia a new source of livelihood. In addition, they were able to utilize previously underutilized rainfed lands for planting materials production. Farmers who are previously trying to cultivate these lands for rice production are getting better income from CPM production. Idle lands were now being utilized while available farm facilities were maximized (both for personal use or for rent/hire), providing them alternative sources of income and employment.

Although, they had experiences financial losses in previous attempts to produce and market CPM, they persistently learn the trade and are now making adjustments in the system based on their and other farmers' successes and failures. The LGU of Sta Ignacia is now on its sixth year of supporting this initiative.

The Sta Ignacia Clean Planting Materials Producers Association (SICPMPA) loans money to farmer members so that they can invest in the CPM. The association, with the financial assistance of the local government, takes care of the release and collection of loans. Together with OMA, they create policies that help to systematize access to and the repayment of loans. When members harvest and sell planting material, the association subtracts loan amounts from the gross sale of the cuttings and roots, and then divides the proceeds of each farmer such that 40% goes to the individual, and the rest gets divided up among the various group costs.

Understanding Impact Creation

Contributions of PR&D

Integrating Knowledge

P R & D effectively addressed different stakeholders expectations by integrating their issues and concerns expressed during discussions in the research agenda. The “camote kulot” problem although technically identified by researchers was considered urgent and important on the basis of farmers’ perceptions elicited using participatory research methods. The control and prevention measures were designed based on farmers’ situations determined through agro-ecosystem and livelihood systems analysis.

PR&D provided venue for self-discovery linking local knowledge with knowledge generated from science. The field school curriculum was an output of the interaction of the interdisciplinary team that managed and implemented the project. In addition to this level of integration, it was further validated with the participants such that the learning agenda will be more relevant and appropriate to them. Constant interaction among the actors under conditions of cordiality and ethics or mutual respect made the process more effective.

Facilitating Innovation

PR&D allowed adaptation of innovations according to farmers and other users’ needs and capacities. The process of rapid multiplication of CPM was subjected to a number of innovative inquiries that fancied farmers imagination. Nethouses were made from resources within the reach of each household. Nethouse sizes and shapes vary - posts were made from bamboo and wooden poles; wooden, steel and wire pins were used to anchor the nets; zippers, buttons and wires were used in lieu of door frames. Aside from doing the sewing of the nets themselves, young women, housewives and children adapted nethouse operations in the backyard.

Water management innovations allowed farmers to propagate their planting materials anytime without fear of lack of irrigation. Farmers experiment on the color, size and use of nethouses, on the number of nodes that appropriate for rapid multiplication of planting materials, on the kind of media which cuttings will grow best, on nutrient requirements, etc.

PR&D interventions initiate processes of building capacities of project participants to address other farming and livelihood problems. The experience of solidarity, self-organization and networking encouraged in the research process prepared farmers for engaging in more meaningful collective action. For example, a typical FFS involves 20-30 farmers from 1-4 villages coordinated and facilitated by staff from 2-6 institutions. These numbers are just the minimum range of interactions. During school launchings and

field days, it is not only the number of farmers, villages and institutions involve that increase but also the people from these participating groups. It is during these events where a number of non-project provided resources are accessed by the farmers.

Encouraging Partnerships

Multi-agency partnerships is one of the key of elements of the PR&D process being promoted by UPWARD. One cannot do PR&D without R&D partners. Partnership is a critical dimension in putting into practice UPWARD's concept of local R&D management. It simply means making R&D responsive to local development needs by involving major stakeholders in the process and encouraging local institutions to offer inputs in a process which is driven by their needs.

Addressing different stakeholders' expectations is critical to maintaining interest and developing mutual trusts. Partnerships work best only when a common problem has been defined and the different agencies have identified their respective roles in solving the problem. The group took pains in jointly creating realistic expectations from each other making sure that the human and financial resources are available to meet expectations. Expectations were defined in the Memorandum of Agreement (MOA) signed by the heads of all participating institutions. Municipal, city and provincial councils passed resolutions to legitimize their involvement with the project.

As a mechanism for building effective platforms for interaction, PR&D engage the different stakeholders in a creative innovation process. In this case, research institutions, state colleges and universities, government line agencies, local government units, farmer associations and cooperatives worked together to develop and promote the use of CPM.

The project did not only encourage LGU's and other R&D partners to contribute more resources to the project but also enhance their capability and interest to take in other roles and responsibilities in the PR&D process. Collaboration and resource complementation were greatly improved as evidenced by the specific roles and responsibilities extended towards the success of the project.

LGU's supported the construction of net houses as in the case of Sta. Ignacia, Paniqui and Moncada, Tarlac as well as of Balanga, Bataan. The Office of the Provincial Agriculturist in Bataan (OPA-Bataan) shouldered the cost of supplies and materials for the FFS in Balanga while the Municipal Planning and Development Office (MPDO) in Aringay, La Union offered to take care of the cost of producing Information, Education and Communication (IEC) materials.

These clearly point out the increasing role of PR&D activities in improving not only the natural, human, and financial assets but also the social capital of the LGUs and other project stakeholders. PR&D provided opportunities for different stakeholders to establish more social networks as well as norms of obligation and trust. It enabled project implementers to go farther and faster in terms of scope or area covered. More FFS were conducted, more nethouses were built and more farmers were served .

Partnership benefits were also observed in institutions and researchers. This, in a sense adds value to the project that implies potential replications and scaling up of participatory approaches at institution level. Researchers involved in these projects claimed to have developed competence in R&D management. Their confidence was boosted by the recognitions awarded them and the improved relationships they developed with their supervisors

Limitations of PR&D

Cleaning is not enough

Development and multiplication of pathogen-tested planting materials is not enough to ensure that benefits from its use will accrue to farmers and other users. Losses from CPM production occurred because the timing of planting was not adequately studied. The age of planting materials has a bearing on its performance and thus planting materials from a more than 75-day old crop will not anymore be bought by root producers. Coupled with uncertainty of weather conditions in root producing areas, probabilities that synchronous planting of CPM will result to financial losses are very high.

Focus group discussions revealed that there were already two instances where a good crop of CPM for planting materials was laid to waste because of flooding in major sweetpotato growing areas in Tarlac. The first instance in 1998 resulted to losses when CPM delivered to farmers was not paid because the newly planted sweetpotato farms were under water. The second was in 2003 when planting materials were not harvested while waiting for the flood to recede. However when water receded, the crop is already more than 75 days old and hence not anymore saleable.

The number of farmers benefiting from CPM production and use was also limited by availability and accessibility of mother plants. Farmers in the region were very much dependent on TCA as a source of starting materials for CPM production. Assessment results indicate the need for more efficient production of mother plants and single node cuttings that will provide CPM producers flexibility in terms of the area and timing of production.

Developing enterprises from CPM production also entails mechanisms for ensuring quality of produce. However, the current system is still beset with the following problems:

- Absence of production and distribution protocols which will serve as a guide to CPM producers/users to ensure quality production.
- Limited capacities of non-FFS graduate farmers to undertake CPM production
- Non-strict observation of FFS graduates from the recommended SP CPM production practices.
- Non-functional/underutilized nethouses

Untrained farmers are also getting into CPM production to cash in on the economic benefits of the enterprise. Hence farmers could be misled in buying these poor quality planting materials and the resulting disillusionment of the unsuspecting buyers can kill the fledgling seed industry as well as local initiatives to improve seed quality

Ensuring quality of CPM requires a comprehensive plan to develop efficient and effective CPM production and distribution system. The plan considers the capacity and distance of the source of mother plants, single node cuttings and planting materials to supply the existing demand. It may also involve locating multiplication farms in areas where disease vectors and alternate hosts are low.

CPM is not enough

CPM re-infection is another key concern that limits its impact. CPM remained virus free only when grown in isolation. They quickly became infected when planted in the field.

On farm experiments showed that yield of planting materials taken from the previous season's CPM crop can be reduced by more than 10%. In addition, even though CPM can reduce incidence of camote kulot and thus improve yield, factors affecting productivity of sweetpotato in the region are multi-faceted and dynamic.

Managing camote kulot alone necessitates reliance on other components of an integrated crop management strategy- resistant varieties disease management, nutrient management, soil and water conservation, etc. Even techniques of cleaning-up a variety needs to be done to other varieties aside from "Super Bureau" so that chances of pest outbreak associated with monocultures of single variety will be minimized.

Varieties resistant to sweetpotato viruses and other pathogens are not yet identified if not developed. New pests such as sweet potato weevil, rough weevil, stem rot, scab army worm, and little leaf are becoming more important. Soil erosion and degradation also incessantly affect sweetpotato yields as farms are continuously to be intensively cultivated. The presence of any of these factors easily negates whatever impacts the use of CPM created.

PR&D is not enough

PR&D can help develop and adapt innovations to solve problems of farm productivity and efficiency of livelihood systems. However, complex production constraint such as camote kulot require's more than technical interventions. CPM use may help reduce disease incidence and improve yield but these gains may not readily be translated into high income or better livelihoods. Prices of farm inputs and farm products are beyond farmers nor the research team's control. The high cost of transport due to long distance of farms to main roads and absence of farm to market road increases cost of production.

Micro-credit, extension and marketing support are way beyond mandates of research institutions. But these concerns largely determine the nature and degree of impact that a

technology like CPM can create. An inter-agency partnership is not an assurance that partners' support will not be used to advance personal and/or institutional agenda.

Summary and Conclusions

Participatory research and development is done within a knowledge system with components, processes and actors that are inter-linked and where innovations emerge as a result of participation and interaction among stakeholders. It is not only associated with perspectives and approaches that are multiple and diverse, but also with processes that are non-linear, iterative and cumulative.

In the context of facilitating innovations to meaningfully address problems such as *camote kulot*, basic elements of participatory research were put in place as guides to identify essential components of an integrated research-development oriented project. The research agenda was based on problems severely affecting farmers in the region for several years. It was a response to their desire for good quality planting materials. A livelihood systems framework was used to plan and implement PR&D interventions that impacted on households.

The interventions were implemented by an interdisciplinary team of plant pathologist, agronomist, agribusiness and PR&D specialists, extension workers and farmer leaders coming from different institutions. Project processes recognized co-equal existence of the different stakeholders not only in the learning but also in the research and development process. More weight was given to underlying principles of experimentation and learning. Research tools and techniques were selected and curriculum was developed to ensure that they bring about maximum independent learning.

Results of the assessment indicated the role of participatory approaches in facilitating project outputs and outcomes. PR&D approaches intensify awareness of research and development institutions about "camote kulot" and the potential of CPM in solving it leading to their provision of resources and other support to its solution. CPM were produced and used by 117 farmers in 19 villages of the provinces of Tarlac and Bataan. Local government units provided their own resources to so that their constituents will benefit from the technology. They build nethouses, finance FFS and mobilize communities leading to establishment of enterprises out of CPM technology.

Unfortunately, there are a number of technical, socio-economic and policy issues that limits more widespread use of CPM and improvements in contributions of sweetpotato to the livelihood systems of households in the region. Absence of an efficient production, distribution and marketing system of CPM affected efficiency and hence productivity and profitability of CPM enterprises. Agroecological and socio-economic factors diminished if not totally negated gains through CPM production and use. Markets, policies and other institutional issues that are way beyond the control of farmers nor the project team influenced heavily the nature and degree of impacts on the livelihood system.

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