SWEETPOTATO GROWERS' PERCEPTION ABOUT LAHAR AND INTEGRATED NUTRIENT MANAGEMENT PRACTICES ADOPTED[1/]

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ABSTRACT

Sweetpotato has been a consistent component crop of farming systems in lahar-laden areas in Central Luzon. It is grown in lahar deposits as shallow as less than 50 cm to as deep as seven meters. The deposit is generally perceived as less fertile as compared to the original soil although few of the 154 farmer respondents perceived it to be more fertile or just like the original soil.

The identified constraints to the utilization of lahar for growing crops/sweetpotato were very similar in the different lahar categories. These were: hard and sticky, plenty of stones and grasses, lack of nutrients, acidic and has foul odor, crops grown in lahar needs more water it being droughty due to sandy texture, fertilizer applied in lahar deposits have low effectivity.

Integrated nutrient management and related practices such as land preparation, irrigation, fertilizer application, weeding, pest management, variety and crop residue management did not vary much with the depth of lahar that affected the farms of the farmers.

INTRODUCTION:

Soil is a natural resource resulting from the weathering of rock minerals. The level of soil fertility depend on factors of soil formation such as climate, organisms, relief or topography, time and parent material. Where one factor becomes more dominant over the other, there will be differences in the physico-chemical properties even if the same soil was derived from the same parent material.

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Differences in the level of soil fertility is equated to the differences in the amount of nutrients supplied to the soil coupled with the other soil management practices that enhances the utilization of applied nutrients. Thus, soil fertility includes both chemical and physical fertility (Orpia et al, 1980) hence, soil fertility management can be considered very similar with integrated nutrient management. Both aim at a) improving the nutrient supplying power of the soil through balance fertilization; b) providing optimum physical soil conditions such as texture, structure and minimum root impedance and c) improving existing crop yields through provisions of nutrients from both "open" and "close" systems.

The case of Mt. Pinatubo eruption in 1991 is an unsurpassed record of volcanic eruption in the world. The devastation caused by ash and most especially lahar* (pyroclastic materials) flow is one if not the most serious in terms of destruction of agricultural lands. It has caused major shift in crop production in Central Luzon particularly rice and sweetpotato (Data et al, 1990). The shifting of sweetpotato production areas to the former most suitable (S1) areas for rice was basically due to soil marginalization brought about by inflow of lahar in these areas.

In most instances, yield variability were commonly observed in sweetpotato areas. This indicates highly probable yield improvement by breaking through limitations inherent in lahar-devastated areas. Although sweetpotato is known to be tolerant of stressed conditions and adopts well in marginal areas, provisions of better environment such as optimum fertilizer and water and use of high yielding but stress tolerant varieties altogether may improve yield. The reported average yield per hectare of sweetpotato in the Philippines is rather low (5.12 t/ha) compared to other Asian countries such as China, India and Indonesia. All factors of production affect yields of sweetpotato. The soil factor, however, can be easily managed.

Adequate documentation of how lahar-affected families coped with the marginal fertility of their farms are important input to future improvement of INM practices or widespread dissemination and adoption by other farmers.

Thus, this study aimed to: a) gather the perception of farmers about lahar as medium for crops production; b) identify and document the existing INM practices adopted by farmers in the different depths of lahar; c) identify problems associated with INM and sweetpotato production and d) come up with comparative data on some variables by province and lahar category and e) conduct case studies on INM farmer practitioners.

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* Lahar are coarse to fine volcanic debris or pyroclastic materials which are carried by moving water and deposited in lower areas or downslopes.

METHODOLOGY:

Project Site Selection

We conducted preliminary surveys in lahar-stricken municipalities and barangays in Region III in coordination with the local government units, particularly the Department of Agriculture. Records on the depth of lahar deposits and presence of SP production farms were taken from the data filed at the different municipalities.

The secondary data obtained were validated at the barangay and farm levels particularly the depth of lahar deposit and the existence of SP farms before and after the eruption of Mt. Pinatubo. As to the depth of lahar, all barangays/farms having less than ½ meter were deleted from the list.

Rapid rural appraisal and key informant surveys were carried out that resulted to the final selection of the study sites. The selected sites were the places that the formal survey was conducted.

Table 1 shows the number of respondents in the study sites which fall under different lahar categories. It will be noted that for a particular barangay, several depth categories may be present and this could be explained by the distance from the river or stream that overflowed and the terrain of that particular barangay. From the gathered data, the municipalities of Moncada, Gerona, Bamban and Capas have lahar depths belonging to almost all of the categories while Zambales towns mostly belong to categories 1 and 2 only.

Farms in the low-lying areas have all the lahar depth categories while the upstream sites have shallower deposits.

After the sites was finally selected we implemented the following activities:

1. In-depth surveys by means of focused group interviews were done to gather information on the existing INM practices, and knowledge, problems and other data.
2. Field observations and documentation. Actual observations and documentation of various INM practices were done.
3. PRA of communities covered. Various techniques and strategies were utilized to fulfill the objectives of the project. Geographical transect was done to get information on the main land forms, the crops, livestock, problems and opportunities associated in each area, particularly those relating to sweetpotato production.

   Historical transect was also employed to provide pictorial representation of the area at different points in time, and to give evolutionary trend in land use pre-and-post-eruption of Mt. Pinatubo in 1990.
4. Processing of Data/Analysis/Report Writing.

   The data generated from the project were collated, analyzed, organized, and presented in this paper. These results will be the basis for improving existing farming systems of the farmers particularly in the introduction of INM in their sweetpotato farms. The improvement will be based on the identified problems, farmer resources and capabilities.

Table 1. Distribution of farmer respondents in the study sites.

Province	Municipality	Barangay	NO. OF RESPONDENTS PER LAHAR CATEGORY									
			1 (<1 m but more than ½ m		2 (1.0 – 1.5 m)		3 (1.6 – 2.0 m)		4 (> 2 m)		TOTAL	
			No.	%	No.	%	No.	%	No.	%	No.	%
Tarlac	Moncada	Banaoang West	6	23	5	19	2	14	13	24	26	22
		Sapang	-	-	4	15	6	43	15	28	25	21
	Gerona	Tagumbao	12	46	-	-	1	7	-	-	13	11
		Dicolor	3	11	2	8	3	21	7	13	15	12
	Capas	St. Lucia	-	-	8	31	2	15	16	30	26	22
	Bamban	Culubana	5	20	7	27	-	-	3	5	15	12
		Sub-total	26	100	26	100	14	100	54	100	120	100
Zambales	San Marcelino	Nagbunga	10	36	1	25	-	-	-	-	11	33
		Laoag	1	3	-	-	-	-	2	100	3	9
	Botolan	Porac	9	32	1	25	-	-	-	-	10	29
		Carael	8	29	2	50	-	-	-	-	10	29
		Sub-total	28	100	4	100	-	-	2	100	34	100
		TOTAL	54	35	30	20	14	9	56	36	154	100

RESEARCH RESULTS

The present farming practices were identified and documented in this study. These include information about the farms of the respondents, the farming system, number of years in sweetpotato production pre-and post-Pinatubo eruption, perception/observations about the lahar as medium for planting crops, constraints in the utilization of lahar for crop production, farming practices related to INM and knowledge of farmers about INM.

Information about the farms of the respondents

Appendix Table 1 presents the data about the farms of the sweetpotato farmers. All the farmers are not new to farming including SP farming as revealed by the information gathered which ranged from 2 – 53 years of farming experience with an average of 24 years. Almost all (94%) of them were farming flat lands, with an average of two (2) available family labor in all the categories.

Almost all the farmers owned two parcels of land each, except those under lahar depth category 3 which averaged three (3) parcels per farmer. The farmers have farmholdings ranging from 0.2 to 10 hectares or an average of 2.46 hectares (Appendix Table 1).

Most of their farms were affected by both fine and coarse lahar deposits with varying depths; from less than one (1) meter (54 or 35%) to 2.1 meters and above (56 or 36%). They possessed multiple tenurial statuses from owner – cultivator (35%) to lease-holder (41%) and CLOA holder (15%). There were few (15%) who considered themselves tenants.

The average farm planted to sweetpotato were 0.76 ha for category 1; 1.3 ha for category 2; 1.31 ha for category 3; and 1.39 ha for category 4.

There were other areas planted to other crops before and after planting sweetpotato. Before sweetpotato, an average of 1.27 hectares in all categories were planted to other crops and an average of 1.04 ha after harvesting the SP crop. Additional crops include rice, corn, mustard, sugarcane, vegetables and others.

Farming System

The farming systems adopted by the farmer-respondents is basically rice based. In most of the areas except in category 2 (1-1.5 meters depth of lahar in Zambales) where it is difficult to impound water in the paddies and death of rice is observed, rice is not planted during the later years of post eruption. The most dominant cropping systems in Tarlac were: rice-corn-vegetables; rice-sweetpotato-corn , sugarcane, rice-yambean-corn (Table 2); while in Zambales the most dominant cropping systems are: rice-sweetpotato, rice-green corn, cassava, rice-yambean, rice-gabi and rice-vegetables. The vegetables includes watermelon, mustard (dominant in Bamban, Tarlac), tomato and ampalaya (dominant in Moncada, Tarlac).

Rice is grown throughout the year, but the bulk of hectarage is on the first cropping period; i.e. June to October until August to December indicating the rainfed nature of rice farming in these lahar-laden areas. Dry season cropping of rice is dependent on shallow tube well irrigation systems.

Sweetpotato is grown throughout the year by very few farmers in all lahar depth categories (6% of respondents) while most common plantings are done from October to March and January to May. Some farmers practiced two croppings of sweetpotato but the second crop was mainly as source of planting materials for the regular cropping of Jan – May, October – March and December - May. May – August and October - December croppings are the periods where farmers multiply their seed pieces for commercial plantings.

Ampalaya, peanut,sugarcane and mustard are grown in all of the lahar depth categories but more in less than one meter deep while yambean eggplant and green corn are grown only in <1 m to 1.5 meters deep. Tomato is grown only in <1 meter deep lahar while yellow corn and gabi in lahar deposits greater than 2 meters (Figure 1).

Poultry and livestock are important component of farming systems. Carabaos are raised throughout the year as source of farm power. Most of the farmers in all the site categories own a carabao.

Pigs/hogs, goat, cattle, horse, chickens and ducks are also raise throughout the year mainly for additional source of income and draft power as in the case of cattle and horse.

Fish production is a major farming systems component particularly for farmers whose farms are located in deeper lahar deposits. About 17 and 15 percent of farms in lahar depth category 2 and 4 have transformed part of their farms into fishponds. Among the species grown were tilapia (*Oreochromis nilotica*), mudfish and catfish and are generally grown throughout the year. Table 2 shows the dominant farming systems in the study sites:

Figure 1 below is a ccropping calendar showing the planting and harvesting of various crops such as rice sweet potato, amargoso, tomato, yambean, sugarcane, mustard, eggplant, yellow corn and green corn.
The farmer-respondents have been growing sweetpotato before the lahar flow from less than 5 years (6 months) to as long as 40 years or an average of 12 years in areas with <1 meter lahar deposits, 11 years in 1 – 1.5 m, 15 years in 1.6 – 2 m and 11 years in farms buried to >2 meters. After the onslaught of lahar most of the farmers have sustained planting, while others started later (Appendix Table 2).

Pinatubo eruption exerted positive effects on the yield of the different sweetpotato farms. Before their farms were devastated with lahar, 43% of the farmer respondents yielded 30 sacks or less (2.4 tons/ha or less). Per category level the yield ranged from 1 to 300 sacks in category 1 and 4, 1 to 120 sacks in category 2 and 1 to 200 sacks in category 3 or an average of 47 sacks (3.76 t/ha) in farms which were buried with Lahar depths of <1 to 1.5 meters; 75 sacks (6 tons/ha) in lahar depths of 1.6 – 2 meters and 56 sacks (4.8 t/ha) in lahar depths of >2 meters (Appendix Table 3).

Table 2. Dominant farming systems in the study sites.

SITE	SITE DESCRIPTION	CROPPING SYSTEM
Moncada, Tarlac Sapang and Banaoang West	Rainfed areas of 0-3% slope with lahar deposit having fine sand to silt size particles. Depth of deposit ranged from <1 to >2 meters. SP areas totalled 200 has	Cropping system is rice-based with corn, sweetpotato and vegetables grown after rice.
Gerona, Tarlac Tagumbao and De Color	Generally a rainfed area with lahar deposit ranging from ½ to 1 meter. The size of particles ranged from coarse to fine sand. The total SP areas pre and post eruption is 57 has.	Rice-corn, rice-yambean and rice-sweetpotato are the major cropping systems. Next to rice, sugarcane has the biggest share of the agricultural area.

Capas, Tarlac Sta. Lucia	The only barangay in Capas affected by lahar totalling 800 ha with a depth of 50 cm and deeper; texture ranging from coarse to fine sand	Rice-sweetpotato, rice-corn rice-amargoso, rice-mungbean rice-leafy vegetables, cassava and sugarcane are among the major cropping systems
Bamban, Tarlac Culubasa	Out of the 325 ha area of the barangay, 150 ha was buried by lahar to a depth of <1 m to 1.5 meters. Lahar deposit are generally coarse sand	Rice – sweetpotato and rice-vegetables occupies about 50% of the agricultural land while the rest are sugarcane areas (102 ha).
Botolan, Zambales Carael and Porac	Out of the 518 ha land area of Carael 50 ha were buried by lahar to a depth of 1 meter or more. Lahar deposits have coarse sand texture. Farms are generally irrigated. Porac has only 58 ha agricultural land, with terrain generally hilly. Lahar affected areas are in the lowlands or foot of the hills, with texture generally sandy.	Rice-sweetpotato and rice-vegetables are the major crops grown in the area. Most of the agricultural lands are planted to orchard (cashew and mango) and sweetpotato are planted in between rows of orchards.
San Marcelino, Zambales Nagbunga	Out of the 569 ha land area only 90 ha are devoted to rainfed agriculture. Lahar deposit reached about 1.5 meter deep with texture ranging from very coarse to coarse. It has flat terrain	Rice-sweetpotato, rice-green corn; rice-peanut, rice-tomato and rice-eggplant are among the cropping systems adopted. Sweetpotato area totalled 13 ha.
Laoag	Out of the 457 ha land area 267 is agricultural and generally irrigated. Lahar deposits ranged from <1 meter to 4 meters deep.	

The average yield of SP have increased with lahar deposition from a value of 47 to 51 sacks, 47 to 52 sacks; 75 to 108 sacks and 56 to 82 sacks in lahar categories of 1, 2, 3 and 4 respectively. The increased in yield could be attributed to the increased porosity of lahar deposits (increased macropose sizes) coupled with high amount of calcium and phosphorus which are also found to improve sweetpotato yields (Aganon, et.al 1996).

Perceptions/Observations about lahar as medium for planting crops/sweetpotato and soil fertility improving measures.

Lahar was perceived by 96 (62%) of the respondents as less fertile medium and this were indicated by the stunted growth of plants, droughtiness, wilting of plants, hard surface, silted, acidic, high amount of fertilizer required, hot and presence of sulfur. The rest of the respondents (32%) regarded lahar as fertile since it is able to add to soil fertility, hasten decomposition of crop residues and gives more yield. In shallow lahar deposits, it can be mixed with the original topsoil making the mixture more fertile (Appendix Table 2).

Only one farmer (from category 4) said that its just the same with ordinary soil.

Additional observations were: soil affected with lahar must be given support for irrigation; the soil is good but hard to prepare, abrasive and requires more fertilizer, it easily dries-up.

Below are the remedies done by the farmers to improve soil fertility: Among these are the incorporation of crop residues from the previous crop, use of inorganic and organic fertilizer which the farmers learned from co-farmers, government agencies parents/grandparents, experience, NGOs/Coops or through training.

Remedies Employed	No.	%
• Incorporation of crop residues from previous crop	91	59
• Use of inorganic fertilizer	89	58
• Use of organic fertilizer	85	55
The adopting of soil practices were learned from the following:		
Sources of Information	No.	%
• Co-farmers	97	63
• Government agencies	80	52
• Parents/Grandparents	41	27
• Self-experience/observation	20	13
• NGOs/Coop	4	3
• Training	1	1

Constraints in the utilization of lahar for crop production

The farmers reported some of their difficulties in the utilization of lahar for crop production. These problems were usually encountered during land preparation and during the growing period of the crop. What they did to solve their problems were also probed and reported. These were:

Some problems were encountered during the growing period of the crop. However, the farmers used their ingenuity and resourcefulness in easing their difficulties.

Among the constraints experienced including the solutions to overcome them are presented below:

One of the constraints observed is the less effectivity of applied fertilizer. This may be looked at two angles: First, since majority of the farmers are not irrigating, the fertilizer applied may not have been dissolved due to lack of soil moisture; and secondly;

those who irrigate more frequently have caused so much leaching of the fertilizer especially if the application takes place before irrigation.

Other problems cited were: diseases (signs resembling FMV), insects (aphids), and wilting.

Constraints during land preparation	**Solutions done/offered**
• Hard, sticky and firm soil	Plow at right moisture content; more plowing and harrowing; plant right away when the soil is moist; scrape and deep plow using big tractors; and apply crop residues.
• Plenty of stones S*accharum* and tree roots	Remove stones, S*accharum* and tree roots from the soil; burn tree roots
• Lack of capital. It is difficult to reclaim lahar laden areas which were seriously infested with “tambo” and talahib	Borrowed from banks, private money lenders, relatives, friends, etc. at varying interest rates.
• Acidic soil; with foul odor	Deep plowing and drying; broadcasting of fertilizer
• Lack of Nutrients	Plowing and harrowing to incorporate and decompose crop residues.
• Fast growth of grasses	Deep plowing use of heavy-duty tractors.

Problems encountered during the growing period of the crop	Solutions done
• High water requirement due to the sandy texture of the soil	Irrigation using shallow tube wells; watering, regardless of the depth of lahar.
• Compaction of lahar	Incorporation of animal manure into the soil; irrigation; deep plowing; hilling-up or off-barring.
• Weed growth in the fields	Thorough land preparation; use of organic fertilizers; use of weedicide; off-barring and hilling-up.
• Droughtiness	Incorporation of rice stubbles; timing of planting; use of drought resistant crops; frequent irrigation; planting early maturing crops and adaptable varieties.
• Less effectivity of applied fertilizer	Application of large amount of fertilizer; shifting to other crops.

Farming practices related to INM

Land preparation

Table 3 below shows the frequency of plowing and harrowing done by the farmer-respondents.

In all lahar depth categories plowing frequency ranged from one to five times, with three times plowing having the highest percentage in categories one, two and three. Two times plowing have the highest percentage in category 4. The result indicated that there is no direct relation of plowing frequency with lahar depth. In fact, the result implies that the more frequent plowing operations instituted in shallower lahar deposits hoped to incorporate the original soil into the lahar.

The same scenario was seen in the number of harrowings. There are more farmers adopting three times harrowing in categories one and two while more farmers practiced two harrowings in categories three and four. More frequent or more intensive plowing and harrowing operations were due to: compactness of the soil, plenty of stones, grasses (cogon, talahib) and roots.

Table 3. Frequency of plowing and harrowing done by farmer-respondents.

1. Land Preparation No. of Plowings	LAHAR CATEGORY									
	1		2		3		4		TOTAL	
	No.	%	No.	%	No.	%	No.	%	No.	%
Once	2	4	3	10	4	29	4	7	13	8
Twice	5	9	6	20	3	21	25	45	39	25
Three times	38	70	17	57	3	21	18	32	76	49
Four times	7	13	3	10	3	21	6	11	19	12
Five times	2	4	1	3	1	8	3	5	7	6
Total	54	100	30	100	14	100	56	100	154	100
verage	3		3		2		3			
No. of Harrowings										
Once	1	2	1	3	-	-	1	2	3	2
Twice	6	11	9	30	9	64	27	48	51	33
Three times	35	65	15	50	3	21	20	36	73	47
Four times	10	18	5	17	2	15	7	12	24	16
Five times	2	4	-	-	-	-	1	2	3	2
Total	54	100	30	100	14	100	56	100	154	100
Average	3		3		3		3			

Irrigation

Sweetpotato production in the study sites is generally a rainfed enterprise. Farmers barely irrigate their farms regardless of lahar depths. Of the total respondents only 17 percent are irrigating their farms. Irrigation water is provided either before planting or during the growth period of sweetpotato. The provision of irrigation have important implication to the total soil fertility and SP growth. Among the important points mentioned by farmers were a) to decompose grasses and other crop residues; b) to maintain the fertility of the soil and facilitate planting (in the case of irrigation before planting); c) for tuber development; and d) to provide moisture for the growth of the plants. Earlier, it was mentioned that lahar is droughty and thus require a lot of water.

Farmers who do not practice irrigation considered that a) the soil is still moist; b) tubers will rot "malulusaw ang laman ng camote"; c) water will be in excess "sobra na ang tubig".

Irrigation frequency ranged from once to three times. Irrigating once throughout the growth period is usually employed either before planting, 10 –15 days after planting, at flowering or one month after planting (Table 4). Two times irrigation was employed 15 and 30 DAP, or 30 and 45 DAP while three irrigations is distributed equally throughout the vegetative stage (from planting to 45 DAP).

Table 4. Frequency and time of irrigation for Sweetpotato.

Frequency of Irrigation	Number	Percent	Stage of the Crop
Once	9	35	1 MAP, at flowering before planting or 10 – 15 DAP
Twice	10	38	15 & 30 DAP 30 & 45 DAP
Thrice	7	27	Before planting, 15 DAP 45 DAP

Fertilizer application

Another farming practice explored was the application of fertilizers. Table 5 shows the details.

Table 5. Data on the farmer-respondents' fertilizer application.

Variable	Lahar Depth Categories									
	1		2		3		4		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Fertilization of Sweetpotato										
Yes	40	74	25	83	13	93	54	96	132	86
No	14	26	5	17	1	7	7	4	22	14
TOTAL	54	100	30	100	14	100	56	100	154	100
Frequency of Application										
Once	26	65	12	48	11	84	36	67	85	64
Twice	14	35	12	48	1	8	15	28	42	32
Three Times	-	-	-	4	1	8	3	5	5	4
TOTAL	40	100	25	100	13	100	54	100	132	100

Source of Fertilizer	Rank
14-14-14	1
Ammonium Sulfate	2
Urea	3
Organic Fertilizer	4
Crop Residues	5
16-20-0	6
Animal Manure	7

High percentage of the farmer- respondents (86%) are fertilizing their SP crops. The frequency of application ranged from one (64%) to three times (4%) in lahar depth categories of 2, 3 and 4 and one to two times in lahar depth category 1. Among the sources of fertilizers were 14-14-14, ammonium sulfate, urea, organic fertilizer, crop residues, and 16-20-0 and animal manure in that order. Application of organic fertilizers is basal and one MAP while inorganic fertilizers are applied as basal, 15-30 DAP and 3 WAP.

The lesser number of fertilizer application in shallow lahar deposits is related with the lesser losses of fertilizer. At this depth the chances of the roots reaching the original soil is highly probable, thus any amount of fertilizer that might have been leached down below the deposit can be access by the root system. In deeper deposits, frequent doses of fertilizer was applied to minimize possible losses particularly on those irrigated farms.

Weed management/cultivation

The efficiency of applied fertilizer is often reduced by the presence of competing weeds. Weeding must be timed in such a way that the competition effect do not allow for significant yield reduction. The study also looked into this practice among the farmers studied.

Table 6. Data on weed management

Variable	Lahar Depth Categories									
	1		2		3		4		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Practicing weed control										
Yes	30	56	28	93	14	100	50	89	122	79
No	24	44	2	2	-	-	6	11	32	21
TOTAL	54	100	30	30	14	100	56	100	154	100

Stage of plant when weeding is done	No.	%
1 – 2 weeks after planting	67	55
3 – 4 weeks after planting	29	24
Before hilling-up ("Bago tabunan para di bumilis and pagdami")	20	16
Growing stage/vegetative stage or 5 – 6 weeks after planting	6	5
TOTAL	122	100

Weed Management Method		
Hilling-up only	58	47
Off-barring and hilling-up	49	40
Off-barring only	9	8
Spot weeding (handweeding)	6	5
TOTAL	122	100

It can be gleaned from the table that farmers from all lahar depth categories employed weed control; however, there were lesser farmers (56%) who employed weeding in shallower depth of deposits compared to 93, 100 and 89 percent of farmer respondents in categories 2,3 and 4 respectively.

Weeding was employed during 1 – 2 weeks after planting by 55% of the respondents, 3-4 WAP by 24%; before hilling-up by 16% and 5-6 WAP by 5% of the respondents. Among the important reasons cited were: a) to control weeds and loosen the soil thus, enhancing the growth of tubers; b) to have more robust plants and more tubers; c) to conserve moisture and d) to cover the applied fertilizer. Weed management is done by hilling-up (47%), off-barring and hilling-up (40%), off-barring only (8%) and spot weeding (hand weeding 5%). Twenty one percent of farmer respondents did not employ any of the weed management practices.

Pest Management

Pesticide application to control pest was observed in all lahar depth categories ranging from 32% of farmer users in category 4 to 63% farmer users in category 2 totalling to 40% of the farmer respondents. Of the 15 pesticides that the farmers used 13 were insecticides and 2 were fungicides (Table 15). Of the 13 insecticides 4 were banned by the FPA for use (Malathion, Lannate, Folidol and Furadan).

The stage at which the pesticides were applied were ranked as follows : 1) 3-4 WAP, 2) 5-6 WAP 3) when disease is visible 4) 1-2 WAP 5) 7-8 WAP and 6) before planting. It was indicated from the responses that pesticides were applied against the

Table 7. Pesticides used and target pest.

Pesticides	Rank	Pesticide Category
Cymbush	1	Insecticide
Karate	2	Insecticide
Marathon*	3	Insecticide
Selecron	4	Insecticide
Nuvacron	5	Insecticide
Brodan	6	Insecticide
Decis R	7	Insecticide
Lannate*	9.5	Insecticide
Sevin	9.5	Insecticide
Folidol	9.5	Insecticide
Dithane	9.5	Insecticide
Gusathion	13.5	Insecticide
Furadan*	13.5	Insecticide
Magnum	13.5	Insecticide
Maptax	13.5	Insecticide

* Declared by FPA as banned as of 1995

wrong pest. Of the 62 pesticide users across lahar depth categories, only 12 observed negative effect of pesticide use in their SP crops such as reduced tuber size and drying of leaves.

Varietal Use

Variety is one factor of production that determine yield levels (AVRDC, 1983). Some varieties may be responsive to cultural factors such as fertilizer management irrigation while others are not; some may be pest resistant, drought resistant, early maturing, high yielding while others may not.

Farmers have their own reasons for varietal preferences. Usually these are based on the socio-economic, biophysical, and cultural factors. Almost all of the farmer respondents (149 or 98%) have varietal preferences for reasons of high yields, early maturity (to cope with soil moisture), adaptability, higher market demand (both tubers + cuttings), high income, delicious and sweet tubers and longer shelf-life. Those who do not have varietal preference utilize any available variety in the locality (Table 8).

Table 8. Varietal preference of farmer-respondents.

Variable	Lahar Depth Categories									
	1		2		3		4		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Varietal preference										
Yes	52	96	30	100	14	100	53	95	149	98
No	2	4	-	-	-	-	3	5	5	2
TOTAL	54	100	30	100	14	100	56	100	154	100

Reasons for vaietal preference	No.	%
1. High yielding variety (Super Bureau) (More tubers, higher production)	78	52
2. Early maturing (to cope with soil moisture, Super Bureau and Taiwan)	43	29
3. Adaptability (tested in the field for several years already including the lahar are)	37	25
4. Higher demand in the market (Marketability of both price in the tubers)	17	11
5. Higher price in the market	8	5
6. Availability of planting materials	4	3
7. More income	3	4
8. Tubers more delicious and sweet	3	4
9. Lasting storage capability	2	1

Super bureau was the variety widely grown in all the areas involved in this study. Farmers preferred this variety because they had observed this to be high yielding, early maturity, with big tubers, has big demand in the market, and there are ready planting materials.

There are alternative varieties planted by few farmers from both Tarlac and Zambales. One of these is Taiwan variety which was known to some as 45 days or Express. This variety was preferred by 32 or 21% of the farmers because of longer shelf-life, clean and fair skin, high price and high demand in the market, and soil adaptability (Table 9)

. Ubi was grown by 11 or 7% of the farmers in all the categories. They reasoned out that this variety was adaptable to the soil, high price and has demand in the market.

Table 9. Varieties preferred by the farmer-respondents.

Variety	Lahar Depth Categories										Rank
	1		2		3		4		Total		
	No.	%	No.	%	No.	%	No.	%	No.	%	
Super Bureau	27	17.53	17	11.03	8	5.19	34	22.07	86	56	
Taiwan	7	4.54	2	1.29	-	-	3	1.94	12	8	1
45 days	7	4.54	3	1.94	-	-	-	-	10	6	9.5
Express	7	4.54	1	0.64	-	-	2	1.29	10	6	9.5
Bureau	8	5.19	5	3.24	4	2.59	13	8.44	30	19	2
Ubi	12	7.79	6	3.89	3	1.94	4	2.59	25	16	3.5
Kurdacol	9	5.84	4	2.59	2	1.29	-	-	15	10	5
Binicol	11	7.14	1	0.64	-	-	-	-	12	8	7
Mangaldan	2	1.29	6	3.89	3	1.94	14	9.09	25	16	3.5
Los Baños	1	0.64	3	1.94	-	-	2	1.29	6	8	7
Dolorong	1	0.64	1	0.64	2	1.29	-	-	4	3	11
Bentong	1	0.64	-	-	1	0.64	1	0.64	3	2	12
Cebu	-	-	-	-	-	-	1	0.64	1	1	13

Crop Residue Management

Crop residue management practices were not widely employed by the farmers. In fact, the practice of burning the crop residue is dominant among them (56%) while crop residue incorporation is practiced by less than 50% of the respondent. Other residue management strategies were for animal feeds, compost and mushroom growing.

Burning of crop residues were applicable to rice straw remaining after threshing. The pile became too laborious for them to scatter in the field or transfer it to other site outside the paddy, thus burning is the most practical way to manage the residue.

Comparison of Farming Practices Employed Pre and Post Eruption

There were five farming practices that were changed after the onslaught of lahar in farms of the respondents. These practices were applicable in any of the depth categories studied (Table 11).

The table revealed that plowing and harrowing operations were increased from two times before the occurrence of lahar to three (3) or four (4) times after the lahar in 16 farms.

Farmers who used to plow using the moldboard plow have to resort to the use of tractors due to difficulty in preparing the land. Some farmers observed that after and before heavy rains the land can be prepared using big tractors.

Table 10. Crop Residue Management Practices*

PRACTICE	LAHAR CATEGORY					
	1	2	3	4	TOTAL	%
Burning	18	16	8	43	85	56
Soil Incorporation	38	16	3	17	74	48
Others :						
Animal feeds	20	10	10	10	66	43
Composting	3	3	1	1	9	6
Mushroom bed	4	-	-	-	4	3

* Multiple responses

Table 11. Farming practices that were changed/modified due to lahar.

PRACTICE	DETAILS			
	BEFORE THE LAHAR	NO.	AFTER THE LAHAR	NO.
Land Preparation	Two plowings	16	4 plowings	10
			3 plowings	6
	Use of plow only	18	+ use of tractor	8
	Easier	4	Difficult	4
	Just plow and harrow	3	scrape and deep plow	2
	Anytime	3	After or before heavy rains	3
Irrigation	Hard to drain	76	High percolation, well drained	76
	Once	10	Three times	6
Planting	Fast	2	Slow	6
	Easier	2	Difficult	2
	On the ridge	1	On the furrow	1
	Early	1	Only if there's rain	1
Cultivation	Handweeding		Deep plowing	
Variety	Old variety	1	HYV	1
	Ubi	1	Super Bureau	1
	Bureau	1	Kordacol	1
	Many varieties	15	Few varieties	15

The sandy texture of lahar causes droughtiness and hence irrigation increased from one to three times in 82 farms. Seepage losses are also observed particularly in the constructed canals. Planting in lahar-laden areas also became more difficult and time consuming. The droughty nature of lahar made them change the method of planting SP from the ridge to furrow.

Cultivation likewise became more difficult due to hardening of the soil and more weeds in some cases particularly in areas with shallower lahar deposits.

The range of varieties that are adaptable in lahar decreases compared to pre-eruption as observed by 10% of the farmers.

Knowledge of farmers about INM and INM practices they are advocating

Ninety-eight (64%) of the farmer-respondents indicated knowledge about INM and 73 recognized the benefit from INM. Knowledge and advocacy about INM exists in all lahar categories.

Table 12 enumerates the farming practices adopted by farmers that advocated INM.

The different practices that the respondents advocated were :

a) Incorporation of animal manure into the soil then plowing to decompose crop residues (29%)
b) Composting (30%)
c) Basal application of animal manures together with complete fertilizer (7%)
d) Composted animal manure as fertilizer in vegetable garden (15%)
e) Incorporation of crop residue into the soil (55%)
f) Incorporation of organic + inorganic fertilizer into the soil (20%)
g) Use of adapted variety + organic and inorganic fertilization (23%)
h) Crop residues + animal manure incorporation into the soil (68%)

The major constraints faced by farmer respondents in the sustained adoption of INM are the source, bulkiness and problem in application, price, odor, labor intensive, slow effect and lack of knowledge in INM (Appendix Table 13). These are important entry points in terms of in-depth participatory R and D and institutionalization of INM at the local level.

Table 12. Farming practices adopted by farmers that advocated INM

Practice	Lahar Category 1		2		3		4		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
1. Incorporation of animal manure into the soil then plowing to decompose the previous crops	20		9		4		10		44	29
2. Composting	18		12		5		12		47	30
3. Basal application of animal manure together with complete fertilizer	3		3		2		3		11	7
4. Decomposed animal manure used as fertilizer in vegetable garden	13		5		3		2		23	15
5. Incorporation of crop residues into the soil	22		13		2		1		38	25
6. Incorporation of organic fertilizers into the soil	16		12		-		3		31	20
7. Crop residues/weeds are plowed and harrowed three times to hasten the decomposition to be used by the SP plants growth	21		9		4		10		44	29
8. Use of adaptable varieties and applications of inorganic and organic fertilizers	15		8		4		8		35	23
9. Use of decomposed rice hay as organic fertilizer	23		11		5		7		46	30
10. Incorporation of rice stubbles and animal manure into the soil	26		14		6		13		59	38

Table 13. Constraints to sustained adoption INM.

Factor	LAHAR CATEGORY									
	1		2		3		4		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
1. Source	17	11.03	17	11.03	9	5.84	40	25.97	83	54
2. Bulkiness hard to apply	23	14.93	14	9.09	9	5.84	32	20.77	78	51
3. Price	3	1.94	9	5.84	2	1.29	19	12.33	33	21
4. Odor	18	11.68	7	4.54	-	-	4	2.59	29	19
5. Labor Intensive	8	5.19	5	3.24	4	2.59	11	7.14	28	18
6. Slow effect of organic fertilizer	5	3.24	3	1.94	6	3.89	12	7.79	26	17
7. Lack of Knowledge	8	5.19	4	7.40	3	1.94	11	7.14	26	17
8. Not accustomed to use	2	1.29	1	0.64	1	0.64	3	1.94	7	4

SUMMARY AND RECOMMENDATION

Sweetpotato production in lahar-laden areas were concentrated in flatlands or flood plains of Central Luzon. The crop is grown throughout the year but the bulk of hectarage were planted starting October to February. Small scale plantings were resorted as sources of planting materials during peak planting months. Farmers who planted sweetpotato had living standards ranging from low to high, the majority belonging to low level of living.

SP farming were observed in farms buried by lahar to a depth as shallow as half meter to as deep as two meters or more. The crop is not grown as monoculture but predominantly rice-based except in areas having very high sulfate content where rice cannot thrive. Several crops were grown at the same time with sweetpotato particularly in Tarlac area.

Lahar as a growth medium for their sweetpotato crops was perceived differently by the farmer respondents; some say it is fertile, some infertile while others said it is just like the ordinary soil. Adoption of INM is done by small percentage of the respondents in order to improve the soil condition of their lahar-laden farms. Even those who considered lahar to be fertile encountered limitations such as droughtiness, compaction and the like.

Among the INM practices that were adopted by farmers alone or in combination were: crop residue incorporation, organic + inorganic fertilization, use of compost, deep plowing use of adapted varieties and others. However, it was pointed out that their sustained use of INM practices are constrained by the source, bulkiness of organic fertilizers as well as their limited knowledge on INM and lack of INM technology.

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Appendix Table 1. Information about the farms of the farmer respondents.

CHARACTERISTICS	LAHAR CATEGORY				
	1	2	3	4	Average
1. Years in farming					
Lowest	6	2	7	5	2
Highest	51	52	45	53	53
Average	22	26	25	23	23
2. Topography of the farm (%)					
Flat	91	90	100	96	94
Hilly	-	3	-	4	7
Slightly Rolling	9	7	-	-	16
Total	100	100	100	100	100
3. No. of available family labor					
Average	2	2	2	2	2
4. No. of parcels of land					
Average	2	2	3	2	2
5. Total farm holding (ha)					
Lowest	0.3	0.5	0.4	0.2	.2
Highest	5	10	5.5	7	10
Average	1.72	3.04	2.19	2.91	2.46
6. Size of farm affected by lahar (ha)					
Average	1.32	2.23	1.72	2.68	1.98
7. Depth of lahar (m)					
less than 1 meter	54				
1.0 - 1.5		30			
1.6 - 2.0			14		
2.1 and above				56	
Total					
8. Texture of lahar (%)					
Fine	91	53	57	54	57
Coarse	44	80	64	61	59
9. Tenurial Status (%)					
Owner	55	20	57	18	35
Leaseholder	30	47	29	52	41
CLOA	4	23	-	25	15
Others: Tenant	9	10	14	14	15
Rented	2	7	7	5	4

Continuation...

CHARACTERISTICS	CATEGORY				
	1	2	3	4	Total/Average
10. Area planted to SP (ha)					
Lowest	0.3	0.5	0.4	0.2	.35
Highest	3.0	2.5	2.0	3.0	2.62
Average	0.76	1.13	1.31	1.39	1.15
11. Area planted to crops before SP (ha)					
Average	1.03	1.18	1.36	1.51	1.27
12. Area planted to crops after SP (ha)					
Average	.76	1.03	1.11	1.27	1.04

Appendix Table 2. Perception/ Observation about lahar as growth medium for planting crops/ sweet potato some improving measures.

	LAHAR CATEGORY					
Perception	1	2	3	4	Total	%
1. Less fertile	18	23	11	44	96	62
Reason						
SP have stunted growth	2	2	-	4	8	
Easy to “evaporate water” or doughtiness	1	-	-	-	-	
Plants are wilting	1	-	1	-	2	
Thick lahar hard surface	3	1	1	9	14	
Silted/acidic	2	2	-	2	6	
More fertilizer needed	3	5	6	16	30	
Hot - presence of sulfur	-	1	-	-	1	
2. More fertile	30	7	3	10	50	32
Reason						
Lahar adds fertility to the soil	1	-	-	-	1	
Plants grow easily and vigorously	4	-	-	-	4	
Because of sulfur	2	-	-	1	3	
Thorough decomposition of crop residues	1	-	-	-	1	
More harvest/ yield	7	1	1	2	11	
Topsoil mixed with lahar	-	2	-	-	2	
3. Just similar with ordinary soil		-	-	1	1	
4. Others, Specify	6	2	-	2	10	6
Supported by irrigation	1	-	-	1	2	
The soil is good but difficult to till	1	-	-	-	1	
Soil abrasive/ acidic	3	1	-	-	4	
More fertilizer used	1	1	-	2	4	
Easy to dry	-	1	-	-	-	

Continuation....

Problem	LAHAR CATEGORY					
	1	2	3	5	Total	%
5. Droughtiness	14	16	10	28	68	44
6.						
Solutions						
Incorporation of rice stubble, plant residues, and animal manure	3	1	-	-	4	4
Timing of planting	1	1	-	-	2	1
Cultivate	1	-	-	-	1	1
Plant drought – resistant crops	-	4	1	5	10	15
Follow rainfall pattern and shift to drought - resistant crops	-	1	1	2	4	6
Always irrigate the area	-	4	1	5	9	13
Plant early maturing variety	-	2	5	2	9	13
Plant adaptable varieties	-	1	1	8	10	15
5. Less effectivity of applied fertilizer to crops	5	13	5	12	35	23
Solutions						
Apply large quantity of organic and inorganic fertilizer	4	11	3	8	26	74
Proper caring of the plants	-	1	-	-	1	3
Planted sugarcane	-	-	-	1	1	3
Other Problems						
Leaves of SP like leaves of onion	-	-	-	1	1	3
Insect pest	1	-	-	1	2	6
Wilting	1	-	-	-	1	3