VOLUME 1

EFFECT OF SWEETPOTATO, TARO AND YAM INSECT PESTS AND DISEASES ON LIVELIHOOD AND FOOD SECURITY OF INDIGENOUS FARMERS IN BENGUET AND NUEVA VIZCAYA, PHILIPPINES

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FOREWORD

The adverse effects of the occurrence of pests and diseases on farmers' livelihood and on the availability and accessibility of food supply always prompts immediately the attention and technical assistance of the academe, the scientists and researchers. The Benguet State University and the Northern Philippines Root Crop Research and Development in particular responded when the yam anthracnose wiped-out credit-assisted yam farms in Tuba, Benguet; when the sweetpotato feathery mottle virus almost diminished the commercial farms in Tarlac; the widespread potato leaf miner infestation in Benguet; and lately, the sweetpotato fusarium wilt damage in Benguet and Nueva Vizcaya.

This research on Rootcrop Diseases Currently Affecting Livelihood and Food Security of Indigenous Farmers in the Highlands of Northern Philippines is in support of current and planned efforts to rehabilitate sweetpotato, yam and taro farms in Benguet, Nueva Vizcaya and elsewhere in the Philippines.

The results of this research will be useful for the local and national agriculture units being tapped to provide mitigation efforts, research and development especially for the many growers of root crops in the Philippines. Furthermore, the results of this research will be an input for the Northern Philippines Root Crops Research and Training Center - Benguet State University in assessing their available technologies like resistant varieties, mass production of clean planting materials, and in directing its research and training programs.

CYNTHIA G. KISWA
Director, NPRCRTC

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Further, the authors also appreciate the Benguet State University administration, especially Dr. Carlito P. Laurean, the Vice President for Research and Extension, for the encouragement, endorsement, approval and recognition of the project as a regular workload of the Northern Philippines Root Crops Research and Training Center.

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EXECUTIVE SUMMARY

This research was conducted because of the report incidence of plant pests and diseases that decreased yields, and loss of crops and varieties of root crop farmers in the highlands of Northern Philippines. The goal is to complement university and local government mitigation measure of mass producing disease-free planting materials of sweetpotato, yam and taro for distribution to farmers, and other R and D initiatives. The research identified villages and municipalities affected by sweetpotato fusarium wilt, taro pests and diseases: its effect on farmers' livelihood and food security of growers in the provinces of Benguet and Nueva Vizcaya.

Data were gathered from primary and secondary sources, key informant interviews, group-interview workshops and focused group discussions followed by farm visits and case study. Data were encoded and analyzed by making use of Excel and SPSS software.

Sweetpotato is grown in 117 barangays (villages) with about 3,385 growers, and taro in 107 barangays (3,029 growers) throughout the 13 municipalities in Benguet. Greater yam is grown in 50 barangays in 8 municipalities in Benguet involving about 917 growers. Sweetpotato fusarium wilt affected more or less 49ha of the 85-258 ha planted per year. Taro blight and taro beetle affected more or less 19ha of the estimated 193-289 ha planted to taro. Yam anthracnose affected 0.035ha out of the 121 ha planted to yam in Benguet.

In Nueva Vizcaya, sweetpotato is grown in 68 barangays with about 834 growers in 10 municipalities and taro in 31 barangays with more than 970 growers in 4 municipalities. There was no yam growing barangay identified based on secondary data. Sweetpotato fusarium wilt and taro beetle is unknown in the 91ha planted to taro.

Sweetpotato, taro and greater yam household growers have multiple sources of cash oncome and food supply, and grow multiple crops. Rice, vegetables, root crops and other casg crops are grown in small areas in parts or borders of terraced paddies, swidden fields, vegetable gardens and backyards. Majority source of cash income is from crop sales with some household members receiving salaries, wages, cash allowance or assistance, and a few engage in formal micro business like crop assemblers, store retailers and transport operators. Food source is firstly from own produce and secondly from purchases with some getting share from family farms or gifts from neighbors. Habitual diet consists or rice staple eaten three times daily with vegetable as viand and sometimes with meat or fish. Rootcrops are consumed more as a snack food, as vegetable and less times as substitute staple. These are characteristics typical of the low income and lower middle income group. Most of the root crop growing households belong to the indigenous peoples – the *Ibalois, Kankana-eys, Kalanguyas* and offspring of mixed marriages.

All sweetpotato growers observed fusarium wilt infection in their fields starting in 2012. Fusarium wilt disease negatively affected the livelihood source and food security of the sweetpotato growing households. Fusarium wilt disease reduced yield ranging from 51-100% among 65-89% of growers, decreased crop sales by 25%, and reduced frequency of sweetpotato consumption. For more than 4,000 growers in Benguet and Nueva Vizcaya,

fusarium wilt infection was estimated to cost a minimum of PhP33 million losses in livelihood and food security.

Taro leaf blight was observed by 100% of the taro growers and taro beetle by 86%. Very few farmers are growing taro as a major cash crop. Most taro is grown mostly for household consumption. More growers rated taro leaf blight as moderate to severe, and taro beetle as mild to moderate where the effect on loss of planting materials and varieties is four percent, six percent in yield loss or PhP1.31/hill loss in cash income. For Benguet and Nueva Vizcaya, the computed loss resulted to 27,352 kilos valued at PhP0.957 million if priced at PhP35 per kilogram.

Twelve percent of the yam growers observed 100% incidence of yam anthracnose in their fields, 24% observed zero incidents, and the rest from 10-80%. Majority (51%) assessed severity as mild. The disease caused 4% loss in planting materials and a yield decrease ranging from 26-50% as claimed by 51% of yam growers. Household consumption of yam is not affected. Of the 917 yam growers in Benguet, the computed yield loss due to the disease damage amounted to 59-699 MT valued at PhP3.38 million.

BACKGROUND INFORMATION

Plant disease reduces the production and quality of food. Losses on the average account for 42% of the production of the six most important food crops. Losses due to postharvest disease can be disastrous, especially when farms are far from markets and infrastructure (Guest, 2012). Crop losses tend to be greatest where knowledge and investments in crop health management are minimal. Low crop yields are common and improved yields/ productivity is vital to increasing food security. One major contributory factor to low yields is crop losses due to plant health problems although the extent attributed to this loss is missing. Yet, crop losses due to plant health issues receive little attention though an important matter of food security (Flood, 2010). The Irish potato famine, the coffee wilt disease in Central and Eastern Africa (Strange and Scott, 2005) and fusarium wilt disease of banana (Vicente and Dita, 2016) are examples that largely devastated livelihoods and food security in the areas affected. In the case of banana fusarium wilt in the Philippines, the disease was confirmed in 2008 which started with 500 cases in 2005 that increased to 15,000 cases in 2007. Only large exporting companies followed the disease control protocol similar to bacterial wilt, i.e., quarantine, sanitation, soil disinfection and fallows (Molina, et al., as cited by Vicente and Dita, 2016).

The increasing pests and diseases problems on root and tuber crops grown traditionally by indigenous peoples in Benguet and Nueva Vizcaya was mentioned in sweetpotato, taro, tannia, greater and lesser yam in 2012 (Gayao, et al., 2013, 2014). However, the assessment of incidence and severity of sweetpotato fusarium wilt, taro leaf blight and taro beetle and yam anthracnose, documentation of background information leading to the disease incidence and its effect on farmers' food production and livelihood were not done.

In 2014, farmers and local government agriculture units requested the assistance of the Northern Philippines Root Crops Research and Training Center (NPRCRTC) and Benguet State University (BSU) to identify and provide mitigating measures to solve the disease problem that wiped out sweetpotato crops. This was confirmed to be fusarium wilt caused by *Fusarium oxysporum* which according to the University Plant Health Clinic, disease incidence increased by 600% in 2015 based on the diagnostic services provided. In response, provision of clean planting materials of tolerant varieties and technical assistance in the establishment of nurseries to multiply clean planting materials for distribution to affected farmers were done. In March 2016, yam seed tubers supplied by traditional yam farmers in Tuba, Benguet were 75% rotten after a month. Damage from these pests and diseases is increasing possibly because of increasing farmed mountain sides and lesser fallow areas. The same is true with the damage caused by taro blight and taro beetle that decreased areas being planted by many small farmers belonging to the indigenous tribes.

In the mountainous *barangay* or villages of Benguet and Nueva Vizcaya, indigenous peoples who traditionally grow sweetpotato, taro, tannia, and yam for their household consumption, also plant these crops as a source of their cash income. The *Kalanguya* farmers in Ambaguio, Nueva Vizcaya can earn PhP30,000 to PhP70,000 per cropping season when they sell their sweetpotato in the Nueva Vizcaya Agricultural Terminal (NVAT) at prices that

ranged from PhP15-25 per kilogram (Gayao, et al., 2014). *Ibaloi* farmers in Tuba, Benguet can earn PhP720 to PhP7,840 for each of the roots and tubers planted in a 1000m^2 swidden farm (Gayao, et al., 2013). Whatever is not sold is used for their own food and animal feed. It is not hard to imagine therefore the food insecurity that these small indigenous farmers will face when plant diseases and insect pests will wipe out their crops.

Plant diseases are a threat to food security because it reduces yield and could actually result to total loss of crop. This means reduced or no cash or food supply for the farm household, and may increase external farm inputs. Effect could also be long-term as planting materials and varieties are lost especially for vegetatively-propagated root crops, and the soil becomes infested which affects other susceptible host crops. For small farmers and minor crops, inadequate technical support may aggravate external impacts like poverty, food insecurity, environment degradation and health concerns (Figure 1).

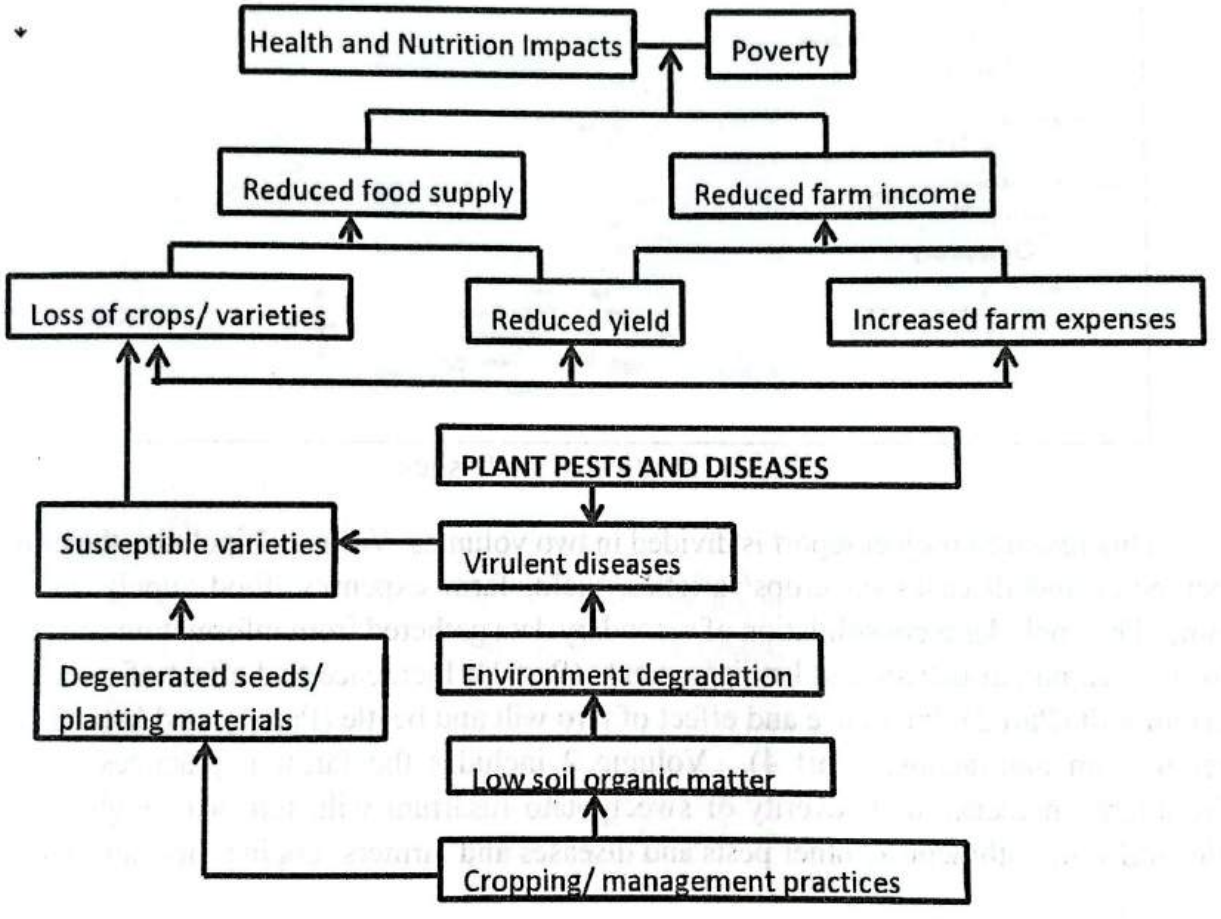

Fig. 1 Causes and consequences of plant disease incidence that may affect food security and livelihood.

Based on Philippines experience, quick response teams coming from the Department of Agriculture, scientists of state colleges and universities, and local government units affected are only activated when there is a rapid and extensive development of a disease. This happens 3-4 years after the disease was observed by farmers. Just like in the banana fusarium wilt, the sweetpotato fusarium wilt was also observed in 2011 and action by mass propagation and

dispersal of clean planting materials was started in 2014. There is no systematic monitoring and collection of data on plant health problems especially for root and tuber crops that are only grown in small areas by many small farmers and households. Even for the leaf miner that devastated potato crops in Benguet in 2000 and yam crops in 1992 due to anthracnose disease, there is lack of documents to show the magnitude of food losses due to plant disease.

Hence, this research documented the incidence and severity of fusarium wilt, taro wilt and beetle, yam anthracnose, and its effect on the farmers' livelihood and food security in the locality, farming practices and farm environment, and the farmers' coping mechanisms among root crop growing households and communities in the highlands and hilly lands of Benguet and Nueva Vizcaya, Northern Philippines (Figure 2).

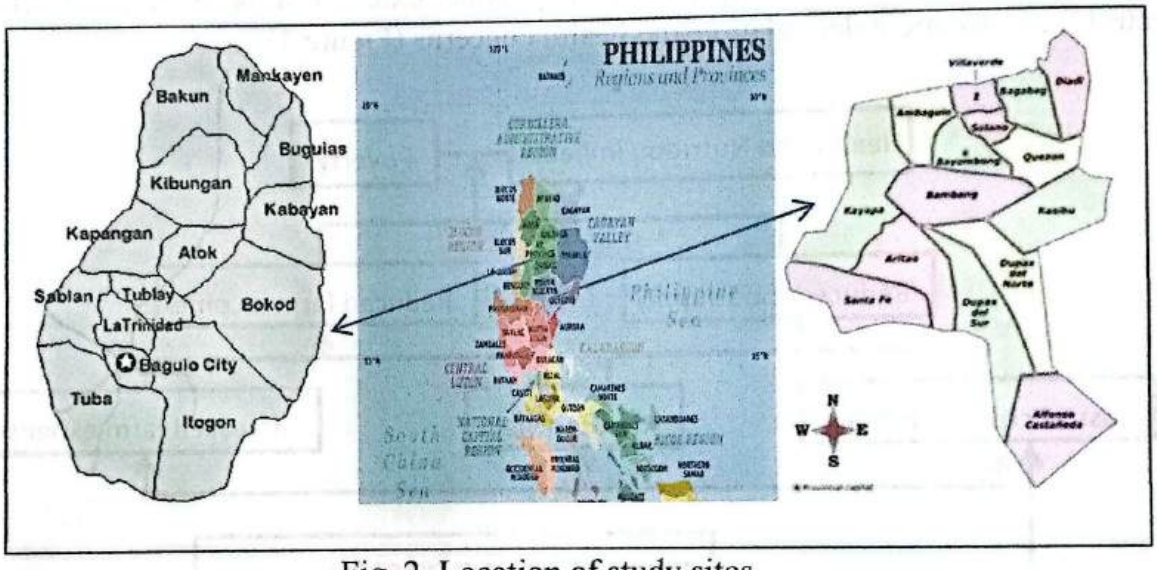

Fig. 2. Location of study sites

This research project report is divided in two volumes. Volume 1 includes the effect of insect pests and diseases on crops/varieties, yield, farm expenses, food supply and farm income. This includes a consolidation of secondary data gathered from information and records of local government offices and key informants (Part 1); Incidence and effect of sweetpotato fusarium wilt (Part 2); Incidence and effect of taro wilt and beetle (Part 3); and Incidence and effect of yam anthracnose (Part 4). Volume 2 includes the farming practices and farm environment, incidence and severity of sweetpotato fusarium wilt, taro leaf blight and taro beetle, and yam anthracnose, other pests and diseases and farmers' coping mechanisms.

PART I

BASELINE SURVEY ON THE PREVALENCE OF SWEETPOTATO FUSARIUM WILT, TARO LEAF BLIGHT, TARO BEETLE AND YAM ANTHRACNOSE IN BENGUET AND NUEVA VIZCAYA, PHILIPPINES

ABSTRACT

Sweetpotato is grown in 117 barangays throughout the 13 municipalities in Benguet with 82-158 ha planted per year. In Nueva Vizcaya sweetpotato is grown in 68 barangays in 10 municipalities with 33ha of sweetpotato planted per year. Sweetpotato fusarium wilt incidence affected more or less 49ha in Benguet and 19ha Nueva Vizcaya.

All the municipalities in Benguet have 107 taro growing barangays while in Nueva Vizcaya, 31 barangays in 4 municipalities are growing taro. Taro blight and taro beetle affected more or less 19ha of taro farms in Benguet, and none was reported in Nueva Vizcaya.

In 8 municipalities in Benguet, 50 barangays were reported having greater yam grown in farms and gardens while no yam growing barangay was identified in Nueva Vizcaya. Yam anthracnose incidence was assessed in 8% of the growing barangays affecting 0.035ha in Benguet.

INTRODUCTION

Baseline agriculture data in the Philippines are provided by the Philippine Statistics Authority (PSA). However, available statistics are mostly on area, volume of production, yield and price of rice, corn and other high value crops but none on pests and diseases. Since the devolution of agriculture services from the national agencies to province-level and to municipal-level government units, it is assumed that the municipal government agriculture offices will provide upstream data. The likelihood that this happens is when plant pest epidemic was already declared and that the pest council is activated. Without the assistance from the Department of Agriculture, the provincial government units and the political leaders, baseline data will be non-existent. Hence, this research to gather, tabulate and summarize pests data on sweetpotato fusarium wilt, taro blight and beetle and yam anthracnose together with related agriculture and climatological data. These data are important information for the conduct of the succeeding parts of this research project.

METHODOLOGY

Data gathered. The data gathered identified the barangays or *sitios* (villages) in the municipalities of Benguet and Nueva Vizcaya that are major producers of sweetpotato, taro and yam. Contingent on the availability of records, details such as the area planted to these crops, production trends, number of farmers or farm households involved in root crop production from barangay to municipal level well as pest problems were gathered. For undocumented information necessary to the study, the team has to recourse to personal

communication with key staff of the municipal agriculture and planning and development offices to gather such data. Geographical and weather data like elevation, rainfall, and temperature were likewise gathered.

Sources of data. The regional office of PSA, the Department of Agriculture (DA), and the provincial government offices of Benguet and Nueva Vizcaya were visited for secondary data gathering. Visit to municipal agriculture and sometimes the planning and development offices were done for documents review and/or key informant interviews. The La Trinidad Agromet Station and Baguio Weather Station were also visited.

Analysis of data. The information gathered were tabulated and summarized in tables. The prevalence of sweetpotato fusarium wilt, taro leaf blight, taro beetle and yam anthracnose was determined using the following formula:

$$\% \text{ incidence} = \frac{\text{\# of barangays with observed/ known cases of the disease}}{\text{total \# of rootcrop growing barangays in the municipality}}$$

or

$$\% \text{ incidence} = \frac{\text{\# of plants/ hills with disease symptoms}}{\text{total \# of plants/ hills planted/ sampled}}$$

RESULTS

Agriculture and Climatic Profile of the Provinces of Benguet and Nueva Vizcaya

Benguet with 140 barangays belongs to the Cordillera Region and the adjoining Province of Nueva Vizcaya with 275 barangays belongs to the Cagayan Valley Region (Tables 1 and 2). Both provinces are considered agriculture-based provinces since majority of the household population are engaged in farming. Differences lies in the major crops planted. Benguet is source of temperate vegetables like cabbage, carrots, lettuce and chayote; rootcrops like potato, sweetpotato and taro; fruits like strawberry and lemon; cutflowers that include roses, anthuriums and mums; tiger grass and heirloom rice which are grown in swiddens, vegetable gardens and rice terraces. On the other hand, Nueva Vizcayas' major crop is rice and corn grown mostly in plains; vegetables like squash, tomato and eggplant; rootcrops like sweetpotato, tannia and cassava; spice crops such as ginger, onions and garlic; and fruits like oranges, pineapple, banana, mango and coconuts which are grown in rainfed fields or swidden farms.

Benguet is mountainous with flatlands located in valleys (La Trinidad and Loo, Buguias), sloping hilly lands and mountain tops with an elevation ranging from 40 masl (in the Municipality of Tuba) to 2,920 masl in the Municipality of Kabayan (Table 3) where Mount Pulag, the third highest mountain in the Philippines is located. Nueva Vizcaya with elevation ranging from 261-2,351 masl has wider flat lands being a part of the Cagayan Valley and bordered by the Cordillera and Sierra Madre mountain ranges.

Benguet has a temperate climate, ranging from 11-27 °C air temperature and 134- 539 mm monthly rainfall based on a 5-year data (2013-2017) provided by the Baguio Weather Station and the BSU-DOST Agromet Station in La Trinidad, Benguet. The highest amount of

rainfall was recorded in the months of July, August, September and October reaching as high as 1,494 mm/mo (Table 4). While Nueva Vizcaya has an average air temperature that ranged from 15-25 °C of and an annual rainfall ranging from 1,400 to 2,400 mm (Nueva Vizcaya PPDO, 2016).

Sweetpotato Growing Areas and Incidence of Fusarium Wilt in Benguet

There are 117 barangays (villages) in the 13 municipalities of Benguet where sweetpotato is grown. The occurrence of fusarium wilt on this rootcrop was observed in 55 of the barangays or 47% of the total number of villages with a disease incidence ranging from 60-70%. in the sweetpotato farms of more or less 3,385 households planting sweetpotato (Table 5). These households are mostly from the municipalities of Kapangan, Itogon and Kabayan.

Each household plant an average of 244-471m^2 of sweetpotato which if multiplied by the number of households (3,345) will result to 82-158 ha total area planted in Benguet, lower than the 475-579 ha as per records of the provincial/ municipal agriculture offices (Table 5). Conservative estimate of 49ha (60% x 82ha) is infected with sweetpotato fusarium wilt in Benguet.

Sweetpotato Growing Areas and Incidence of Fusarium Wilt in Nueva Vizcaya

Around 68 barangays in 10 municipalities of Nueva Vizcaya are known sweetpotato growing areas. As early as 2012-13, fusarium wilt affected sweetpotato farms at 30-85% disease incidence and has been identified as a problem in four of the 30 growing barangays in Kayapa. This is in addition to three more municipalities of Ambaguio, Sante Fe and Kasibu reporting incidence of fusarium wilt problem (Table 6). Ambaguio and Kasibu at 95.9 ha and 38.43ha, respectively are the leading producers of sweetpotato in Nueva Vizcaya.

About 834 sweetpotato growers were identified of which 42% plant in an area that is 100m^2 or less, 47% are planting 500m^2 and less, and the remaining 11% are planting more than 500-1,000m^2. Based on the aforementioned data, the total area is computed at 33ha which is below the 200.6ha recorded in PAO/MAO record. Fusarium wilt infection affected at least 19 ha planted to sweetpotato (30-85% x 32.7ha).

Taro Growing Areas and Incidence of Taro Leaf Blight and Taro Beetle in Benguet and Nueva Vizcaya

In Benguet, almost all farm households have at least a few hills of taro and as a result account for 107 taro-growing barangays throughout the province. Ten percent of the barangays or around 19ha are affected by taro blight and taro beetle (Table 7). From more or less 3,029 growers maintaining as few as 10 hills to as many as 1,000 hills of taro, there is a total of 193-289 ha planted to this crop.

In comparison, only four municipalities in Nueva Vizcaya (Bagabag, Diadi, Kayapa and Sta. Fe) with a total of 31 barangays have records of taro-growing villages. There are 570

taro-growers in these towns and just like in Benguet, majority plant in small areas. 45.65% has an area of 100m^2 or less, 51.50% with >100-500 m^2, 1.80% with >500-1,000 m^2 and only 1.1% with more than 1,000 m^2 (Table 8). There was no reported or known incidence of taro leaf blight and taro beetle.

Further, during the workshop-interviews in June 2018, four more barangays in Santa Fe with almost all households (400) are growing few hills of taro for own use

Greater Yam Growing Areas and Incidence of Yam Anthracnose in Benguet and Nueva Vizcaya

Greater yam has been recorded to be grown in 50 barangays of 8 municipalities of Benguet. Majority of which are located in Kapangan, Tuba and Sablan. Only 4 (8%) of these *sitios* have been affected with yam anthracnose disease. Considering that there are 917 households planting this crop in 48-380m^2 area, the prevalence of this disease, which is about 0.35 ha, is still restricted and therefore not alarming (Table 9).

In Nueva Vizcaya, both the provincial and municipal agriculture offices visited have no available records on greater yam though in previous research and field work (Gayao, Meldoz and Backian, 2014) some yam growers exists among the Bugkalot (Belance, Dupax del Norte) and the Kalanguya (Tiblak, Ambaguio) indigenous people. Also during the workshop interviews (June 2018) in Bambang and Sta. Fe, the participants reported and an estimate of 63 and 53 farm households, respectively growing yams for own food and sometimes for sale.

Local Government `Bantay Peste' Program

The Department of Agriculture- Cordillera Administrative Region (DA-CAR) through its Integrated Pest Management (IPM) program launched the "*Bantay Peste*", which aims for early detection, prevention of pest outbreaks and fast intervention through regular monitoring on the population dynamics of pests in farming communities. Farmers are tapped under the Bantay Peste Volunteer Brigade Field School to help survey the occurrence of insect pests and diseases in their respective areas. Reports on the presence or absence of pests are being prepared by the local government units (LGUs) through the provincial and municipal agriculture offices (Manila Times, 2014). However, it is up to their supervisors or political leaders to initiate action. For example, the Municipality of Kayapa sought the technical assistance of both the Nueva Vizcaya State University and the Northern Philippines Root Crops Research and Training Center- Benguet State University in February 2014 regarding pest causing damages on their sweetpotato crops. The Center responded with a needs and pest assessment, diagnosis of infected crops and soil and dispersal of new sweetpotato varieties planting materials (Meldoz, Backian and Masangcay, 2014). Also, in the Municipality of Santa Fe, no less than the Secretary of Agriculture during a farmers forum sometime in May 2015, ordered the local government officials and the Nueva Vizcaya State University to conduct visual field assessment of also on fusarium wilt of sweetpotato. This resulted to the conduct of training on management of insect pests and diseases, good agricultural practices, and the establishment of techno-demo areas on pest management and variety trials.

In the province of Benguet and in other municipalities in Nueva Vizcaya, no concrete disease assessment or action were done although complaints on high incidence of sweetpotato fusarium wilt were mentioned during their consultation meetings.

DISCUSSION AND CONCLUSION

The identification of major municipalities and barangays that produce sweetpotato, taro and yam growing were all based on records and personal knowledge of local agriculture staff. However, a more conservative total area planted to these crops based on actual area planted per household were chosen over the higher estimates of areas planted as recorded in municipal/ provincial reports.

There are 117 sweetpotato growing barangays and 107 taro growing barangays in all the 13 municipalities in Benguet and 50 yam growing barangays in eight municipalities.

There are 68 sweetpotato growing barangays in ten municipalities in Nueva Vizcaya, and 31 taro growing barangays in four 4 municipalities.

This baseline research identifying the sweetpotato, taro and greater yam growing barangays and municipalities facilitated the conduct of the follow-up research on pests and diseases, and likewise future research and extension activities.

Fusarium wilt incidence affected about 50ha in 47% of the sweetpotato growing barangays in Benguet, and about 19ha in in 4 of 10 municipalities growing sweetpotato in Nueva Vizcaya.

Taro leaf blight and taro beetle incidence affected about 19ha of taro farms in 10% of the growing barangays in Benguet. No reported incidence was noted in Nueva Vizcaya.

Incidence of yam anthracnose was noted in 8% of the growing barangays affecting 0.035ha only in Benguet and none in Nueva Vizcaya.

This research identifying barangays and farms with observed or reported incidence of sweetpotato fusarium wilt, taro leaf blight, taro beetle and yam anthracnose should open up opportunities for national and local government to provide a more focused assistance with respect to rootcrops. The consolidated data summarized in tables are for easier reference which will also guide future users in updating data, especially with the limitations encountered in the availability of uniform and updated records from various sources.

Table 1. Agricultural profile of municipalities in Benguet

MUNICIPALITY	# OF BRGY*	# OF HHS**	# OF FARMERS*	MAJOR CROPS PLANTED	FARMSCAPES
Atok	8	4, 738	9,792	1. Potato and chayote 2. Cabbage and carrots 3. Rice 4. Cutflowers, anthurium and taro	Vegetable terraces and irrigated rice fields
Bakun	7	3,350	3,731	1. Rice/ heirloom rice 2. Vegetables (potato, cabbage, carrots, g.peas) and legumes	Swidden farms and vegetable gardens
Bokod	10	2,877		Beans, tomatoes, taro and rice	Rice fields and swiddens
Buguias	14	10,874	6938***	Carrots, cabbage, Chinese cabbage and potato	Vegetable terraces/ gardens
Itogon	9	14,226	4,486	Sweetpotato, coffee, cocoa, yam	Swiddens
Kabayan	13	3,489	3,432	Cauliflower, broccoli, cabbage, bell pepper, carrots	Vegetable terraces
Kapangan	15	4,198	5,460	1. Bell pepper 2. Beans and chayote 3. Tomato, cucumber and rice 4. Sweetpotato, taro, yam and tiger grass	Swiden farms, rice terraces and backyard gardens
Kibungan	7	3,587	463	1. Rice 2. Chayote 3. Potato, cabbage and other vegetables 4. Coffee	Swiddens, rice fields and gardens
La Trinidad	16	34,157	628	Cutflowers, strawberry, lettuce, broccoli and chayote	Terraces, valley
Mankayan	12	8,088	198	Rice, vegetables and taro	Vegetable/rice terraces and backyard gardens
Sablan	8	2,603	377	Fruit including pineapple, root crops like sweetpotato, yam and taro	Swiddens, rice/vegetable and backyard gardens
Tuba	13	11,152	1050	Fruit trees including lemon, sweetpotato, yam and taro	Swiddens
Tublay	8	3,859	487	Chayote, rice, beans and anthurium	Rice terraces
TOTAL	***140***	***106,838***	***37,042***		

**Provincial/municipal data*

***PSA, 2015 Census*

****Based on 4625 farm households*

Table 2. Agricultural profile of municipalities in Nueva Viscaya

MUNICIPALITY	# OF BRGYS **	# OF HHS*	# OF FARMERS **	# OF HHS W/ AGR'L LAND*	AGR'L LAND AREA (HA)**	MAJOR CROPS PLANTED
Alfonso Castañeda	6	1,496	1,294	649	1009	Rice and corn; Ginger, onions and garlic; Tomatoes, squash, eggplant; Banana, pineapple, oranges, mango and coconut; Sweetpotato, tannia and cassava
Ambaguio	8	2,953	1,568	1,765	2,570	
Aritao	22	8,398	3,266	2,696	6077	
Bagabag	17	8,260	4,438	2,992	6,944	
Bambang	25	11,496	4,507	3,753	6,282	
Bayombong	25	13,407	4,190	2,799	3,839	
Diadi	19	3,740	2,438	2,119	5188	
Dupax del Norte	15	5,936	4,740	3,373	5310	
Dupax del Sur	19	3,975	2,523	1,886	2793	
Kasibu	30	7,001	5,195	5,241	10633	
Kayapa	30	4,342	3,622	2,744	5221	
Quezon	12	4,324	2,124	2,453	4739	
Sante Fe	16	2,960	2,004	1,458	2162	
Solano	22	13,546	3,836	3,878	4806	
Villaverde	9	4,165	2,415	1,726	4018	
TOTAL	***275***	***95,999***	***48,160***	***39,532***	***71,591***	

**NSO, 2010 census*
***PPDO, Socio-economic Profile, 2016*

Table 3. Elevation, dry and wet season months in Benguet and Nueva Vizcaya and the municipalities of Benguet

PROVINCE/ MUNICIPALITY	ELEVATION (MASL)	DRY SEASON MONTHS	WET SEASON MONTHS
Benguet*	***40-2,920***	***Nov-April***	***May-Oct***
Atok	540-2,660		
Bakun	180-2,600	Nov-April	May-Oct
Bokod	580-2,680		
Buguias	1,240-2,780	Dec-May	June-Nov
Itogon	160-2,080		
Kabayan	840-2,920	Nov-March	April-Oct
Kapangan	240-1,740	Dec-April	May-Nov
Kibungan	140-2,580		
La Trinidad	520-1,720		
Mankayan	540-2,340	Nov-April	May-Oct
Sablan	100-1,500		
Tuba	40-2,240		
Tublay	480-1,820	Dec-April	May-Nov
Bambang	322		
Nueva Vizcaya*	***261-2,351***	***Nov-Apr***	***May-Oct***
Kasibu	1,077-1,332		
Kayapa	956-2,351		
Sante Fe	598-1,599		
Bambang	261-1,117		

** Source: PAO, NAMRIA topographical map*

***elevation.maplogs.com/poi/nueva_vizcaya_philippines*

Table 4. Climate data in Benguet and Nueva Vizcaya

Month	Baguio City, 2013-2017			La Trinidad, Benguet, 2013-2017		
	Mean Air Temperature (oC)	Total Rainfall (mm)	Average Humidity (%)	Mean Air Temperature (oC)	Total Rainfall (mm)	Average Humidity (%)
January	16-19	0-40	82-86	11-22	17 -92	80-87
February	17-19	T-72	83-86	12-22	7-83	70-90
March	19-20	6-64	76-87	12-24	22-82	82-91
April	20-22	61-126	82-90	15-25	58-141	83-92
May	20-21	213-570	83-90	16-24	213-646	83-94
June	20-21	177-402	84-92	16-27	238-305	85-91
July	19-20	368-1494	90-93	16-24	454-1329	87-93
August	19-20	450-1220	92-95	16-24	425-840	87-95
September	19-20	207-980	91-92	16-24	186-607	87-93
October	18-20	107-1212	88-91	15-25	170-879	85-93
November	19-20	8-120	78-88	13-24	2-108	83-91
December	19-19	10-167	83-88	14-23	25-127	84-89
Benguet	***16-22***	***134-539***	***76-95***	***11-27***	***151-438***	***70-95***
Nueva Vizcaya	***15-25***	***1400-2400***				

Source: Baguio Weather Station; BSU-DOST Agromet Station; Nueva Vizcaya PPDO, Socio-economic Profile, 2016

Table 5. Sweetpotato growing barangays in Benguet and reported/observed incidence of sweetpotato fusarium wilt

MUNICI-PALITY	# OF BRGY GROWING SP	BRGY W/ INCIDENCE OF SPFW*		MAJOR SP GROWING BARANGAYS	MAJOR SP GROWING SITIOS	# OF HHS GROWING SP	AREA PLANTED TO SP		% OF SPFW INFECTION IN SP FARMS*
		#	%				PER HHS (SQM)	TOTAL (HA)**	
Atok	6	4	67	Abiang, Caliking, Paoay, Pasdong, Poblacion, Topdac	Lower Abiang; Damsite Proper,; Beckes, Salat, Balangbang; Proper, Bahong, Allay, Dituan; Banayakew; Pual, Nalseb, Makidot	283	191	5.4	15-20
Bakun	6			Ampusongan, Bagu, Dalipey, Kayapa, Sinacbat		nd	100-1000	49.2	40-65
Bokod	10	10	100	Ambuclao, Bila, Bisal, Daclan, Ekip, Nawal, Pito, Poblacion, Tikey	Palansa, Naswek	60	333	10-20	100
Buguias	5	5	100	Amgalueyguey, Amlimay, Baculongan Sur, Buyacaoan, Catlubong	Bayoyo	300	50-1000	8.5-30.32	80-100
Itogon	9	1	11	Dalupirip, Tinongdan		nd	50-100	10-100	
Kabayan	13	1	7	Pacso, Gusaran, Bashoy, Tawangan, Eddet, Adaoay, Ballay		260	363	94.35	50
Kapangan	15	7	47	Beleng-bilis, Cuba, Gadang, Gaswiling, Labueg, Pongayan, Sagubo, Taba-ao		1830	800-1000	146	55-75
Kibungan	7	7	100	Madaymen, Poblacion, Sagpat, Tacadang	Napsong; Daklan, Liwen, Polis; Sablang; Proper, Beckes, Lanipog	71	84	6	50
La Trinidad	11					177	25-150	3.5-6.5	
Mankayan	7	7	100	Lower Balili, Bedbed, Cabiten, Colalo, Sapid, Tabio		70	50-500	8	
Sablan	8	1	5	Bayabas		94	729	68.5	100
Tuba	13	6	46	San Pascual, Camp 1, Tabaan, Norte, Tabaan Sur		240	150-200	25-42	
Tublay	8	6	75	Ambassador, Basil, Baayan, Daclan, Tuel		nd		0.8-23	50-70
TOTAL	***117***	***55***	***47***			=/- 3,385	244-471	***425-579****	60-70
Computed								***82-158***	49 has

**As assessed by local government agriculture staff*
***PAO/ MAO records*
nd-no data

Table 6. Sweetpotato growing municipalities in Nueva Vizcaya and reported/ observed incidence of fusarium wilt

MUNICIPALITY	SP GROWING BARANGAYS		# OF SP GROWERS	AREA PLANTED (% OF HHS)				AVERAGE AREA/ FARMER (SQM)	TOTAL AREA PLANTED TO SP (HA)	INCI-DENCE OF SPFW	YEAR KNOWN
	#	Major growing barangays		100sqm & less	>100 to 500sqm	>500 to 1000 sqm	>1000 sqm				
Alfonso Castañeda	nd										
Ambaguio	4	Tiblak, Labang, Poblacion, Salingsingan,	285	91	9			0.336	95.9	*	2013
Aritao	nd	nd	nd						nd		
Bagabag	15	Careb, Sta. Lucia, Pogonsino, Murong	104	74	26				11.84		
Bambang	12	Pallas, Salinas,Abian	134	61	39				18.75		
Bayombong	3	Magapuy, Masoc	51	51	49				13.43		
Diadi	1	San Pablo	1				100		1		
Dupax del Norte	3	Parai	9		89	11			3.03		
Dupax del Sur	nd	nd	nd						nd		
Kasibu	11	Pudi, Cordon, Dine, Lupa	125	2	96	1	1		38.43	*	2016
Kayapa	7	Amelong Labeng, Cabayo, Talmoy, Banao	67	57	43				10.36	**	2012
Quezon	nd	nd	nd						nd		
Sante Fe	10	Baracbac, Canabuan	46	50	50				5.76	*	2013
		Buyasyas, Canabuan,, Bantinan,Atbu, Poblacion***	311								
Solano	2	Bangar, Communal	12	33	67				2.08		
Villaverde	nd	nd	nd						nd		
Total	***+/-68***		***+/-834***	***42***	***47***	***1***	***10***		***+/-200.6***	13%	
Computed									***33***	***19has***	

**Based on Provincial Agriculture Office survey data/ municipal agriculture reports and field visits*

*** Total area planted in Kayapa based on Meldoz, et al. (2015) is 467ha with fusarium wilt incidence was noted in 4 out of the 30 barangays (13%) at 30-85% incidence in 3 farms inspected.*

***Workshop-interview, with barangay officials and sweetpotato growers, June 2019, Santa Fe

Table 7. Taro growing barangays in Benguet and reported/observed incidence of taro blight/ wilt and taro beetle

MUNICIPALITY	# OF BRGY GROWING TARO	BRGY WITH INCIDENCE OF TBL/BE*		MAJOR TARO GROWING BARANGAYS	# OF HHS GROWING TARO	AREA PLANTED TO TARO		TARO BLIGHT AND BEETLE INFECTION IN TARO FARMS*
		#	%			Per hhs (# of hills)	Total (ha)**	
Atok	7	0	0	Naguey, Pasdong, Abiang (Beckes, Proper Bahong, Allay, Maragem, Lower Abiang)	526		16.9	
Bakun	3	3	100	Ampusongan, Dalipey, Kayapa	nd	50	18	30-50% of bettle and blight damage
Bokod	10	0	0	Poblacion, Karao,Nawal, Pito	69	50-250	17.2-20	Few leaf damage
Buguias	3	0	0	Baculongan Sur, Bangao, Loo	140	50	2.6-3.5	
Itogon	6	0	0	Dalupirip, Tinongdan	nd	nd	20	
Kabayan	13	0	0	Ballay, Bashoy, Lusod, Pacso	nd	10-250	1.0-36.8	Only taro beetles, 1/10 plants
Kapangan	13	2	15	Gadang,Paykek, Sagubo, Datakan	710	50	30.5-36	Pests (beetle) not felt since few are planted
Kibungan	7	3	43	Tacadang, Poblacion, Sagpat	130	100-1000	18-37.5	50
La Trinidad	11	nd	nd	Bineng, Beckel, Wangal	104	100	1.5-2.8	nd
Mankayan	5	1	20	Sapid	50	100-200	23-47.5	nd
Sablan	8	nd	nd	Bayabas, Kamog	93	373	29.2-34.7	nd
Tuba	13	2	50	San Pascual, Taloy Norte, Tabaan Norte	720	nd	0.87	Only during rainy season
Tublay	8	nd	nd	Ambassador, Baayan, Caponga, Basil, Tuel	487	290	14.1	Taro beetle but not serious
TOTAL	**107**	**11**	**10**		**+/- 3,029**	***10-1,000, ave. 205***	***193-289***	

Table 8. Taro growing municipalities in Nueva Vizcaya and reported/ observed incidence of taro blight and beetle

MUNICIPALITY	TARO GROWING BARANGAYS*		# OF TARO GROWERS*	AREA PLANTED/HHS (SQM), %*				TOTAL PLANTED (HA)
	#	Barangays		100 & less	>100 to 500	>500 to 1000	>1000	
Alfonso Castañeda	nd		nd					nd
Ambaguio	nd		nd					nd
Aritao	nd		nd					nd
Bagabag	14	Santa Lucia, Careb, Pogonsino	378	92	7	0	1	52.47
Bambang	nd		nd					nd
Bayombong	nd		nd					nd
Diadi	2	Villa Aurora	9	22	67	0	1	4.76
Dupax del Norte	nd		nd					nd
Dupax del Sur	nd		nd					nd
Kasibu	nd		nd					nd
Kayapa	6	Binalian, Tubongang	54	29	62	7	2	14.4
Quezon	nd		nd					nd
Sante Fe	9	Sinapaoan, Tactac, Bacneng Buyasyas, Atbu, Bantinan, Canabuan, Poblacion***	129 400	35	65	0	0	19.48
Solano	nd		nd					nd
Villaverde	nd		nd					nd
Total	*31*		*970*	*45.6*	*51.5*	*1.8*	*1.1*	*91.11*

**Based on survey data obtained from the Provincial Agriculture Office of Nueva Vizcaya*

***There is no reported or observed incidence of taro blight and beetle as per secondary sources*

****June 2018 interview results show additional 400 taro growers in Santa Fe (Buyasyas- 150, Atbu- 95, Bantinan-62, Canabuan- 86 and Poblacion-70.*

Table 9. Greater yam growing barangays in Benguet and reported/observed incidence of yam anthracnose

MUNICIPALITY	# OF BRGY GROWING YAM	BARANGAYS WITH INCIDENCE OF ANTHRACNOSE*		MAJOR YAM GROWING BARANGAYS	# OF HHS GROWING YAM	AREA PLANTED TO YAM	
		#	%			Per HHS (sqm/# of hills)	Total (ha)**
Atok	4	nd	nd	Naguey	25	100-150	0.45
Bakun	none						
Bokod	none						
Buguias	none						
Itogon	5	nd	nd			50-100	6
Kabayan	none						
Kapangan	13	nd	nd	Gadang, Datakan	650	48	37.5
Kibungan	3	nd	nd	Badeo, Tacadang	62	2-3 hills	5
La Trinidad	none						
Mankayan	4	nd	nd	Colalo, Sapid	nd		1.9
Sablan	8	1	12	Bayabas	180	380	60
Tuba	9	3	33	San Pascual, Taloy Norte, Tabaan Norte, Nangalisan, Camp 1	nd		9
Tublay	4	nd		Daclan, Tublay Central	nd		0.94
TOTAL	**50**	***4***	***8***		*917*	*2- 380, ave.110*	***120.79***

**As assessed by local government agriculture staff*
***PAO/MAO records*
nd-no data

Table 10. Greater yam growing barangays in Nueva Vizcaya and reported/observed incidence of yam anthracnose

MUNICIPALITY*	# OF BRGY GROWING YAM	BARANGAYS WITH INCIDENCE OF ANTHRACNOSE*		MAJOR YAM GROWING BARANGAYS	# OF HHS GROWING YAM	AREA PLANTED TO YAM	
		#	%			Per HHS (sqm/# of hills)	Total (ha)**
Santa Fe**				Buyasyas	30		
				Bantinan	10		
				Canabuan	10		
				Poblacion	7		
				Atbu	6		
Bambang**		1	40	Pallas	53		
TOTAL					***116***		

* There is no secondary record for yam growing municipalities in Nueva Vizcaya in PAO/MAO

** *Gathered during the June 2018 field work, in Santa Fe and Bambang.*

PART 2

INCIDENCE AND EFFECT OF SWEETPOTATO FUSURIUM WILT (*FUSARIUM OXYSPORUM F. SP. BATATAS*) ON LIVELIHOOD AND FOOD SECURITY OF GROWERS IN BENGUET AND NUEVA VIZCAYA, PHILIPPINES

ABSTRACT

Sweetpotato fusarium wilt was confirmed to devastate sweetpotato farms in Benguet and Nueva Vizcaya so that this research aimed to document the extent of the fusarium wilt damage and its effect on the livelihood and food security of the sweetpotato growers.

Farm households affected by the sweetpotato fusarium wilt disease mostly belong to the indigenous people- the Ibalois, Kanakana-eys, Kalanguyas and offsprings of mixed marriages. Sweetpotato growing households have multiple sources of cash income and food supply, and smaller farm sizes which are characteristics typical of the low income and lower middle income group. All the sweetpotato growers experienced fusarium wilt infection in their fields, starting in 2012, moderate to severe in 2014-16.

Fusarium wilt disease negatively affected the livelihood source and food security of the sweetpotato growing households. Fusarium wilt disease reduced yield ranging from 51-100% among 65-89% of growers, decreasee crop sales income by 25%, and reduced frequency of sweetpotato consumption among others. For the more than 4,000 growers in Benguet and Nueva Vizcaya, fusarium wilt infection was estimated to cost a minimum of PhP33 million losses in livelihood and food security.

INTRODUCTION

This is the first time that fusarium wilt disease was reported to devastate sweetpotato crop in the Philippines, particularly in Benguet and Nueva Vizcaya. Though, in South Africa, a survey conducted from 2006-2008 among commercial and resource-poor growers showed widespread but very low disease incidence and severity (Thompson, et al., 2011). Fusarium wilt is caused by the widespread soil and plant-borne fungus, *Fusarium oxysporum batatas*. It is frequently observed when susceptible cultivars are grown. Vines are stunted, the base of the vines may turn brown to purple and pith may decay, older leaves turn yellow, vascular tissue in storage roots may be discolored, and the plants wilt and die. This description of the disease symptoms is similar to the '*dappog*' disease devastating sweetpotato farms of the Kalanguya indigenous people during the 2013 field survey in Kasibu, Nueva Vizcaya (Gayao, Meldoz and Backian, 2014).

This was confirmed as fusarium wilt when the Kayapa, Nueva Vizcaya local government unit requested for a field and laboratory assessment at the Northern Philippines Root Crops Research and Training Center- Benguet State University and it was assessed to be destroying 30-85% of the sweetpotato farms visited (Meldoz, Backian and Masangcay, 2014). The BSU Plant Health Clinic also reported that fusarium wilt incidence increased by 600% based on the diagnostic services provided as of 2016. According to the farmers and the Kayapa local government agriculture staff, this disease affected the livelihood of sweetpotato farmers,

to the point that even if sweetpotato prices in the market increased because of lack of supply, they have no harvest to sell. This research therefore aimed to document the extent of the fusarium wilt damage and its effect on the livelihood and food security (food and cash income loss) of the sweetpotato growers in Benguet and Nueva Vizcaya, Philippines.

According to Anke and Price (2001), livelihood is the material means whereby one lives comprising of activities, assets and resources, and outcomes. Household food security is a situation where everyone has access at all times to sufficient food for an active and healthy life (DVL/VM, Elly Leemhuis- de Regt (ed), 1998).

METHODOLOGY

Secondary Data Gathering

The research started with finding out the sweetpotato growing areas in Benguet and Nueva Vizcaya and the reported or known incidence of fusarium wilt and other pests from records and from interviews of provincial and municipal agriculture offices. Based on this results as reported in Part I of this project report, eight municipalities were selected for the field interviews and farm visits.

Group Interview Workshops

In coordination with the municipal partners, group interview workshops and focused group discussion (FGD) were conducted in the recommended barangays or villages (Table 1) except in the Municipality of Kayapa and Santa Fe where municipal-wide farmer representatives were invited. A total of 95 respondents growing sweetpotato from 18 barangays attended the workshops. Attendees were 72 females and 23 were males. According to the participants and the local government coordinator, women are mostly responsible for taking care of the sweetpotato crop among the indigenous people in Benguet and Nueva Vizacaya.

In Benguet and Nueva Vizcaya, majority of the participants are descendants of the minority indigenous people, i.e. the Ibalois, northern and southern Kankana-eys and Kalanguyas, and some belong to the majority Ilocano ethnolinguistic group.

Data Gathered

An open-ended questionnaire was used as a guide in the group interviews and FGDs. It started with knowing the barangay- the sub-villages, number of households with sweetpotato crops, pests particularly fusarium wilt (FW) incidence. A picture of sweetpotato infected with FW was shown to reconcile how FW symptoms look like. It was followed with a focused group discussion on the participants who encountered FW disease in their farms. Their observation when FW became visible, what parts of the plant and what varieties were infected, severity of the disease and coping mechanisms were recorded in the questionnaires. Individually, the participants were also requested to fill-in their household and farm profile including farming practices on sweetpotato crop. The effect of FW disease on the sweetpotato yield, future source of planting materials, their household consumption and crop sales were also asked.

Table 1. Number of barangays and respondents in the municipalities selected

PROVINCE	MUNICIPALITY	# OF BARANGAYS	# OF RESPONDENTS		
			MALE	FEMALE	TOTAL
Benguet			*5*	*44*	*49*
	Atok	1		13	*13*
	Kabayan	1	2	15	*17*
	Kapangan	1	1	10	*11*
	Mankayan	1	2	6	*8*
Nueva Vizcaya			*18*	*28*	*46*
	Bambang	1	6	11	*17*
	Kasibu	1	1	9	*10*
	Kayapa	5	4	5	*9*
	Santa Fe	7	7	3	*10*
TOTAL		*18*	*23*	*72*	*95*

Field Observation

Farm visit to nearby sweetpotato crop of the workshop participants followed where counts were done to validate FW incidence observed by the participants. Pictures and samples of affected plants and farm soil were also gathered. Samples of soil and the diseased plant were taken for laboratory identification and diagnosis. A sweetpotato farm was also identified for pests monitoring purposes.

Data Analysis

Incidence and severity. Fusarium wilt incidence was determined or defined from the viewpoint of the researchers (perceived incidence) and from the viewpoint of the growers (percentage incidence and severity) as follows:

$$\text{Perceived incidence} = \frac{\text{number of farmers who observed the symptoms like yellowing of leaves and rotting of vines particularly at the base}}{\text{total number of sweetpotato growers interviewed}}$$

$$\text{Percentage incidence} = \frac{\text{estimated number of plants/ hills with observed infection}}{\text{for every10 plants/hills of sweetpotato}} \times 100$$

$$\text{Field incidence} = \frac{\text{number of hills with FW symptoms per 10 – 20 hills counted in an area selected at random}}{} \times 100$$

Observation on severity was based by the growers on how many of the plants or how wide the area planted was harvested by choosing either:

1- Mild (at least 75% of crop was harvested),
2- Moderate (40-60% of crop was harvested), and
5- Severe (at least 25% of crop was harvested)

Statistical analysis. The questionnaires were completed, reviewed then encoded. The gathered information was further coded using the Excel software then some of the data were transferred for statistical analysis using the SPSS software. Descriptive analysis using cross-tabulation, Pearson chi-square and contingency coefficient correlation was done. Level of significance was set at five percent. For this Part 2 write-up, fusarium wilt disease incidence was discussed in relation to its effect on farming livelihood and household food consumption of sweetpotato. Fusarium wilt history and the aggravating factors are discussed in Volume 2.

RESULTS AND DISCUSSION

History and even excerpts from the Bible has shown that pests and diseases affected livelihoods and food security of many people. Their effects range from mild to catastrophic (Strange and Scott, 2005). Some catastrophic examples which led to crop losses, starvation and death are the Irish potato famine due to late blight (1845-46), the rice brown leaf spot in Bengal (1942-43) and the African cassava mosaic virus disease (1990's). However, present knowledge of global crop and food supply losses due to pests is very limited (Andersen, 2001) especially for secondary crops that negatively affects small farmers. It is also important to understand how the small farmers live. For this reason, some facts on household livelihood, habitual diet and farm profile of the sweetpotato farmers are gathered to aid in interpreting the effects of fusarium wilt incidence.

Household Profile

Source of cash income. Household cash income source significantly differs among sweetpotato growers from the municipalities of Benguet and Nueva Vizcaya as shown in Table 2. These sweetpotato growers are not only farmers as they have multiple sources of cash income, though 95% of the households source their cash from crop sales, 67% from salary or wages and 17% from small-scale businesses like sari-sari store, public transport and vegetable trading. Since, it is culture among Filipinos to have extended families, 53% of the household members include the elderly receiving pension, or families receiving cash assistance from government social services. These multiple source of income also implies that the sweetpotato growers belong to the low-middle income group.

The poor has a monthly income of PhP7,890; the low income class has between PhP7,890-15,780/mo; the lower middle income class has between PhP15,780-31,560/mo; and the middle class has between PhP31,560-78,900/mo for a family size of 5 members based on the PSA 2012 Family Income and Expenditure Survey (Albert, Gaspar and Raymundo, 2015).

Source of household food supply. While sweetpotato growing households highly differs in source of food supply, 92% consume their own crop production especially for farmers in Nueva Vizcaya where majority plant the rice staple food crop, and 87% buy their food using the proceeds of their crop sales, salary or wages (Table 3). Others (33%) also received food gifts, give-aways or share of rice and excess harvest from parents, relatives, friends and neighbors.

Table 2. Household sources of cash income in the different municipalities of Benguet and Nueva Vizcaya, Philippines

PROVINCE/ MUNICIPALITY	SALARY/ WAGES	CROP SALES	BUSINESS	OTHERS
Benguet, n=49	*38 (78%)*	*47(96%)*	*10 (20%)*	*29 (59%)*
Atok	12	13	4	9
Kabayan	14	16	2	10
Kapangan	8	10	2	1
Mankayan	4	8	2	9
Nueva Vizcaya, n=46	*26 (56%)*	*43 (94%)*	*6 (13%)*	*21 (46%)*
Bambang	9	16	5	3
Kasibu	8	10		3
Kayapa	5	8		9
Santa Fe	4	9	1	6
Total- all sites, n=95	***64***	***90***	***16***	***50***
%	***67%***	***95%***	***17%***	***53%***

**multiple response*

X^2value=12.652, p.244^{ns} between provinces; 93.076, p.034 among municipalities*

Table 3. Household sources of food in the different municipalities in Benguet and Nueva Vizcaya

PROVINCE/ MUNICIPALITY	OWN FARM PRODUCE	PURCHASES	OTHERS
Benguet, n=49	*41 (84%)*	*43(94%)*	*19(39%)*
Atok	13	13	4
Kabayan	11	13	10
Kapangan	10	11	1
Mankayan	7	6	4
Nueva Vizcaya, n=46	*46 (100%)*	*40(87%)*	*12(26%)*
Bambang	17	12	10
Kasibu	10	10	2
Kayapa	9	9	
Santa Fe	10	9	
Total- all sites, n=95	**87**	**83**	**31**
%	**92%**	**87%**	**33%**

**multiple response*

x^2value= 14.148, p.028 between provinces; 1.028E2, p.000 municipalities** among*

Habitual Diet

For three meals a day, the sweetpotato growing households eat rice (93-100%) and vegetables (54-86%). Vegetables include taro stalk and leaves, sweetpotato tops and tannia cormels. Roots and tubers which include sweetpotato roots, cassava tubers, taro corms and yam roots are mostly eaten as snack food (72-82%), and sometimes during breakfast and

supper; among 43-65% of households in Nueva Vizcaya and 23-33% in Benguet. Respondents claim that coffee (16-43% of households) is the best beverage when roots and tubers are eaten, surprisingly more frequent than water that is drank during meals and snack time. Other food items like eggs, meat and meat products, fish and fish products, fruits, etc. as shown in Table 4 are less frequently eaten in every meal.

Table 4. Kinds of food included in the habitual diet of sweetpotato growers in Benguet and Nueva Vizcaya (% of respondents)

PROVINCE	BREAKFAST											
	Rice	Vgtbl	Rt & tbr	Cff	Egg	Wtr	Fish & prdt	Meat & prdt	Brd	Frt	Othr	Mlk
	(% of respondents)											
Benguet	100	86	33	39	27	18	18	20	18	2	4	2
N.Vizcaya	91	65	65	43	15	22	20	9	6	6	2	2
All Sites	***93***	***74***	***48***	***40***	***20***	***20***	***18***	***14***	***12***	***4***	***3***	***2***
PROVINCE	**LUNCH**											
	Rice	Vgtbl	Fish & prdt	Rt & tbr	Meat & prdt	Wtr	Cff	Egg	Mlk	Othr	Brd	Frt
Benguet	100	63	14	20	18	12	16	12	8		4	4
N.Vizcaya	96	54	24	17	20	22				9	2	
All Sites	***95***	***57***	***19***	***18***	***18***	***17***	***8***	***6***	***4***	***4***	***3***	***2***
PROVINCE	**SUPPER/ DINNER**											
	Rice	Vgtbl	Rt & tbr	Cff	Meat & prdt	Fish & prdt	Wtr	Othr	Brd	Frt	Egg	Mlk
Benguet	100	71	24	16	24	24	2		4	4	2	
N.Vizcaya	96	74	43	24	11	2	20	9	2	2		
All Sites	***95***	***71***	***33***	***20***	***17***	***13***	***10***	***4***	***3***	***3***	***1***	
PROVINCE	**SNACK**											
	Rt & tbr	Brd	Frt	Cff	Wtr	Othr	Rice	Meat & prdt	Vgtbl	Mlk	Fish & prdt	Egg
Benguet	82	51	24	27	16	12		2	2	2		
N.Vizcaya	72	43	35	28	20	4	9					
All Sites	***75***	***46***	***29***	***27***	***17***	***8***	***4***	***1***	***1***	***1***		

Farm Profile

In interpreting effect on livelihood, it is also relevant to understand kind and size of farm operated, kind and purpose of crops planted and cropping system for sweetpotato.

Farmscape planted to sweetpotato and other crops. As shown in Table 5, there are four farmscape operated by the sweetpotato growers, namely: (1) the *uma* or swidden farm located in sloping hilly or mountain sides planted to a mixed crop of any of the following,

roots and tubers, legumes, vegetables, spices, corn, rice and tiger grass (Gayao, Meldoz and Backian, 2013-2014); (2) *talon* or rice field that is flat and/or terraced farms oftentimes planted to rice during rainy season and planted to sweetpotato or other vegetables during dry season, (3) sometimes called gardens when flatlands, terraces and sloping farms are planted to vegetable cash crops and sometimes planted to sweetpotato and taro, and (4) backyard gardens which are small plots near dwelling units planted to crops for kitchen use. Kinds of farms planted to sweetpotato highly differed significantly among respondents in all sites. Though, 75% of sweetpotato growing household's plant in swiddens, 46% plant in backyard gardens, 35% in rice fields and 21% in vegetable gardens.

Table 5. Types of farm operated by household growers of sweetpotato in Benguet and Nueva Vizcaya, Philippines

PROVINCE/ MUNICIPALITY	*UMA*/ SWIDDEN	*TALON*/ RICE FIELD	GARDEN	BACKYARD GARDEN
Benguet, n=49	*29 (59%)*	*25(51%)*	*12 (25%)*	*24 (49%)*
Atok	7	11	5	
Kabayan	8	5	3	15
Kapangan	7	2	3	4
Mankayan	7	7	1	5
Nueva Vizcaya, n=46	*42 (91%)*	*8 (17%)*	*8 (17%)*	*20 (43%)*
Bambang	16	1	2	4
Kasibu	9	4	2	6
Kayapa	9			9
Santa Fe	8	3	4	1
Total- all sites, n=95	**71**	**33**	**20**	**44**
%	**75%**	**35%**	**21%**	**46%**

**multiple response*

*x^2value= 35.070,p.000** (province);1.643E2,p.000** (municipality)*

Cropping system/pattern. In swidden and homegarden mixed cropping (47%), sweetpotato is planted as intercrop (8%) or border crop (27%). In vegetable gardens and rice fields, sweetpotato is planted in mono crop as main rotation crop (53-65%), confirming earlier findings in the traditional roots and tubers knowledge study among indigenous people (Gayao, Meldoz and Backian, 2013-2014). Cropping systems and cropping patterns highly differed among sweetpotato growers in the municipalities (Table 6).

Table 6. Cropping system and cropping pattern for sweetpotato as practiced growers in Benguet and Nueva Vizcaya

PROVINCE/ MUNICIPALITY	MONO-CROPPING	MIXED CROPING	MAIN / ROTATION CROP	INTER CROP	BORDER CROP
Benguet, n=49	*25 (51%)*	*24 (49%)*	*27 (61%)*	*3 (7%)*	*14 (32%)*
Atok	*9*	*4*	12	1	0
Kabayan	*9*	*8*	7	0	10
Kapangan	*3*	*8*	4	1	1
Mankayan	*4*	*4*	4	1	3
Nueva Vizcaya, n=46	*25 (54%)*	*21 (46%)*	*22 (71%)*	*3 (10%)*	*6 (19%)*
Bambang	8	9	10	2	1
Kasibu	5	5	2	0	2
Kayapa	5	4	9	0	0
Santa Fe	7	3	1	1	3
Total- all sites, n=95	***50***	***45***	***49***	***6***	***20***
%	***53%***	***47%***	***65%***	***8%***	***27%***

**multiple response (less 5 in Benguet and 15 in Nueva Vizcaya with no specific cropping pattern)*
*x^2value= 10.430,p.005**; 78.622,p.000** (cropping system)*
*x^2value= 8.980,p.062^{ns};75.3187;p.000** (cropping pattern)*

Farm size planted to sweetpotato and other crops. Differences in the size of farms operated by the respondents are highly significant (Table 7). There are 33% of growers who cultivate 1,001m^2 to 0.5ha, 23% from 0.5 to 1.0ha, and 19% cultivate more than one hectare, especially in Nueva Vizcaya who have bigger farm size than the growers in Benguet. Majority of the 20% who plant only 500m^2 or less, and the 5% who plant from 501-1,000 m^2 are from Benguet. This result is consistent with the earlier implication that the sweetpotato growers belong to the low-middle income families, as most of them are actual tillers of smaller farm sizes not necessarily their own. Part of the farm area planted to sweetpotato per cropping per household ranges from 50-1,000m^2 averaging 432m^2 in the selected municipalities in Benguet, and from 100-500m^2 averaging 257m^2 in selected municipalities in Nueva Vizcaya (Part 1).

Purpose of crops planted. Among farmers in the different municipalities (Table 8), crops planted including sweetpotato is both for own household consumption and for sale (83-84%), with the excess crop harvest for animal feeds (37%) and given away as gifts (4%). Bigger and undamaged roots harvested during first priming are sold, the smaller and mechanically injured roots, and the succeeding priming harvest are usually for home consumption among the indigenous people.

Table 7. Total farm sizes operated by sweetpotato growers in Benguet and Nueva Viscaya planted to sweetpotato and other crops

PROVINCE/ MUNICIPALITY	500SQM AND BELOW	>500 TO 1000SQM	>1000 TO 0.5HA	>0.5HA TO 1 HA	>1 HA
Benguet, n=49	*17 (35%)*	*4 (8%)*	*11 (22%)*	*10 (20%)*	*7 (14%)*
Atok	9	3	1	0	0
Kabayan	3	0	7	5	2
Kapangan	4	0	2	3	2
Mankayan	1	1	1	2	3
Nueva Vizcaya, n=46	*2 (4%)*	*1 (2%)*	*20 (43%)*	*12 (26%)*	*11 (24%)*
Bambang	0	0	12	4	1
Kasibu	0	0	1	1	8
Kayapa	0	0	1	6	2
Santa Fe	2	1	6	1	0
Total- all sites, n=95	**19**	**5**	**31**	**22**	**18**
%	**20%**	**5%**	**33%**	**23%**	**19%**

**multiple response*

*x^2value= 17.245,p.002** (province);94.107;p.000** (municipality)*

Table 8. Household purpose of sweetpotato and other crops planted by sweetpotato growers in Benguet and Nueva Vizcaya

PROVINCE/ MUNICIPALITY	SALE	FOOD	FEED	GIFTS
Benguet, n=49	*36 (74%)*	*38 (78%)*	*17 (35%)*	*2 (4%)*
Atok	9	12	7	2
Kabayan	8	8	2	
Kapangan	11	11	3	
Mankayan	8	7	5	
Nueva Vizcaya, n=46	*43 (93%)*	*42 (91%)*	*18 (39%)*	*6 (13%)*
Bambang	17	15	7	1
Kasibu	8	9	5	1
Kayapa	9	9		
Santa Fe	9	9	6	
Total- all sites, n=95	79	80	35	4
%	83%	84%	37%	4%

**multiple response*

x^2 value= 6.785, p.452^{ns}; 69.681, p.028 (municipality)*

Incidence and Severity of Sweetpotato Fusarium Wilt

Incidence. All the 95 (100%) sweetpotato growers interviewed had encountered FW incidence in their farms. Growers claimed that FW started in 2012, and worst in 2014 and already recovering in 2017. Highly significant (p.000) differences in FW percentage incidence ranged from 10-100% but majority (47%) of growers' estimated 40-69% FW incidence and another 40% of growers estimated 70-100% FW incidence, higher in Benguet than in Nueva Vizcaya (Table 9). Field count of FW infected plants confirmed estimates of growers, a minimum of zero to a maximum of 100% or a mean of 37% FW incidence regardless of the age of sweetpotato crop at 1.5 to 12 months after planting (Table 10).

Severity. Assessment of FW severity highly differs (p.000) among growers in the municipalities selected, 49% indicated severe when they hardly can harvest roots, and 41% indicated moderate when they can still harvest but significantly reduced number and size of roots. Only 9% indicated mild severity, especially when the growers were only referring to their recent crops (2016-17).

Table 9. Incidence and severity of sweetpotato fusarium wilt in selected municipalities in Benguet and Nueva Vizcaya, Philippines

PROVINCE/ MUNICIPALITY	PERCEIVED INCIDENCE	% INCIDENCE			SEVERITY RATING		
		10-39	40-69	70-100	Mild	Moderate	Severe
Benguet	***49 (100)***	***5 (10)***	***26 (53)***	***18 (37)***	***4 (8)***	***19 (39)***	***26 (53)***
Atok		2	7	4	2	2	9
Kabayan		2	9	6	2	9	6
Kapangan		0	6	5	0	6	5
Mankayan		1	4	3	0	2	6
Nueva Vizcaya	***46 (100)***	***7 (15)***	***19 (41)***	***20 (43)***	***5 (11)***	***20 (43)***	***21 (46)***
Bambang		3	12	2	2	13	2
Kasibu		2	5	3	2	4	4
Kayapa		1	0	8	0	1	8
Santa Fe		1	2	7	1	2	7
Total- all sites	***95***	***12***	***45***	***38***	***9***	***39***	***47***
%	***100***	***13***	***47***	***40***	***9***	***41***	***49***

x2 value
- province *12.564, p.028** *29.700, p.029**
- municipality *72.985, p.000*** *2.016E2, p.000***

Table 10. Field count of infected sweetpotato plants

BARANGAY	# OF SAMPLES	AGE of CROP (MAP)	FW INFECTION (average %)
Pallas, Bambang	4	1.5	50
	3	5	27
	4	6	28
Cordon, Kasibu	4	2	60
	3	3	37
Ucao, Santa Fe	2	12	40
Sagubo, Kapangan	1	4	11
	1	11	40
Total	***22***		
Average		***9***	***37***

% infection= # of plants or hills infected / 10-20 plants or hills sampled

Effect of Fusarium Wilt

Plant health problem is one contributory factor in global food crop losses (Flood, 2010) and global food security (Strange and Scott, 2005). At the household-level, crop failure due to pests results to direct food losses, loss of farm income, no money to buy other food items and farm inputs, inability to pay debts, etc. (Lenne, 2000). For the sweetpotato growers, their decision to continuously plant the crop depended not only on the gravity but also on the consequences of fusarium wilt like the following:

Loss of planting materials and varieties. For the vegetatively-propagated sweetpotato, growers source out their planting materials from their own old crop and from their neighbors or relatives. As shown in Table 11, there was no loss but a reduction in using own planting materials from 76% to 59%, and a slight increase (from 35 to 39%) in sourcing-out from others. However, sources of planting materials highly differs among growers in the municipalities, as some has no change (Atok and Kayapa), some had increased using their own planting materials (Kapangan, Kasibu and Santa Fe) and some did not re-plant their own crop (Kabayan, Mankayan and Bambang). Reasons for continuously using their own old crop as planting materials is because not all plants are infected and there is no alternative source. Neighbors also have infected crops.

With respect to susceptibility and resistance of varieties to fusarium wilt, the growers observed that all varieties were not spared of the disease although some farmers also observed that the native longer maturing varieties were more tolerant than the more common salable and shorter maturing varieties.

Table 11. Source of planting materials before and after occurrence of fusarium wilt

MUNICIPALITY	OWN CROP		FROM OTHERS	
	BEFORE FW	AFTER FW	BEFORE FW	AFTER FW
Atok	8	8	5	5
Kabayan	14	2	3	15
Kapangan	6	10	5	1
Mankayan	8	6	0	2
Bambang	14	8	3	9
Kasibu	7	15	3	4
Kayapa	9	9	0	0
Santa Fe	6	7	4	3
Total- all sites, n=95	***72***	***56***	***33***	***37***
%	***76***	***59***	***35***	***39***
multiple response				
x2 value	*41.748*		*64.09*	
p-value	*.005***		*.000***	

Increase in pesticide inputs. It is very seldom that sweetpotato growers belonging to the indigenous peoples of Benguet and Nueva Vizcaya apply external chemical inputs as compared to the lowland sweetpotato farmers in Central Luzon (Gayao, 2017). The growers claimed that the sweetpotato crop, as a rotation crop, border or intercrop makes use of residual fertilizer as the main crop of rice and vegetable cash crop are fertilized and sprayed. Thus, even with the FW incidence, 97% of the growers did not incur additional farm inputs. Only one grower sprayed fungicide and two growers sprayed insecticide in trying to control FW infestation.

Loss or reduction in root yield. Zero root harvest because of FW is claimed by only 14% of the growers. Majority (86%) claimed that FW decreased yield because of smaller root size, fewer number of roots harvested and/ or reduced priming harvest (Table 12). In all sites, reduction in sweetpotato root yield is higher at 75-100% among 89% of the Nueva Vizcaya growers than among 65% of the Benguet growers at 51-100% yield reduction. Reduction in root yield of 50% or less is claimed by 20% of the growers. Observations on the percentage reduction in yield significantly differed among the sweetpotato growers but not on the effect of FW on yield.

Further, the higher the severity the higher the yield reduction. Statistically however, there is no close association of FW severity to the decrease in yield (Table 13).

Table 12. Change and percentage decrease in yield of sweetpotato planted due to fusarium wilt infection

Province/ Municipality	Zero yield	Decreased yield/ small roots	Percentage Decrease			
			25 & less	26-50	51-75	76-100
Benguet, n=49	***10 (20)***	***39 (80)***	***3 (6)***	***14 (29)***	**21 (43)**	**11 (22)**
Atok	2	11	0	10	1	2
Kabayan	5	12	1	2	9	5
Kapangan	3	8	0	0	11	0
Mankayan	0	8	2	0	0	4
Nueva Vizcaya, n=46	***3 (6)***	***43 (94)***	***1 (2)***	***1 (2)***	***3 (7)***	***41 (89)***
Bambang	0	17	0	0	0	17
Kasibu	3	7	1	0	3	6
Kayapa	0	9	0	1	0	8
Santa Fe	0	10	0	0	0	10
Total- all sites, n=95	***13***	***82***	***4***	***15***	24	52
%	***14***	***86***	***4***	***16***	25	55

	Province	*Municipality*	*Province*	*Municipality*
x2 value	*4.988*	*20.991*	63.458	4.08E+02
p-value	*0.083ns*	*.102ns*	.000**	.000**

Table 13. Association of fusarium wilt severity to decrease in yield of sweetpotato

SEVERITY OF FUSARIUM WILT	EFFECT ON YIELD	
	Zero yield	Decreased yield/ small roots
Mild	1	8
Moderate	1	30
Severe	11	44

x^2 value =4.779, p.092ns
Contingency coefficient= 0.219

Loss or decrease in livelihood or farm income. The sweetpotato growing households have multiple sources of cash income and food supply, and that sweetpotato harvest is both for sale and for food. As computed in Table 14, 1,000 hills (500m^2 or less) of sweetpotato planted will contribute PhP15,440 to PhP31,220 in household farm income within a period of 4-12 months. At 50% reduction in yield, loss in livelihood (crop sales, food, feed, planting materials and self-employment) was estimated to range from PhP7,720 to PhP15,610 and at 75% yield reduction from PhP11,580 to PhP23,415 per household. For all the 4,219 growers (Part 1) planting 250-300m^2 of sweetpotato in Benguet and Nueva Vizcaya, fusarium wilt infection was estimated to cost Php33 M to PhP99 M worth of food and livelihood.

As previously implied, the sweetpotato household growers belong to the low and the lower middle income group with a monthly income ranging from PhP7,890 to PhP15,780 and from PhP15,780 to PhP31,560, respectively. So that, a 50% yield reduction due to FW was calculated to result in a 25% decrease in household income of the low income group computed as follows: (7720/4 mos //7890 x 100; or 15,610/4//15,780 x 100) assuming they planted 1,000 hills of sweetpotato.

Table 14. Contribution of sweetpotato crop to farm income or livelihood and estimated reduction in farm income as a result of FW

FARMSCAPE/ CROPPING SYSTEM	YIELD (g/ hill)	CROP SALES, FOOD & FEED (PhP/hill)	SELF-EMPLOYMENT (PhP/hill)	TOTAL CONTRIBUTION	
				(PhP/hill)	PhP/1000 hills)
Garden/ monocrop	1,022-1,820	17.38-28.95	4.92	28.08	28,080
Swidden/ mixed	980-1,738	14.37-25.36	11.35	31.22	31,220
Homegarden	100-800	4.94-15.09	5.42	15.44	15,440
ESTIMATED REDUCTION IN FARM INCOME					
		50% YIELD REDUCTION		75% YIELD REDUCTION	
Garden/ monocrop		14,040		21,060	
Swidden/ mixed		15,610		23,415	
Homegarden		7,720		11,580	

Based on benefits and costs (Gayao, 2017)

Reduction in area planted. Even if the sweetpotato growers experienced FW infection, 47% did not reduce the area planted to sweetpotato. The other 53% had negative effect on area planted, i.e. 38% planted lesser area, 7% planted other crops and 8% did not plant sweetpotato (Table 15). Difference in these changes in area planted to sweetpotato among the growers is significant at 1% level. With more severe FW infection the higher the reduction in area, although the association of area changes to FW severity is weak at a contingency coeffcient of 0.342.

Table 15. Change in area planted to sweetpotato and its association to fusarium wilt severity

MUNICIPALITY	NONE	REDUCE	NOT PLANTED	PLANTED OTHER CROPS
Atok	8	5	0	0
Kabayan	8	4	3	2
Kapangan	0	11	0	0
Mankayan	4	3	1	0
Bambang	17	0	0	0
Kasibu	8	2	0	0
Kayapa	0	0	4	5
Santa Fe	0	10	0	0
FUSARIUM WILT SEVERITY				
Mild	5	3	0	1
Moderate	21	9	0	1
Severe	19	23	8	5
Total- all sites	***45***	***35***	***8***	***7***
%	***47***	***37***	***9***	***7***
	Municipality		*Contingency coeffcient*	
x2 value	*1.16E+02*		*12.599*	
p-value	*.000***		*.050**	

Reduced consumption of sweetpotato. The allegation that pests have a negative effect on household food supply is consistent with the results of this study where majority have decreased (73%) sweetpotato consumption and 7% have zero consumption especially for those with moderate to severe FW incidence. According to growers in Sagubo, Kapangan, sweetpotato consumption was reduced to once a day during a one-time harvest unlike before where consumption ia at least once a day for a two months harvesting period. In the same village, household consumption of sweetpotato roots averages 256 kg/mo or 38kg/family member, once to three times a week, during the rainy months of July to August (Unpublished data, B. Gayao, 1991). Nowadays, the shift to other crops, pests and diseases and lifestyle changes led to reduction in household consumption of sweetpotato. Despite all these problems, there were 20% of households who claimed no change in their sweetpotato consumption. While sweetpotato consumption highly differs among growers, its association to FW severity is not very strong at a consistency coefficient of 0.162 (Table 16).

Another pest, sweetpotato weevil is also causing reduction in sweetpotato consumption (Table 17). These pests render the unmarketable roots unfit for human and livestock consumption. Sweetpotato just like other root and tuber crops is the number one snack food among growers in Benguet and Nueva Vizcaya, and as an alternate or supplementary staple food during breakfast and supper.

Table 16. Association of fusarium wilt severity and effect on sweetpotato consumption

PROVINCE/ MUNICIPALITY	EFFCT OF FW INFECTION		
	NO EFFECT	DECREASED CONSUMPTION	ZERO CONSUMPTION
Benguet, n=49	*6 (12%)*	*36 (74%)*	*7 (14%)*
Atok	1	12	0
Kabayan	3	7	7
Kapangan	0	11	0
Mankayan	2	6	0
Nueva Vizcaya, n=46	*13 (28%)*	*33 (72%)*	*0*
Bambang	0	17	0
Kasibu	7	3	0
Kayapa	0	9	0
Santa Fe	6	4	0
FUSARIUM WILT SEVERITY			
Mild	2	**7**	**0**
Moderate	6	24	1
Severe	11	38	6
Total- all sites	***19***	***69***	*7*
%	***20***	***73***	*7*

	Province	*Municipality*	*Contingency coefficient*
x2 value	9.624	71.948	*0.162*
p-value	.000**	.000**	

Table 17. Other factors causing decrease in sweetpotato consumption

PROVINCE/ MUNICIPALITY	NOT CONSUMMABLE REJECTS	WEEVIL / DISEASE-DAMAGED ROOTS	OTHER REASONS
Benguet, n=49	*0*	*7 (14%)*	*7 (14%)*
Nueva Vizcaya, n=46	*20 (43%)*	*24 (52%)*	0
Total- all sites	***20***	***24***	*7*
%	***21***	***25***	*7*

x2 value	46.482
p-value	.000**

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The farmers affected by the sweetpotato fusarium wilt disease mostly belong to the indigenous people of Benguet and Nueva Vizcaya. Women household members are generally responsible for the sweetpotato crop. Sweetpotato growing households have multiple sources of cash income and food supply, and smaller farm sizes. They source out their cash income from crop sales (95%), wages or salary (67%) and others (53%). Their food supply comes from their own crop (92%), purchases (87%) and food assistance from others (33). More than half (56%) operates 1,000m2 to one hectare consisting of swidden (75%), backyard garden (46%), rice field (35%) and vegetable garden (21%). These are characteristics typical of the low income and lower middle income group with household income that ranges from PhP7,890 to PhP31,560 per month.

Sweetpotato is planted in less than 100m2 to 1,000m2 per household as one of the mixed crops or rotation crop purposely for sale in local markets, and for food. Sweetpotato is mostly eaten as snack food (75%) and as supplemental food to rice and vegetable for breakfast (48%) and supper (33%).

All the sweetpotato growers in Benguet and Nueva Viscaya had experienced fusarium wilt infection in their fields, starting in 2012, moderate to severe in 2014-16. Percentage incidence affected 40-69% of the sweetpotato plants according to 47% of growers and 70-100% among 40% of the growers.

Consequences of the fusarium wilt infection were (1) reduction in the number of growers using their own crop as source of planting materials; (2) lesser area planted to sweetpotato, (3) reduction in root yield, (4) reduced cash income from crop sales, and (5) reduced consumption of sweetpotato. At 50% reduction in root yield, there will be 25% decrease in household family income (crop sales, food feed and self-employment) ranging from PhP1,930 to PhP3,902 per month. The expected increase in pesticide use and loss of their variety did not happen.

Considering the aforementioned, fusarium wilt disease negatively affected the livelihood source and food security of the sweetpotato growers. For the 4,219 growers in the provinces of |Benguet and Nueva Vizcaya, PhP33-99 million worth food and crop sales income was lost.

Continuing research and technical assistance is recommended to prevent worsening of fusarium wilt occurrence; to explain the alleged recent recovery of their sweetpotato crops from fusarium wilt infection or the accurate identification of the causal organism; and to provide adequate resources to strengthen the formal and informal seed system for provision of disease-free planting materials and recommended varieties.

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PART 3

INCIDENCE AND EFFECT OF TARO WILT (*PHYTHOPHTHORA COLOCASIAE*) AND TARO BEETLE (*GENUS PAPUANA*) IN LIVELIHOOD AND FOOD SECURITY OF GROWERS IN BENGUET AND NUEVA VIZCAYA, PHILIPPINES

ABSTRACT

Reduction in quantity and quality of yield is immediate consequence of taro leaf blight and taro beetle. This research documented extent of damage caused by these pests, and estimated effect of these pests damage on the livelihood and food security of the taro growing households.

Taro household growers are also rice farmers, vegetable growers, sweetpotato growers and/ or yam growers. In short, taro growers are farming households with multiple crops, multiple sources of cash income and multiple sources of food. Majority source of cash income is from crop sales with some household members receiving salaries, wages, cash allowance or assistance, and a few engage in informal micro businesses like crop assemblers, store retailers and transport operators. Food source is firstly from own produce and secondly from purchases with some getting share from family farms or gifts from neighbors.

Very few farmers are growing taro as a major cash crop. Most taro crop is grown as secondary crop and thus is grown in small areas in parts or borders of swidden fields, rice fields, vegetable gardens and backyards mostly for household consumption. Taro leaf blight was observed by 100% of the taro growers and taro beetle by 86%. More growers rated taro leaf blight as moderate to severe, and taro beetle as mild to moderate. Despite these high pests prevalence, the effect on loss of planting materials and varieties is only four percent. The effect to increased farm inputs applied only to growers engaged in taro cash cropping. Chemical spraying reduced incidence of taro leaf blight and taro beetle resulting to only six percent yield loss or a PhP1.32/hill loss in cash income.

INTRODUCTION

Taro is a relatively minor crop in the Philippines but has the largest area devoted to taro in Asia proper, apart from China (FAO, 1997). In the Philippines, 0.110 million tons of taro are produced, and bulk (95%) of taro is for food consumption (Philippine Statistics Authority, 2014). Yields are generally low throughout the country, usually averaging less than 5 tonnes/ha. The taro leaf blight is present in the country, and reductions in corm yield of 25 to 35% in the Philippines. Losses may be greater among highly susceptible cultivars as high as 95% as reported in Hawaii (FAO, 2016). *Phytophthora colocasiae* is primarily a foliar pathogen, but it also affects the petioles and corms of its hosts. The first symptoms on taro (*Colocasia esculenta*) are small, dark brown flecks or light brown spots on the upper leaf surface. These early spots often occur at the tips and margins of leaves where water accumulates. The spots enlarge rapidly, becoming circular, zonate, and purplish brown to brown in color. On the lower leaf surface, spots have a water-soaked or dry gray appearance and hard globules of plant exudate are sometimes present. As spots increase in size they coalesce and quickly destroy the leaf. Dead leaves often hang on their long petioles like flags.

Bright orange or reddish brown plant exudate oozing from infection sites is another symptom of leaf blight disease in taro. The presence of yellow tissue around lesions is not well understood, but could be a cultivar-specific reaction or a stress response to dry weather. Infected corm tissue is brown, firm, and develops rapidly after harvest. A prominent sign of *P. colocasiae* is the whitish ring of sporangia around the edge of lesions during periods of high relative humidity (Brooks, F.E. 2005).

The taro beetle specie of *Papuana* has been reported in the country (FAO, 1997). The taro beetles of economic importance are several species belonging to the genus *Papuana* (Coleoptera: Scarabaeidae). These include *Papuana woodlarkiana, Papuana biroi, Papuana huebneri,* and *Papuana trinodosa*. The adult beetle is black, shiny, and 15-20 mm in length. Many species have a horn on the head. The adult beetles fly from the breeding sites to the taro field and tunnel into the soil just at the base of the taro corm. They then proceed to feed on the growing corm, leaving large holes that degrade the eventual market quality of the corm. Also the wounds that they create while feeding promote the attack of rot-causing organisms. The feeding activity can cause wilting and even death of the affected plants. After feeding for about two months, the female beetle flies to neighbouring bushes to lay eggs. The eggs are laid 5-15 cm beneath the soil close to a host plant. The eggs are cylindrical and brown or white in colour. Larvae hatch from the eggs in 11-16 days. The larvae feed on plant roots and dead organic matter at the base of the host plants. The larva moults about three times in its 3-4 months of life, and then pupates. After about two weeks, the adults develop from the pupa and fly to neighboring taro plots to cause another cycle of damage. The adult lives for 4-8 months. Not only does the taro beetle have a wide host range for breeding, but it also has a wide host range of crops including tannia, sugarcane, banana, sweet potato, yams, etc. This versatility of hosts makes the taro beetle additionally destructive, and its control much more difficult (FAO, 2016).

Literature review on the extent of taro leaf blight and taro beetle in the Philippines particularly in Benguet and Nueva Vizcaya is unavailable. This research therefore aimed to document the extent as well as its effect on household livelihood and food security among taro growers in these provinces.

Livelihood is work done to earn a living or whatever provides a source of income (Encarta, 2005), but as a concept in research and development, livelihood includes what people do given their resources and assets to achieve basic needs brought about by the process or system of livelihood generation (Niehof and Price, 2001).. Household food security is a situation where everyone has access at all times to sufficient food for an active and healthy life (DVL/VM, Elly Leemhuis- de Regt (ed), 1998).

METHODOLOGY

Selection of Sites and Respondents

Based on secondary information gathered on taro growing areas from provincial and municipal records and interviews on reported or known incidence of taro leaf blight and taro beetle, ten barangays in six municipalities in Benguet and one municipality in Nueva Vizcaya were selected as shown in Table 1. Selection of barangays was done in coordination with

municipal agriculture office and/or village leader. Two other municipalities in Nueva Vizcaya were initially identified (Santa Fe and Bambang) but during the field work barangay key informants claimed that almost 100% of those growing taro, plant only few hills for household use and that most have not observed severe incidence of taro leaf blight and taro beetle, thus were excluded in this study.

A total of 71 respondents consisting of 63 females and 8 males were interviewed (Table 1). Majority are women since they are more responsible for care and use of taro. Respondents in Sablan, Tuba, Atok, Tublay and Kayapa belong mostly to the Ibaloi indigenous people (IP). Respondents in Kabayan and Mankayan are a mixture of Kalanguya, Ibaloi and Kankana-ey IPs.

Table 1. Number of respondents in the barangays/ municipalities selected

MUNICIPALITY	BARANGAY	# OF RESPONDENTS		
		MALE	FEMALE	TOTAL
1. Sablan	1. Bayabas	4	3	7
2. Atok	2. Naguey		4	4
3. Tuba	3. San Pascual	1	11	12
	4. Taloy Sur			
4. Kabayan	5. Tawangan		12	12
5. Mankayan	6. Cabiten	2	6	8
6. Tublay	7. Basil		16	16
7. Kayapa	8. Besong	1	6	7
	9. Amelong-labeng		4	4
	10. Kayapa Proper East		1	1
TOTAL		*7*	***63***	***71***

Data Gathering Procedure

Group interview workshops and focused group discussion (FGD) were conducted in the recommended barangays or villages.

An open-ended questionnaire was used as a guide in the group interviews and FGDs. It started with knowing the number of households with taro crops and observed pests and diseases of taro particularly taro leaf blight and taro beetle. A picture of the leaf blight and beetle was shown to reconcile how the disease and pest look like. It was followed with a focused group discussion among participants on when the pests and diseases became visible, what parts of the plant and what varieties were infected, and severity of the pest and disease and coping mechanisms which were all recorded in the questionnaires. Individually, the participants were also requested to fill-in their household and farm profile including farming practices on taro. The effect of leaf blight and beetle damage on the yield, future source of planting materials, their household consumption and crop sales were also asked.

Case Study

A case farm was also identified for field observation and validation of taro pests and diseases, and where sample of diseased plants including the soil were taken for laboratory identification and diagnosis.

Data Analysis

Similarly, incidence and severity of taro leaf blight and taro beetle was determined or defined from the viewpoint of the researchers (perceived incidence) and from the viewpoint of the growers (percentage incidence and severity) as follows:

$$\text{Perceived incidence} = \frac{\text{number of farmers who observed leaf blight and beetle in their farms}}{\text{total number of taro growers interviewed}} \times 100$$

$$\text{Percentage incidence} = \text{estimated number of plants/ hills with observed infection for every10 plants/hills of taro} \times 100$$

Observation on severity was based by the growers on how many of the plants or how wide the area planted was harvested by choosing either:

1- Mild (at least 75% of crop was harvested),
2- Moderate (40-60% of crop was harvested) , and
5- Severe (at least 25% of crop was harvested).

Statistical analysis. The questionnaires were completed, reviewed then encoded. The gathered information was further coded using the Excel software then some of the data were transferred for statistical analysis using the SPSS software. Descriptive analysis using cross-tabulation, Pearson chi-square and contingency coefficient correlation was done. Level of significance was set at five percent. For this Part 3 write-up, taro leaf blight and taro beetle incidence was discussed in relation to its effect on farm income and household food consumption of taro. Causal factors leading to the build-up of the pests and diseases is discussed in Volume 2.

RESULTS AND DISCUSSION

Present knowledge of global crop and food supply losses due to pests is very limited (Andersen, 2001) yet history has shown that pests and diseases affected livelihoods and food security of many people. Their effects range from mild to catastrophic (Strange and Scott, 2005). Some catastrophic examples which led to crop losses, starvation and death are the Irish potato famine due to late blight (1845-46), the rice brown leaf spot in Bengal (1942-43) and the African cassava mosaic virus disease (1990's). To better understand the effect of taro leaf blight and taro beetle infection on livelihood and food security, it is important to gather some facts on sources of cash income and food, habitual diet and farm profile of the taro growers.

Household Livelihood

Source of cash income. Statistical analysis shows highly significant differences (p.000) in source of cash income among households in the barangays. Although 99% of the taro growing households source their cash income from crop sales, some household members are receiving salaries as employees or barangay officials, and wages as laborers (51%) as shown Table 2. Very few (14%) are engaged in business either as sari-sari store owners, agricultural crop assemblers and/or public utility owners. These multiple source of income also implies that the taro growers mostly belong to the low-middle income group and some to the poor income group as they receive from other sources (27%) like cash assistance from social services including families with elderly household members. For the poor, cash income is barely enough to buy food necessities.

The poor has a monthly income of PhP7,890; the low income class has between PhP7,890-15,780/mo.; the lower middle income class has between PhP15,780-31,560/mo.; and the middle class has between PhP31,560-78,900/mo. for a family size of 5 members based on the PSA 2012 Family Income and Expenditure Survey (Albert, Gaspar and Raymundo, 2015).

Table 2. Household sources of cash income among taro growers in selected barangays in Benguet and Nueva Vizcaya

BARANGAYS	SALARY/ WAGES	CROP SALES	BUSINESS	OTHERS
	# of respondents			
Bayabas	4	6	2	
Naguey	3	4	1	2
Cabiten	4	8	2	6
Tawangan	8	12		3
Taloy Sur	1	6	1	2
San Pascual	2	6	2	1
Basil	14	16	2	5
Besong		7		
Amelong-labeng		4		
Kayapa Poblacion East		1		
Total- all sites, n=71	**36**	**70**	**10**	**19**
%	**51**	**99**	**14**	**27**

**multiple response*

*x^2value=1.904E2, p.000***

Source of household food supply. Taro growing households from the different barangays or villages highly differs in source of food supply, though majority source out their food from multiple sources, i.e., own produce (93%) and purchases (69%) and for some (27%) from other sources like crop share especially for rice from parents or family farm and/or gifts from other farmers or neighbors (Table 3). This means that their taro crop is an important source of food. Further, there were four respondents who sourced out their food only from their

own produce which means that whatever cash income they earn is spent for other non-food necessities.

Table 3. Household sources of food among taro growers in the selected barangays in Benguet and Nueva Viscaya

BARANGAY	OWN FARM PRODUCE	PURCHASES	OTHERS
	# of respondents		
Bayabas	7	7	3
Naguey	4	4	1
Cabiten	4	4	1
Tawangan	12	12	2
Taloy Sur	6	6	1
San Pascual	6	6	1
Basil	16	13	10
Besong	6	7	
Amelong-labeng	4	4	
Kayapa Poblacion East	1		
Total- all sites, n=71	***66***	***49***	***19***
%	***93***	***69***	***27***

**multiple response*

*x^2value= 1.665E2, p.000***

Habitual Diet

Similar to the sweetpotato growers, taro growing households eat rice (77-97%) as staple, vegetables (76-82%) as viand and water as beverage (30-61%) three times a day, i.e. breakfast, lunch and supper. Sometimes meat and products (21-38%) and fish and products such as dried fish and canned sardines (25-42%) are included and/or added to vegetables. Vegetable also include taro stalk and leaves, sweetpotato tops and tannia cormels. Roots and tubers which include sweetpotato roots, cassava tubers, taro corms and yam roots are mostly eaten as snack food (76%), and sometimes during breakfast, lunch and supper (18-27%). These show the importance of taro in the habitual diet of the households. Coffee or tea is also drunk after meals (18-34%) and during snacks (30%) in addition to water. Other food items like fruits, eggs, bread and noodles as shown in Table 4 are less frequently eaten in every meal. Six percent of the taro households don't have snacks.

Table 4. Kinds of food/ beverage included in the habitual diet of taro growers in Benguet and Nueva Vizcaya (% of respondents)

BREAKFAST		LUNCH		SUPPER		SNACK	
Rice	97	Rice	90	Rice	77	Rootcrops	76
Vegetables	82	Vegetables	80	Vegetables	76	Bread	45
Water	61	Water	37	Water	30	Fruits	34
Fish/fish products	42	Fish/fish products	30	Fish/fish products	25	Coffee/tea	30
Meat/meat products	38	Meat/meat products	30	Meat/meat products	21	Water	20
Coffee/tea	34	Coffee/tea	28	Coffee/tea	18	Others	4
Rootcrops	27	Rootcrops	23	Rootcrops	18	Vegetables	3
Fruits	15	Eggs	11	Fruits	8	Milk	3
Eggs	15	Fruits	4	Others	4	Rice	1
Bread	14	Bread	4	Bread	3	Meat/meat products	1
Milk	7	Milk	3	Milk	3	Eggs	1
Others	7	Others	3	Eggs	0	Fish/fish products	0
						No snack	6

Farm Profile

Farmscape planted to taro and other crops. Kinds of farm operated highly differed among taro growers in all sites. Majority have at least three kinds of farms operated taro growers, namely: uma or swidden farm (80 %) located in sloping hilly or mountain sides (Gayao, Meldoz and Backian, 2013-2014), backyard gardens (68%) which are small plots planted to crops for kitchen use, and *talon* or rice field (54%) that is flat and/or terraced farms oftentimes planted to rice during rainy season and sometimes called gardens (18%) when planted to vegetable cash crops, sweetpotato and taro (Table 5).

Farm size planted to taro and other crops. Farm sizes planted to taro ranged from 10 to 373m^2 in the municipalities where the study areas were selected (Part 1) which was part of the total area farmed by the taro growers as shown in Table 6. On a per household basis, 25% of the growers operate greater than 1,000-5000m2, and another 25% who operate greater than one hectare followed by 24% who cultivates 500m^2 and below, and 13% who operates from >0.5 to 1ha or >500 to 1,000m^2. The small area farmed was justified by the respondents as the only area that can actually be tilled by head of the household sometimes with help of spouse or children if there are any available. As previously shown in Table 2, farming is just one source of livelihood.

Table 5. Types of farm operated by taro household growers in Benguet and Nueva Vizcaya

BARANGAY	*UMA*/ SWIDDEN	*TALON*/ RICE FIELD	GARDEN	BACKYARD GARDEN
Bayabas	6	5	3	1
Naguey		4		2
Cabiten	6	7		5
Tawangan	6	2	2	9
Taloy Sur	6	1		6
San Pascual	6	4		5
Basil	15	13	1	12
Besong	7		3	5
Amelong-labeng	4	1	4	2
Kayapa Poblacion East	1	1		1
Total- all sites, n=71	***57***	***38***	***13***	***48***
%	***80***	***54***	***18***	***68***

**multiple response*
*x^2value= 2.707E2, p.000***

Table 6. Total farm sizes operated by taro growers in Benguet and Nueva Vizcaya

BARANGAY	500SQM and BELOW	>500 TO 1000SQ M	>1000 TO 0.5HA	>0.5HA TO 1 HA	>1 HA
Bayabas				1	6
Naguey	1	1	2		
Cabiten	1	1	1	3	2
Tawangan	2	1	6	1	2
Taloy Sur		2	2	2	
San Pascual	1		2		3
Basil	4	4	5	2	1
Besong	6				1
Amelong-labeng	2				2
Kayapa Poblacion East					1
Total- all sites, n=71	**17**	**9**	**18**	**9**	**18**
%	**24**	**13**	**25**	**13**	**25**

*x^2value= 1.430E2 p.000***

Cropping system/pattern. Taro is planted by growers as a mono crop (49%) in rice fields and gardens mostly as a rotation crop (41%) especially in Naguey, Cabiten and Tawangan (Table 7). As one of the mixed crops (68%) planted in any of the farmscapes, taro is planted either intercrop (42%) or border crop (30%).

Purpose of crops planted. Multiple use of taro highly differs among respondents (p.000). Taro is firstly used for household food purposes (97%) and if there are more than enough harvest and there are buyers, taro corms and stalk are sold (83%), though 14% (97-83)

of respondents plant taro only for home use. Some 32% of households give the uneaten cooked corms or stalk and leaves to pigs and chicken Sometimes crop harvest are given as gifts to visitors (10%). Since taro is an important food source especially among indigenous farmers, 73% perpetually grow and sourced out their planting materials from their old crop (Table 8).

Table 7. Cropping system and cropping pattern for taro as practiced growers in Benguet and Nueva Vizcaya

BARANGAY	MONO-CROPPING	MIXED CROPING	MAIN / ROTATION CROP	INTER CROP	BORDER CROP
Bayabas	6	7	7	7	
Naguey	4		4		
Cabiten	7	4	6		2
Tawangan	8	4	2		10
Taloy Sur		6	3	3	
San Pascual	2	6	1	5	
Basil	5	11	5	7	6
Besong	2	5	1	4	2
Amelong-labeng		4		3	1
Kayapa Poblacion E.	1	1		1	
Total- all sites, n=71	***35***	***48***	***29***	***30***	***21***
%	***49***	***68***	***41***	***42***	***30***

**multiple response*

x^2value *1.803E2, p.000*** *2.015E2, p.000***

Table 8. Household purpose of taro and other crops planted by taro growers in Benguet and Nueva Vizcaya

	SALE	FOOD	FEED	GIFTS	PLANTING MATERIALS
Bayabas	6	6	2		7
Naguey	4	4	1		4
Cabiten	7	8	4		6
Tawangan	11	11	1		9
Taloy Sur	6	6	5		6
San Pascual	3	6	2	1	5
Basil	13	16	3		15
Besong	5	7	3	3	
Amelong-labeng	3	4	1	2	
Kayapa Poblacion E.	1	1	1	1	
Total- all sites, n=71	***59***	***69***	***23***	***7***	***52***
%	***83***	***97***	***32***	***10***	***73***

**multiple response*

*x^2value= 1.798E2, p.000***

Incidence and Severity of Taro Leaf Blight

Incidence. One hundred percent incidence of taro leaf blight was observed by all growers in their taro crop especially during the rainy season. However, growers highly differ (p.000) in how they rate gravity of the taro leaf blight incidence. Percentage incidence is almost equally grouped by 34, 38 and 28 percent of the taro respondents at 5-39%, 40-69% and 70-100%, respectively (Table 9). The difference could be attributed to climate and also to environment. In Bayabas, Sablan where a case farm monitoring was done, actual count of taro plants with leaf blight symptoms show 98% incidence at 84 days after planting (DAP) gradually decreasing to 78% at 147 DAP (Table 10). The higher incidence at 84DAP could be attributed to cooler climate in February, and the gradual lowering of incidence could also attributed to chemical spraying practice. A field count done after the workshop interview in January also shows that taro leaf blight was higher (60%) for the plants planted in an area that is not fully exposed to sunlight or closer to the terrace wall as compared to taro plants in other parts of the farm (3%).

Severity. In assessing gravity of the disease, 42% of the grower-respondents rated disease prevalence as moderate, 31% rated prevalence as severe similar to the 70-100% percentage incidence, and 27% rated severity as mild. The greater number of farmers claiming moderate to severe incidence of taro leaf blight disease in all sites was only able to harvest 25-60% of their crop. This should be a matter of concern for farmers, researchers and extension technicians who are yet to determine the best control or preventive measures, though one or two growers in Bayabas and Cabiten had tried chemical spray. One case farmer who sprayed fungicide four times within a 5-month period from date of planting was able to reduce taro leaf blight incidence.

Table 9. Incidence and severity of taro leaf blight in selected barangays in Benguet and Nueva Vizcaya

BARANGAY	PERCEIVED INCIDENCE	% INCIDENCE			SEVERITY RATING		
		5-39	40-69	70-100	Mild	Moderate	Severe
Bayabas	7		7			7	
Naguey	4	2	2		2	2	
Cabiten	8			8		1	7
Tawangan	12	5	7		4	3	5
Taloy Sur	6	3		3	1	5	
San Pascual	6	1	2	3		1	5
Basil	16	7	4	5	5	6	5
Besong	7	4	3		5	2	
Amelong-labeng	4	1	2	1	1	3	
Kayapa Poblacion East	1	1			1		
Total- all sites, n=71	***71***	***24***	***27***	***20***	***19***	***30***	***22***
%	***100***	***34***	***38***	***28***	***27***	***42***	***31***
x2 value	*74, p.000***	*2.231E2, p.000***			*1.636E2, p.000***		

Table 10. Observations on incidence of taro leaf blight and taro beetle on Mr. Garoy's farm (Feb. 6-April 16, 2018)

SAMPLE #	# OF HILLS WITH BLIGHT INFECTED LEAVES/ 10 HILLS				
	84DAP	96DAP	112DAP	129DAP	147DAP
1	10	9	7	8	6
2	10	10	8	8	7
3	10	10	10	6	7
4	10	9	10	10	9
5	10	10	10	10	9
6	9	10	9	10	9
Total	**59**	**58**	**54**	**52**	**47**
%	**98**	**97**	**90**	**87**	**78**

DAP- days after planting

Incidence and Severity of Taro Beetle

Perceived incidence, percentage incidence and severity of taro beetle damage significantly differed (p.000) among taro growers in the different barangays. Taro beetle damage was observed by 86% of the growers. Percentage of taro plants destroyed by beetle ranged from 5 to 100%, with only 16% of growers claiming 70-100% of the crop damaged by beetles, majority of growers (48%) claimed 40-69% crop damage and 37% claimed 5-39% damage. Severity of beetle damage which is based on the percentage of the taro plants the growers were able to harvest was rated as mild by 38% of growers (at least only 75% was harvested), 34% rated the beetle damage as severe where only 25% of the crop was harvested especially in Cabiten, Tawangan and Taloy Sur. The rest (28%) of respondents rated severity as moderate wherein 40-75% of the crop was harvested (Table 11).

Monitoring of the case farm showed no taro beetle incidence and this could be attributed to insecticide application at once in 3 months after planting.

Effect of Taro Leaf Blight and Taro Beetle

Plant health problem is one contributory factor in global food crop losses (Flood, 2010) and global food security (Strange and Scott, 2005). According to Lenne (2000), crop failure due to pests results to direct food losses, loss of farm income, and no money to buy other food items and farm inputs, and inability to pay debts at the household level. However, this statement depends on the position of the crop, whether this is minor crop or major cash crop. As previously discussed, areas planted to taro generally ranged from 10-373 m2 and the priority purpose is for household use and secondly for sale. In addition, there are also other alternative cash crops that could replace taro. That is why the direct effect on food and cash income is less felt among the growers in Kayapa, Nueva Vizcaya, and in Cabiten, Mankayan, Benguet where households stopped growing taro starting in 2012, and the taro growers in Bayabas, Sablan who only realized the gravity of pests and diseases that are attacking their taro crop during the FGD. The probable effects tackled during the FGD shown in the succeeding paragraphs.

Table 11. Incidence and severity of taro beetle in selected barangays in Benguet and Nueva Vizcaya

BARANGAY	PERCEIVED INCIDENCE	% INCIDENCE			SEVERITY RATING		
		5-39	40-69	70-100	Mild	Moderate	Severe
Bayabas	7	2	5		1	6	
Naguey	4	4			3	1	
Cabiten	8		7	1			8
Tawangan	10	5	6	1	5		7
Taloy Sur	6		1	5		1	5
San Pascual	6	3	3		3	3	
Basil	10	9	5	2	7	7	2
Besong	7		6	1	4	1	2
Amelong-labeng	4	3		1	3	1	
Kayapa Poblacion East	1		1		1		
Total- all sites, n=71	***63***	***26***	***34***	***11***	***27***	***20***	***24***
%	***89***	***37***	***48***	***16***	***38***	***28***	***34***
x2 value	*97.481,p.000***	*2.107E2, p.000***			*1.711E2, p.000***		

Loss of planting materials and varieties. Majority (92%) of the taro growers make use of their existing crop as source of planting materials although sometimes they purchase and get new varieties from their neighbors or relatives (28%). As shown in Table 12, there was a reduction in using own planting materials from 92% to 89% particularly in the villages of Bayabas and San Pascual, which was attributed to the desire to replace existing varieties or infected taro plants and also to expand to taro cash cropping.

Table 12. Source of planting materials before and after occurrence taro leaf blight and taro beetle in Benguet and Nueva Vizcaya

BARANGAY	OWN CROP		FROM OTHERS	
	BEFORE	AFTER FW	BEFORE	AFTER FW
Bayabas	8	7	2	2
Naguey	4	4		
Cabiten	6	6	6	6
Tawangan	9	9	7	7
Taloy Sur	6	5	3	3
San Pascual	5	5	1	1
Basil	15	15	1	1
Besong	7	7		
Amelong-labeng	4	4		
Kayapa Poblacion East	1	1		
Total- all sites, n=71	***65***	***63***	***20***	***20***
%	***92***	***89***	***28***	***28***
multiple response				
x^2 value, before and after	*1.531E2, p.000***		*1.506E2, p.000***	

As shown in Table 13, there are two commonly planted varieties, namely: Chinese or Itsina where majority (32) of growers observed as more susceptible than Mindanao. Apparently, grower's observation of Mindanao variety is mixed, where 18 growers observed as more tolerant and 16 growers observed as susceptible to taro leaf blight and taro beetle. Except for the stalk and leaf color which could influence tolerance and susceptibility, the response of the growers generally shows that there is no concrete identification of a tolerant or a susceptible variety. As observed in Mr. Garoy's taro crop, there is a high possibility of the crop recovering from the leaf blight disease that is why farmers are hesitant to specifically identify a susceptible variety.

Table 13. Varieties observed by growers to be tolerant or susceptible to taro leaf blight and taro beetle

VARIETY	TOLERANT	SUSCEPTIBLE
Chinese/Itsina	13	32
Mindanao	18	16
Dem-an		1
Violet/Subok		3
Native/ old varieties	13	14
New varieties	1	1
Total- all sites	**45**	**64**

The Chinese variety had green leaves and stalk, white and violet flesh which is aromatic. The Mindanao variety had dark green and violet stalk and leaves with yellow or orange corm flesh which is sticky (Gayao, Meldoz and Backian, 2017).

Increase in farm inputs. Majority (52%) of the taro growers including those who claim to apply organic fertilizer like compost if available (11%) do not apply fertilizer, and majority (78%) also do not spray pesticides since the priority use of the crop is for household consumption. As shown in Table 14, only those who are growing taro as a cash crop are applying inorganic (NPK) fertilizer, and even with their claim of moderate to severe taro leaf blight and taro beetle, only few (4-7%) had sprayed insecticide and/or fungicide. Thus, increase in farm inputs particularly pesticides cost is positive only to those who are into taro cash crops like some farmers in Bayabas, Naguey, Cabitin, Tawangan and San Pascual. In the case of Mr. Garoy's farm, fertilizer (16-20-0 NPK) application was estimated at 20g/hill, fungicide application at 29ml/105 hills and insecticide application of 10g/105 hills.

Loss or reduction in root yield. Observations on the percentage reduction in yield significantly differed among the taro growers (Table 15). Majority (87%) claimed that taro leaf blight and taro beetle decreased yield. Yield decrease ranges from 26-50% as claimed by 51% of the growers; from 51-75% by 28% of growers, less than 25%, by 17% of growers, and from 76-100% by 4$ of the growers. However, even with a high incidence of leaf blight at the early stages, the possibility of recovery towards maturity or harvest is high especially with fungicide application as in the case of Mr. Garoy's farm (Table 16). Yield loss was computed at only six percent (3,954/65,280) or 38g/hill at a leaf blight incidence ranging from 78-98%.

On a larger scale, for Benguet and Nueva Vizcaya with an estimated total of 3,599 household taro growers at an average of 200 hills per household, computed loss resulted to 27,352 kilos valued at PhP0.957 million if priced at PhP35 per kilogram.

Table 14. Pesticide and fertilizer use for taro crop among growers in Benguet and Nueva Vizcaya

BARANGAY	PESTICIDE USE				FERTILIZER USE			
	None	Insecticide	Fungicide	Insect./ Fungi.	None	Inorganic (NPK)	Organic	Org./Inorganic
Bayabas	4			3	1	6	5	
Naguey			1	1		2		1
Cabiten	6	1				2	1	5
Tawangan	11	1			12			
Taloy Sur	6				4	1	1	
San Pascual	1	1	3	1	1	4		1
Basil	16				7	7	1	1
Besong	7				7			
Amelong-labeng	4				4			
Kayapa Poblacion E.	1				1			
Total- all sites, n=71	***55***	***3***	***4***	***5***	***37***	***22***	***8***	***8***
%	***78***	***4***	***6***	***7***	***52***	***31***	***11***	***11***
x2 value	*1.517E2, p.000***				*2.022E2, p.000***			

Table 15. Change and percentage decrease in yield of taro due to taro leaf blight and taro beetle

BARANGAY	NO EFFECT	ZERO YIELD	DECRESED YIELD	PERCENTAGE DECREASE			
				25 & less	26-50	51-75	76-100
Bayabas	1		6	1	5	1	
Naguey	1		3	1	3		
Cabiten			5	3	1	4	
Tawangan		1	10	2	10		
Taloy Sur			6	1	2	3	
San Pascual	1		5	4			2
Basil			16		9	7	
Besong			7		5	2	
Amelong-labeng			4		1	2	1
Kayapa Poblacion E.			1			1	
Total- all sites, n=59	***3***	***1***	***62***	***12***	***36***	***20***	***3***
%	***4***	***1***	***87***	***17***	***51***	***28***	***4***
x2 value	*1.314E2, p.000***			*1.388E2, p.033**			

Table 16. Corm yield of leaf blight infected taro plants after 6 months in Mr. Garoy's farm (Bulala, Bayabas, Sablan)

BLOCK #	TOTAL # OF HILLS	TOTAL # OF HILLS WITH BLIGHT INFECTED LEAVES		# 0F HILLS HARVESTED @183DAP	TOTAL CORM YIELD (g)	YIELD/ HILL (g)
		84DAP	147DAP			
1	35	35	25	34	18,640	548
2	35	35	25	32	28,241	882
3	35	33	32	33	18,399	558
Total	***105***	***103***	***82***	***99***	***65,280***	***659***
% incidence		***98***	***78***	***Yield loss***	***3,954****	

**65280/99 * (105-99)*

Further, statistical analysis show close association of taro leaf blight and taro beetle severity rating to yield reduction with contingency coefficient values of 0.747 and 0.762, respectively (Table 17).

Table 17. Association of taro leaf blight and taro beetle severity to effect on yield of taro (# of respondents)

SEVERITY RATING	TARO LEAF BLIGHT EFFECT ON YIELD			TARO BEETLE EFFECT ON YIELD		
	No effect	Zero yield	Decreased yield	No effect	Zero yield	Decreased yield
Mild			18	4		23
Moderate	3		27			20
Severe	3	1	18	3	1	20
x2 value		*93.394, p.00***			*1.025E2, p.000***	
Contingency coefficient		*0.747*			*0.762*	

Loss or decrease in livelihood or farm income. In the study sites, most of the taro growers are generally also the sweetpotato growing households, thus they have multiple sources of cash income and food supply. However, there are more households growing taro for kitchen use. Thus the effect would be more on food consumption of taro than on farm income. . Previously in Table 8, 97% of the respondents use their crop for food confirming findings of Gayao (2017) that the Ibaloi indigenous people use their taro crop for household food.

Further, for indigenous people who grew taro for multiple purposes, contribution to livelihood on a per hill basis was computed at PhP7.37 for cash income, PhP0.07 for food, PhP0.04 for feed, PhP0.27 for gifts or give-aways and PhP0.42 for self-employment (Gayao, 2017). Total loss to farm income, for example, in the case of Mr. Garoy was computed at PhP138.39 for the six hills with zero yield (3.94kg x PhP34/kg) due to the 6% taro leaf blight incidence.

Reduction in area planted. As previously stated, only the households who use taro primarily for sale did not plant (3%) or reduced area planted (20%) as shown in Table 18 especially for those who have moderate to severe taro leaf blight infection. Severity of infection has a close association to reduction in area with a contingency coefficient of close to one (0.761 and 0.784, Table 19). Majority (78%) continuously grow taro as some of the households, once planted in farm borders or in backyards perpetually grew taro in small areas.

Table 18. Change in area planted to taro resulting from incidence of taro leaf blight and taro beetle

MUNICIPALITY	NONE	REDUCE	DID NOT PLANT	INCREASE AREA
Bayabas	7			
Naguey	4			
San Pascual	5	1		
Cabiten	8			
Tawangan	4	8		
Basil	16	0		
Taloy Sur	1	5		1
Besong	6		1	
Amelong-labeng	3		1	
Kayapa Poblacion East	1			
Total- all sites, n=71	***55***	***14***	***2***	***1***
%	***78***	***20***	***3***	***2***
x2 value	*1.593, p.000***			

Table 19. Association of taro leaf blight and taro beetle severity to area planted to taro

SEVERITY RATING	TARO LEAF BLIGHT EFFECT ON AREA			TARO BEETLE EFFECT ON AREA PLANTED		
	None	Reduce area	Not planted	None	Reduce area	Not planted
Mild	17	1	1	12	3	1
Moderate	22	7	1	20	1	
Severe	16	6		13	10	1
x2 value		*1.019E2, p.000***			*1.182E2, p.001***	
Contingency coefficient		*0.761*			*0.784*	

Reduced consumption of taro. In the survey sites selected, taro is consumed often as vegetable. Since the taro leaf blight affects first the leaves then the stalks, 34% claimed to have

decreased their taro consumption while the majority (63%) claimed no effect (Table 20). The 3% who claimed to have increased consumption are those who previously sell their corm yield but the taro beetle had reduced marketability of the corm. There is a close association of taro consumption to severity of taro leaf blight and taro beetle as shown by the contingency coefficient of 0.743 and 0.758 (Table 21).

Table 19. Change in taro consumption resulting from incidence of taro leaf blight and taro beetle

BARANGAY	NO EFFECT	DECREASED CONSUMPTION	INCREASED CONSUMPTION
Bayabas	7		
Naguey	1	1	2
San Pascual	3	3	
Cabiten	7	1	
Tawangan	5	7	
Basil	11	5	
Taloy Sur	3	3	
Besong	4	3	
Amelong-labeng	3	1	
Kayapa Poblacion East	1		
Total- all sites, n=71	***45***	***24***	***2***
%	*63*	*34*	*3*

x2 value *1.401E2, p.000***

Table 18. Association of taro leaf blight and taro beetle severity to consumption of taro

SEVERITY RATING	TARO LEAF BLIGHT EFFECT ON CONSUMPTION			TARO BEETLE EFFECT ON CONSUMPTION		
	No effect	Decreased consumption	Increased consumption	No effect	Decreased consumption	Increased consumption
Mild	14	4	1	19	6	2
Moderate	19	10	1	13	7	
Severe	12	10		13	11	

x2 value *91.037, p.000*** *99.939 p.000***
Contingency coefficient *0.743* *0.758*

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Taro household growers just like the sweetpotato growing households have multiple sources of cash income and food, firstly from their own crop harvests. Secondly, those who are receiving salary, wages or cash assistance buy food especially rice. Taro growers generally eat rice as a staple, vegetable as viand, sometimes with added meat, fish or their products, and water as beverage three time's day. Vegetables also include taro stalks, leaves and corm, though boiled corm if available are eaten in-between meals just like sweetpotato.

Taro are grown in sloping swidden farms, parts or borders of the backyard, the rice field or vegetable gardens, firstly for own food source such that plots as small as $10m^2$ are planted. Though, there are some farmers who grew taro as a cash crop in areas greater than $500m^2$.

Since taro is not a major cash crop, taro pests and diseases like taro leaf blight and taro beetle are not given much attention as farmers could just stop planting or shift to other cash crops. Awareness to taro pests however was enhanced during this survey with the taro growers claiming 100% incidence of taro leaf blight. The magnitude was rated by 27% of growers as mild, 42% as moderate and 31% as severe. Taro plants destroyed by beetle were observed by 89% of the growers, incidence ranging from 5-100% with 38% of the respondents rating severity as mild, 28% moderate and 34% severe.

The effect of taro leaf blight and taro beetle incidence to loss of planting materials is small at 3%. Loss of varieties could be attributed to other factors as taro growers are divided in their observation of tolerant and susceptible varieties. On the increase of farm inputs cost, only the cash crop growers are affected, since most household growers do not apply chemical inputs. In the case farm where fungicide spraying was done, taro leaf blight incidence was reduced from 98% to 78%, and only 6 deaths or zero yields of taro hills planted leading to PhP1.32/hill loss in income. Regardless of the magnitude of taro leaf blight and taro beetle, area planted to taro and taro consumption by individual households is generally not reduced.

However, considering the more or less 3,599 taro household growers in Benguet and Nueva Vizcaya, yield loss will result to 27,352 kilos or PhP0.957 million if valued at PhP35.00 per kilo. At this amount of livelihood loss or food loss, and concerns for food diversity, food safety and crop- variety conservation, appropriate pest control and prevention methods is recommended. Furthermore, it is not only taro leaf blight and taro beetle that are doing damage to the crop, others like aphids and rot are more common among farmers, and it is not only taro that is affected but also their other crops like tannia, sweetpotato and yam.

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PART 4

INCIDENCE AND EFFECT OF YAM ANTHRACNOSE (*COLLETOTRICHUM GLOEOSPORIOIDES*) IN LIVELIHOOD AND FOOD SECURITY OF GROWERS IN BENGUET AND NUEVA VIZCAYA, PHILIPPINES

ABSTRACT

Limited and poor quality of planting materials that is likely caused by the accumulation of yam anthracnose carrying organisms in the tubers and in the soil could be responsible for the low supply of greater yam tubers needed by the food processing industry. The supply depends on the production efforts of the farmers, so that this research documented extent of damage caused by yam anthracnose on the livelihood and food security of the yam growing households.

Yam growing households are no different from the sweetpotato and taro growers having multiple crops, multiple sources of cash income and multiple sources of food. Greater yam is not a major cash crop and few farmers plant them as one of the mixed crops in small areas in parts or borders of swidden fields, vegetable gardens and backyards. Twelve percent of the yam growers observed 100% incidence of yam anthracnose in their fields, 24% observed zero incidence and the rest from 10-80%. Majority (51%) assessed severity as mild. The disease caused 4% loss in planting materials and a yield decrease ranging from 26-50% as claimed by 51% of respondents. Household consumption of yam is not affected. Of the 917 yam growers in Benguet, the computed yield loss due to the disease damage amounted to 59-669 MT valued at PhP3.38 million.

INTRODUCTION

Greater yam tuber is an in-demand raw material for the food processing industry in the Philippines. While, there seems to be an increasing number of food processors, the supply of greater yam tubers is decreasing due to effects of climate change, pests and diseases especially the fungal disease anthracnose. Once a crop is infected it will take 2-3 years to recover as claimed by a farmer in Palawan, Philippines (Pro-MED, 2010; Abello, 2010). Anthracnose is one of the most serious diseases of the crop, especially *D. alata* and *D. rotundata*, and is a limiting factor for production of these crops worldwide. It is caused by the fungus *Colletotrichum gloeosporioides* (synonym *Glomerella cingulata*) *C. truncatum* and may also be present in infected tissue, but its role in anthracnose etiology remains unclear. The disease affects leaves, vines and tubers. Symptoms include rapidly expanding brown/black leaf lesions, necrosis, defoliation and dieback of the entire plant, orange-brown tuber rots, and small blisters on the tuber surface. Reduced photosynthesis leads to undersized yams. The fungus is spread mainly by infected plant material, seed tubers, mechanical means and splashing rain. It has long saprophytic survival ability on crop residues (ProMED, 2014).

The first documented occurrence of anthracnose disease in Benguet happened in 1991 during the credit-assisted commercial production of ubi or greater yam in Taloy Sur and Taloy Norte, Tuba involving 43 farmers. Yam crop was planted in April and by July 19% of all the farms monitored were infected with the disease. By August, yam farms infected increased to

50% which is aggravated by the month-long rains after the Mount Pinatubo eruption (July 1991). Infected plants have wilted leaves, stem rot and tuber rot. Report of analysis of the infected plant done by J.Perez, (August 1991) states that the leaf spots are caused by *Colletotrichum sp.*, that there is presence of *Fusarium sp* and *Botryodiplodia theabromae* found in necrotic leaves which caused rotting in yam tubers (HADFI-DAR-DRDAP Annual Report 1991).

After two decades, this research aims to document the prevalence of the anthracnose disease and the effect of this disease to livelihood and food security of the yam growers in Benguet and Nueva Vizcaya.

Livelihood is work done to earn a living or whatever provides a source of income (Encarta, 2005), but as a concept in research and development, livelihood includes what people do given their resources and assets to achieve basic needs brought about by the process or system of livelihood generation (Niehof and Price, 2001). Household food security is a situation where everyone has access at all times to sufficient food for an active and healthy life (DVL/VM, Elly Leemhuis- de Regt (ed), 1998).

METHODOLOGY

Selection of Sites and Respondents

The yam growing areas are not different from the sweetpotato and/or taro growing areas based on secondary information gathered from provincial and municipal agriculture offices and market outlets. Greater yam or ubi is a specialty cash crop in the towns of Sablan and Tuba, Benguet. Other towns like in Kapangan, Tublay and Kibungan in Benguet, and the towns of Bambang and Santa Fe in Nueva Vizcaya also grow yam but most of the farming households plant only for household use and very seldom for market purposes. Seven barangays in four municipalities, namely: Sablan, Tuba and Tublay in Benguet and the municipality of Bambang in Nueva Vizcaya were selected as shown in Table 1. There were 49 respondents consisting of 36 females and 13 males who attended the workshop-interviews. Tuba and Sablan respondents grow yam primarily for the market while respondents in Tublay and Bambang grow yam primarily for household food.

Data Gathering Procedure

Group interview workshops and focused group discussion (FGD) were conducted in the barangays or villages except in Kamog barangay where one-on-one interview was done.

An open-ended questionnaire was used as a guide in the group interviews and FGDs. It started with knowing the number of households in the barangay who have yam plants growing in their farms or gardens and whether the yam harvested are used primarily for market or for household use. The reason for the workshop was then explained followed with the group interview and discussions on pests observed in their yam crops particularly on the yam anthracnose complex. Showing a picture of the yam anthracnose symptoms, the participants shared information on when the yam anthracnose or other pests infesting the yam crop became visible, what parts of the plant and what varieties were infected, and severity of the pest and disease and coping mechanisms which were all recorded in the questionnaires. Other information on their household profile, habitual diet and farm profile including farming

practices on yam were individually filled-up by the participants and assisted by the researchers. The effect of the yam anthracnose disease on the yield, future source of planting materials, their household consumption and crop sales were also asked.

Table 1. Number of respondents in the barangays/ municipalities selected in Benguet and Nueva Vizcaya

MUNICIPALITY	BARANGAY	# OF RESPONDENTS		
		MALE	FEMALE	TOTAL
Sablan	Bayabas	4	2	6
	Kamog			
Tuba	Taloy Norte	6	23	29
	Taloy Sur			
	San Pascual			
Tublay	Basil	0	9	9
Bambang	Pallas	3	2	5
TOTAL		***13***	***36***	***49***

Field Visit

After the workshop in Taloy Norte researchers and participants visited some fields to physically assess pests and diseases infecting the crop. Visit to other yam farms in Sablan were also done.

Data Analysis

Similar to the sweetpotato and taro studies, incidence and severity of yam anthracnose was determined or defined from the viewpoint of the researchers (perceived incidence) and from the viewpoint of the growers (percentage incidence and severity) determined as follows:

$$\text{Perceived incidence} = \frac{\text{number of farmers who observed yam anthracnose}}{\text{total number of yam growers interviewed}} \times 100$$

$$\text{Percentage incidence} = \frac{\text{estimated number of plants/ hills with observed infection}}{\text{for every10 plants/hills of yam}} \times 100$$

Observation on severity was based by the growers on how many of the plants or how wide the area planted was harvested by choosing either:

1- Mild (at least 75% of crop was harvested),
2- Moderate (40-60% of crop was harvested) , and
5- Severe (at least 25% of crop was harvested).

Statistical analysis. The questionnaires were completed, reviewed then encoded. The gathered information was further coded using the Excel software then some of the data were transferred for statistical analysis using the SPSS software. Descriptive analysis using cross-tabulation, Pearson chi-square and contingency coefficient correlation was done. Level of

significance was set at five percent. Yam anthracnose incidence was discussed in this research in relation to its effect on farming livelihood and household food consumption of the yam growers. Causal factors leading to the build-up of the pests and diseases is discussed in Volume 2.

RESULTS AND DISCUSSION

Literatures had shown that pests and diseases affected livelihoods and food security of many people (Andersen, 2001; Strange and Scott, 2005), but their effect could be understood better in consideration of present household livelihood sources, habitual diet and farm profile of the yam growers.

Household Livelihood

Source of cash income. There is no statistical difference in source of cash income among households in the barangays as all yam growing households have two to four sources of cash income. This is typical of the root crop farmers, the poor and middle-income group, and the close-knit family ties where children or parents have to help to sustain household livelihood. The poor has a monthly income of PhP7,890; the low income class has between PhP7,890-15,780/mo.; the lower middle income class has between PhP15,780-31,560/mo.; and the middle class has between PhP31,560-78,900/mo. for a family size of 5 members based on the PSA 2012 Family Income and Expenditure Survey (Albert, Gaspar and Raymundo, 2015).

Majority of the yam growers source their cash income from crop sales (96%) with 47% of household members getting salaries as employees or wages as laborers as shown Table 2. Twenty seven percent are engaged in retail store, agricultural crop assembly or public transport businesses. Others (31%) receive cash allowance as barangay officials or volunteers or cash assistance from social services.

Source of household food supply. Just like the sweetpotato and taro growing households, yam growers also source out their food from multiple sources. Almost equally from own produce (98%) and purchases within or outside the locality (96%) and less from other sources (35%) like gifts from other farmers or neighbors (Table 3). That is why it is important for them to plant crops which are easier to sell at a shorter time than yam crop as they need cash to buy other food items. Food sources highly differs (p.000) among households in the different barangays or villages.

Table 2. Household sources of cash income among yam growers in selected barangays in Benguet and Nueva Vizcaya

BARANGAYS	SALARY/ WAGES	CROP SALES	BUSINESS	OTHERS
	# of respondents			
Bayabas	1	4	2	1
Kamog		2		
Taloy Norte	1	8	4	4
Taloy Sur	1	6	1	2
San Pascual	10	13		5
Basil	6	9	2	2
Pallas	4	5	2	1
Total- all sites, n=49	**23**	**47**	**10**	**15**
%	**47**	**96**	**27**	**31**

**multiple response*

X^2value= 68.339, p.215^{ns}

Table 3. Household sources of food among yam growers in the selected barangays in Benguet and Nueva Viscaya

BARANGAY	OWN FARM PRODUCE	PURCHASES	OTHERS
	# of respondents		
Bayabas	4	4	
Kamog	2	2	
Taloy Norte	7	9	3
Taloy Sur	6	6	1
San Pascual	13	14	4
Basil	9	7	5
Pallas	5	5	4
Total- all sites, n=49	***48***	***47***	***17***
%	***98***	***96***	***35***

**multiple response*

*x^2value= 84.402, p.000***

Habitual Diet

Ninety to 94% of yam growing households eat rice as a staple three times a day. Rootcrops is snack food as claimed by 51% of yam growers and sometimes as a supplemental staple during breakfast (41%). Vegetables are common viand during breakfast (61%) and supper (84%) while meat or meat products are viand during lunch by 31% of the households. Vegetable also include taro stalk and leaves, sweetpotato tops and tannia cormels. Rootcrops include sweetpotato roots, cassava tubers, taro and tannia corms and cormels and yam roots. Water is beverage during meals among 33-37% of households while coffee at breakfast (59%) and snack time (47%). Milk is seldom drunk. Fish and fish products is served from time to time by 22-29% of households. Fruit harvest like banana is also important source of snack

food (41%). Other food items like eggs, bread and noodles as shown in Table 4 are less frequently eaten in every meal. Two percent don't eat lunch and another eight percent of the yam households don't have snacks.

Table 4. Kinds of food/ beverage included in the habitual diet of yam growers (% of respondents)

BREAKFAST		LUNCH		SUPPER		SNACK	
Rice	90	Rice	90	Rice	94	Rootcrops	51
Vegetables	61	Water	35	Vegetables	84	Coffee	47
Coffee	59	Meat/meat products	31	Water	33	Fruits	41
Rootcrops	41	Fish/fish products	22	Meat/meat products	31	Bread	39
Water	37	Rootcrops	18	Fish/fish products	29	Water	14
Fish/fish products	24	Fruits	12	Coffee	18	Milk	4
Meat/meat products	18	Coffee	10	Rootcrops	14	Rice	2
Others	16	Eggs	8	Fruits	14	Meat/meat products	2
Fruits	14	Vegetables	8	Others	8	Fish/fish products	2
Bread	12	Others	6	Bread	4	Others	2
Eggs	12	Bread	4	Eggs	2	Eggs	0
Milk	4	Milk	0	Milk	0	Vegetables	0
		No lunch	2			No snack	8

Farm Profile

Farmscape planted to yam and other crops. Yam is normally grown in uma or swidden farms in hills or mountain slopes where 98% of the yam growers operate in addition to some having ricefields (35%), vegetable garden (20%) and backyard gardens (49%). The kinds of farm operated highly differed (p.000) among yam growers (Table 5). If the yams are not planted in swiddens, these are planted in parts of backyard near trees or in borders of vegetable gardens.

Farm size planted to yam and other crops. Swidden farming in the Philippines is family operated so that farm sizes are usually small to suit available family labor. For vegetable gardens, areas operated depend on sufficiency of water for irrigation. Rice fields are located in lower terraced slopes usually near rivers or water source. So that majority of the yam grower-respondents farm less than a hectare: 30% from >1000m^2 to 0.5ha, 25% (>500-1000m$^{2)}$ and 14% (500m^2 and below). Seventeen percent plants >0.5 to 1.0ha and only 14% have farms that is more than a hectare (Table 6).

Table 5. Types of farm operated by yam household growers

BARANGAY	*UMA/* SWIDDEN	*TALON/* RICE FIELD	GARDEN	BACKYARD GARDEN
Bayabas	4	0	3	3
Kamog	2	0	0	2
Taloy Norte	9	1	0	1
Taloy Sur	6	2	3	6
San Pascual	13	7	0	7
Basil	9	7	3	4
Pallas	5	0	1	1
Total- all sites, n=49	***48***	***17***	***10***	***24***
%	***98***	***35***	***20***	***49***

**multiple response*
*x^2value= 75.297 p.000***

Table 6. Total farm sizes operated by yam growers

BARANGAY	500SQM and BELOW	>500 TO 1000SQM	>1000 TO 0.5HA	>0.5HA TO 1 HA	>1 HA
Bayabas	1	0	2	0	1
Kamog	0	0	1	1	0
Taloy Norte	0	7	0	1	0
Taloy Sur	0	2	2	2	0
San Pascual	3	0	3	2	6
Basil	3	3	3	0	0
Pallas	0	0	3	2	0
Total- all sites, n=48	*7*	*12*	*14*	*8*	*7*
%	*14*	*25*	*30*	*17*	*14*

*x^2value= 61.170, p.006**

Cropping system/pattern. Only 8% of the respondents plant yam as the main crop particularly in Taloy Sur and San Pascual where yam is a cash crop. Majority (98%) consider yam as just one of the mixed crops planted in addition to rice, other root crops, vegetables and legumes, tiger grass and others, often as intercropped (80%). Those who had planted rice or vegetables, yams are often planted as border crop (Table 7) usually in areas near trees even in backyards.

Table 7. Cropping system and cropping pattern for yam as practiced by growers

BARANGAY	MONO-CROPPING	MIXED CROPING	MAIN / ROTATION CROP	INTER CROP	BORDER CROP
Bayabas	0	4	0	4	4
Kamog	1	2	0	2	0
Taloy Norte	0	9	0	9	0
Taloy Sur	1	6	2	6	1
San Pascual	1	13	2	12	0
Basil	0	9	0	1	8
Pallas	0	5	0	5	0
Total- all sites, n=49	***3***	***48***	***4***	***39***	***13***
%	***6***	***98***	***8***	***80***	***27***

multiple response

Purpose of crops planted. As shown in Table 8, multiple use of yam highly differs (p.000) among respondents in the different barangays, although, 100% of the growers primarily grow them for food especially in Basil, Tublay, Benguet. The rest of the grower's plant yam for market sale (76%) particularly the purple-fleshed varieties. The white-fleshed and other varieties which are not saleable are for food use and whatever is not eaten is given to animals like pigs, chicken, dogs and ducks, and one farmer also feed it to fish. Only 2% of yam growers share their harvest to visiting relatives. None of them mentioned using the harvested roots as planting materials as it is a practice to leave the small roots for succeeding crop.

Table 8. Household purpose of taro and other crops planted by yam growers

BARANGAY	SALE	FOOD	FEED	GIFTS
Bayabas	4	4	4	1
Kamog	2	2	1	0
Taloy Norte	9	9	2	0
Taloy Sur	6	6	5	0
San Pascual	11	14	1	0
Basil	0	9	0	0
Pallas	5	5	1	0
Total- all sites, n=49	***37***	***49***	***14***	***1***
%	***76***	***100***	***29***	***2***

**multiple response*

*x^2value= 60.969, p.000***

Incidence and Severity Yam Anthracnose

Only 76% (perceived incidence) of the growers observed symptoms of yam anthracnose unlike in sweetpotato and taro where all of the growers interviewed observed 100% incidence of fusarium wilt and taro leaf blight, This observation highly differed (p.000) among growers in the different barangays with 24% of growers observing zero incidence

particularly in Basil, Tublay and some in Taloy Norte, Tuba, while 12% of growers observed 100% yam anthracnose incidence in San Pascual, Taloy Norte and Taloy Sur, Tuba, Benguet. Most growers or 41% observed 10-35% incidence, 16% observed 40-69% incidence and 6% observed 70-80% incidence (Table 9).

In assessing severity of the disease, 57% of the grower-respondents rated yam anthracnose disease as mild, 20% rated the disease as moderate and 23% rated the disease as severe. The rating of mild incidence is consistent with the field count where an average of 5% ranging from 0 to 12% of anthracnose affected hills/ plants were counted in the yam farms visited in July, 2-3 months after planting (Table 10). Anthracnose disease appears often after heavy and/or continuous rains usually happening from July to September (Table 4, Part 1).

Table 9. Incidence and severity of taro leaf blight in selected barangays in Benguet and Nueva Vizcaya

BARANGAY	PERCEIVED INCIDENCE		% INCIDENCE					SEVERITY RATING		
	Yes	No	0	10-35	40-69	70-80	100	Mild	Moderate	Severe
Bayabas	4	0	0	4	0	0	0	4	0	0
Kamog	2	0	0	2	0	0	0	2	0	0
Taloy Norte	6	3	3	4	0	0	2	7	0	2
Taloy Sur	6	0	0	2	1	2	1	2	1	3
San Pascual	14	0	0	8	2	1	3	4	4	6
Basil	0	9	9	0	0	0	0	-	-	-
Pallas	5	0	0	0	5	0	0	0	5	0
Total- all sites, n=49	***37***	***12***	***12***	***20***	***8***	***3***	***6***	***28***	***10***	***11***
%	***76***	***24***	***24***	***41***	***16***	***6***	***12***	***57***	***20***	***23***
x^2 value	38.185, p.000**			*1835E2, p.000***				*97.042, p.000***		

Table 10. Field validation yam anthracnose incidence in Sablan and Tuba, Benguet

FARM #	LOCATION	MONTHS AFTER PLANTING	TOTAL # OF HILLS COUNTED	# OF HILLS WITH SYMPTOMS	% INCIDENCE
1	Palali, Sablan	2-3	54	5	9
2	Palali, Sablan	2.5	25	3	12
3	Taloy Norte, Tuba	2	14	1	7
4	Taloy Norte, Tuba	3	60	0	0
5	Taloy Norte, Tuba	2	47	1	2
Total			**200**	**10**	**5**

Effect of Yam Anthracnose

Plant health problem is one contributory factor in global food crop losses (Flood, 2010) and global food security (Strange and Scott, 2005). According to Lenne (2000), crop failure

due to pests results to direct food losses, loss of farm income, and no money to buy other food items and farm inputs, and inability to pay debts at the household level. However, this statement depends on the position of the crop, whether this is minor crop or major cash crop. Yam is a minor crop even if it is a secondary cash crop in the barangay identified as growing areas in Part 1. As a minor crop with multiple purposes, the priority is for household use and secondly for sale. Expectedly, the supposed effect on household livelihood and food security will not be catastrophic

Loss of planting materials and varieties. The yam growers do not purposely grow for planting materials as they depend on the small tubers left in the field, or the unsold or uncooked tubers left-over after harvest. With this practice, there is only 4% reduction in using own planting materials from 100% to 96%, signifying a loss of planting materials that could be attributed to the yam anthracnose disease as shown in Table 11. The relationship is significantly closer at a contingency coefficient of 0.594 (p.023).

Table 11. Source of planting materials before and after occurrence yam anthracnose and relationship to anthracnose severity

BARANGAY	BEFORE DISEASE			AFTER DISEASE		
	OWN	BUY	OTHERS	OWN	BUY	OTHERS
Bayabas	4	0	0	4	0	0
Kamog	2	0	0	2	0	0
Taloy Norte	9	0	0	9	0	0
Taloy Sur	6	2	0	5	2	1
San Pascual	14	0	0	13	0	1
Basil	9	0	0	9	0	0
Pallas	5	0	0	5	0	0
Total- all sites, n=49	49	2	0	47	2	2
%	***100***	***4***	***0***	***96***	***4***	***4***
ANTHRACNOSE SEVERITY						
Mild				28	0	1
Moderate				9	0	1
Severe				11	1	2
multiple response						
x^2 value, before and after	*63.881, p.000***			*22.087, p.228^{ns}*		
Contingency coefficient				*0.594, p.031**		

There were 50 commonly grown varieties out of the 77 indigenous greater yam varieties documented by Gayao, Meldoz and Backian (2017) in Northern Philippines but there were only 16 varieties mentioned in this survey. The few varieties gathered in this survey however, do not mean that those not named were lost because of the yam anthracnose disease rather it confirmed the loss of knowledge on indigenous names of varieties.

Out of 16 varieties mentioned, only one is almost unanimously identified as susceptible and this is the Sampero, Kinampay or Round variety as shown in Table 12. The varieties

Rapang, Mindoro, Padihot, other violet and white varieties are more or less tolerant. The respondents are divided in the tolerance and susceptibility of Tungkol, Tuwiran and Deshek varieties.

Table 12. Varieties observed by growers to be tolerant or susceptible to yam anthracnose (# of farmers)

VARIETY	TOLERANT	SUSCEPTIBLE
Tungkol and/or Tuwiran	11	11
Rapang	3	
Sampero, Kinampay or round	1	16
Mindoro	8	5
Padihot	7	2
Deshek or long	6	7
White	9	4
Violet	13	1
9-	4	
Others-10,11,12,15	4	

Increase in farm inputs. There is no increase in farm inputs resulting from yam anthracnose occurrence since all the growers interviewed do not spray pesticides. From the viewpoint of the growers, yam crop population or area is small (20-380m^2) and only 12% of growers observed 100% yam anthracnose incidence while majority rated severity as mild, so as to merit spraying. Majority also do not apply fertilizer (Table 13) and even if there is some association of fertilization and disease severity at a contingency coefficient of 0.560, it is not significant (p.099)

Table 13. Pesticide and fertilizer use for yam crop in Benguet and Nueva Vizcaya

BARANGAY	PESTICIDE	FERTILIZER			
	None	None	Inorganic	Organic	Org./Inorganic
Bayabas	4	4			
Kamog	2				2
Taloy Norte	9	9			
Taloy Sur	6	5		1	
San Pascual	14	9	4	1	
Basil	9	9			
Pallas	5	5			
Total- all sites, n=49	***49***	***41***	***4***	***2***	***2***
%	***100***	***84***	***8***	***4***	***4***
ANTHRACNOSE SEVERITY					
Mild		23	1	2	2
Moderate		9	1		
Severe		9	2		

x^2 value *63.996, p.000***

Contingency coefficient *0.560, p.099^{ns}*

Loss or reduction in root yield. Small tubers or reduced yield as claimed by 69% of growers significantly differed among the yam growers although nine growers in Basil, three in

Bayabas, two in San Pascual and one in Taloy Norte claimed that there is no change in yield (Table 14). Estimated decrease in yield ranged from 0-25% for 37% of growers, 26-50% decrease for 51% of growers and the rest of the growers (12%) estimated more than 50% yield decrease. Some grower said that yield decrease is not mainly due to yam anthracnose but also if the yam crop is not transferred to newly operated farms. Old yam farms may also be infected which maybe means the disease is again the underlying cause of yield decrease. Statistical analysis show that there is a close association of yield decrease to severity of the yam anthracnose disease (contingency coefficient of 0.590, p.003) as shown in Table 15.

At yields averaging 1,825g/hill for the round variety and 5,238 g/hill for the other varieties (Gayao, 2017), the 917 yam growers planting an average of 110 hills, i.e. from two hills to 380m^2 (Part 1), the total yield loss due to disease computed for Benguet Province ranged from 59,028 to 169,418 kilograms at an average value of 3.380 million pesos.

Table 14. Change and percentage decrease in yield of yam due to anthracnose

BARANGAY	**NO EFFECT**	**DECRESED YIELD**	**PERCENTAGE DECREASE**			
			0-25	**26-50**	**51-75**	**76-100**
Bayabas	3	1	3		1	
Kamog		2	1	1		
Taloy Norte	1	8	2	7		
Taloy Sur		6		1	4	1
San Pascual	2	12	3	11		
Basil	9		9			
Pallas		5		5		
Total- all sites, n=59	***15***	***34***	***18***	***25***	***5***	***1***
%	***31***	***69***	***37***	***51***	***10***	***2***
x^2 value	*46.431, p.000***			*1.181E2, p.000***		

Table 15. Association of yam anthracnose severity on yield of yam

SEVERITY RATING	**YAM ANTHRACNOSE EFFECT ON YIELD**	
	No effect	**Decreased yield**
Mild	14	14
Moderate	1	9
Severe	0	11
Total- all sites, n=49	**15**	***34***
x^2 value	*26.198, p.003***	
Contingency coefficient	*0.590, p.003***	

Loss or decrease in livelihood or farm income. Almost all the yam growers interviewed in this study grew yam primarily for food and secondarily for sale, and as one of the mixed crops planted by the farmers in addition to other root crops, rice, fruits and vegetables. While the growers depend on crop sales as major source of cash income, they have

other crops to be sold and to be consumed by the household. That is why the loss of the crop or decrease in yield due to the anthracnose disease is not felt drastically. However, based on Gayao (2017), 100% crop loss will result to 3,417-7282 peso worth of crop sales and 1,885-4,018 peso-worth of food per household per cropping.

Reduction in area planted. Few growers (14%) reduced the area planted to yam because of the anthracnose, rather majority (71%) continuously plant yam. Fewer still did not plant or changed to other crops (Table 16). Of this few who reduced area planted, the anthracnose disease is more severe significantly confirming a close association (contingency coefficient of 0.705, p.000).

Table 16. Change in area planted to yam resulting from incidence of yam anthracnose

BARANGAY	NONE	REDUCE	DID NOT PLANT/PLANTED OTHER CROP
Bayabas	4	0	0
Kamog	1	1	0
Taloy Norte	9	0	0
Taloy Sur	0	0	0
San Pascual	7	6	1
Basil	9	0	0
Pallas	5	0	0
Total- all sites, n=49	***35***	***7***	***1***
%	*71*	*14*	*2*

x^2 value *38.909, p.028**

Table 17. Association of anthracnose disease severity to area planted to yam

SEVERITY RATING	EFFECT ON AREA PLANTED		
	NONE	REDUCE AREA	NOT PLANTED
Mild	23	4	1
Moderate	8	1	0
Severe	5	7	0
Total- all sites, n=59	***36***	***12***	***1***

x^2value *48.509, p.000***
Contingency coefficient *0.705, p.000***

Reduced consumption of yam. As shown in Tables 18 and 19, the occurrence of yam anthracnose disease has no or very little effect on yam consumption. Analysis shows no statistical difference or a strong association of disease and consumption.

Table 18. Change in yam consumption resulting from incidence of anthracnose disease

BARANGAY	NO EFFECT	DECREASED CONSUMPTION
Bayabas	3	1
Kamog	2	0
Taloy Norte	9	0
Taloy Sur	5	1
San Pascual	9	5
Basil	9	0
Pallas	4	1
Total- all sites, n=49	***41***	***8***
%	***84***	***16***

x^2 value *8.025, p.236^{ns}*

Table 19. Association of anthracnose disease severity to consumption of yam

SEVERITY RATING	EFFECT ON CONSUMPTION	
	No effect	Decreased consumption
Mild	25	3
Moderate	7	3
Severe	9	2
Total- all sites, n=49	**41**	**8**

x^2 value *5.088, p.405^{ns}*

Contingency coefficient *0.307, p.405^{ns}*

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The growing demand of the food processing industry for ubi or greater yam brought about the shortage in production which was attributed to lack of planting materials aggravated by yam anthracnose and other pests. The greater yam is not the only crop planted by a yam growing household, as other root crops, vegetables, rice, spices, fruits and tiger grass are grown, although crop sales is their primary source of cash, some household members receive salary, wages, allowances or cash assistance and/or proceeds from micro businesses, Household food supply comes from own produce and purchases, and habitual diet are similar to the sweetpotato and taro growing households. Rice staple is eaten three times a day with vegetable viand during breakfast and super. Rootcrops including greater yam is consume more as a snack food and less times as substitute staple.

Greater yams are grown as one of the mixed crops in parts of swidden farm, vegetable garden or backyards with household maintaining only two hills or a crop area equivalent to $380m^2$ on the average. Market preferred varieties are occasionally sold, but majority of farmers interviewed especially in Basil, Tublay and Pallas, Bambang plant the crop for food security.

Not all yam growers observed the anthracnose disease in their crops; 24% observed zero incidence; 12% observed one hundred percent incidence, and the rest of the growers observed 10-80% incidence. Majority (57%) assessed yam anthracnose severity as mild, 20% assessed disease as moderate and 23% as severe.

Because of the small plant population of greater yam as compared to the other crops, the negative effect of yam anthracnose to household livelihood and food security is not felt. Just like in taro crop, the effect of yam anthracnose incidence to loss of planting materials or varieties is small at 4%. There is also a yield decrease ranging from 26-50% as claimed by 51% of growers but this yield decrease do not drastically affect livelihood or farm income. Only when anthracnose disease is severe that households reduce area, do not plant or shift to other crops. But regardless of the magnitude of disease yam consumption is not affected. In previous studies, a 100% crop loss will result to PhP1,885 to PhP7,282 worth of crop sales and food. However, considering the more or less 917 yam growers in Benguet, computed yield loss for Benguet Province due to yam disease damage amounted to 59 -169 MT valued at PhP3.380 million.

With the aforementioned value of yield, livelihood and food loss, research and extension of appropriate pest control and prevention methods is recommended taking into account traditional production and consumption practices, environment-friendly and food safety issues. Which is more beneficial to the farmer, the consumers and the industry?

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Appendix 1

List of key informants/workshop coordinators in municipal agriculture office

List of Key Informants		
Name	**Position**	**Address**
1. Cherry L. Sano	Municipal Agricultural Officer	LGU-Atok, Benguet
2. Lolita Beganio	Agricultural Technologist	LGU-Atok, Benguet
3. Julia Mendoza	Agricultural Technologist	LGU-Bakun, Benguet
4. Georgina Mayo	Agricultural Technologist	LGU-Bokod, Benguet
5. Delfin D. Rufino	Municipal Agriculturist	LGU-Buguias, Benguet
6.Dr. Prudencio Pedro	Municipal Agriculturist	LGU-Itogon, Benguet
7. Nida Felicitas	Agricultural Technologist	LGU-Itogon, Benguet
8. Samuel Geking	Agricultural Technologist	LGU-Kabayan, Benguet
9. Geofrey B. Binaliw	Municipal Agriculturist	LGU-Kabayan, Benguet
10. Claire Pataras	Agricultural Technologist	LGU-Kabayan, Benguet
11. Dr. Peter Begawen Jr.	Municipal Agriculturist	LGU-Kapangan, Benguet
12. Freda Pacsi	Agricultural Technologist	LGU-Kapangan, Benguet
13. Denialyn Pis-et	Agricultural Technologist	LGU-Kibungan, Benguet
14. Rudy S. Daculan	Municipal Agricultural Officer	LGU-Mankayan, Benguet
15. Maribel Pinas	Agricultural Technologist	LGU-Mankayan, Benguet
16. Ramon M. Anacioco	Municipal Agricultural Officer	LGU-Sablan, Benguet
17. Arthur G. Mariano	Agricultural Technologist	LGU-Sablan, Benguet
18. Marlyn N. Cabanes	Municipal Agriculturist	LGU-Tuba, Benguet
19. Michelle T. Saingan	Agricultural Technologist	LGU-Tuba, Benguet
20.Jeoffrey D. Sotero	Municipal Agriculturist	LGU-Tublay, Benguet
21. Susan A. Lino	Agricultural Technologist	LGU-Tublay, Benguet
22. Manuel M. Tucay	Municipal Agriculturist	LGU-Bambang, Nueva Vizcaya
23. Angelo Ramos	Agricultural Technologist	LGU-Bambang, Nueva Vizcaya
24. Delia Cagungaw	Agricultural Technologist	LGU-Sta. Fe, Nueva Vizcaya
25. Ruth B. Damaso	Agricultural Technologist	LGU-Kayapa, Nueva Vizcaya
26. Rufin D. Fernandez	Municipal Agriculturist	LGU-Kayapa, Nueva Vizcaya

Pictures taken during the secondary data gathering and key informant interviews

Appendix 2

List of workshop participants – sweetpotato, taro and yam growers

A. Naguey, Atok, Benguet			
Name	**Age**	**Sex**	**Agency/ Address**
1. Elpedia M. Alos		F	Egang, Naguey
2. Ester L. Biniahan		F	Sawingan, Naguey
3. Frida P. Bachangan	32	F	Sawingan, Naguey
4. Josie K. Laoyan	45	F	Despag, Naguey
5. Morenia D. Padsiko		F	Sawingan, Naguey
6. Myrna P. Badiwal	60	F	Sawingan, Naguey
7. Florina Aliknas	49	F	Casdan, Naguey
8. Jane S. Badival	64	F	Sawingan, Naguey
9. Richel D. Podaan	47	F	Sawingan, Naguey
10. Sofia K. Kimbongan	50	F	Casdan, Naguey
11. Didith M. Alsaen	34	F	Casdan, Naguey
12. Wilsa Palayao		F	Casdan, Naguey
13. Anabelle Kigis	39	F	Casdan, Naguey



Workshop interview and field visit in Naguey, Atok, Benguet

B. Tawangan, Kabayan			
Name	**Age**	**Sex**	**Agency/ Address**
1. Mercy Lesino	30-<	F	Tawangan, Kabayan
2. Anghelita Payagen	51-60	F	Tawangan, Kabayan
3. Fatima Bugtong	30 - <	F	Tawangan, Kabayan
4. Rosa Ventura	51-60	F	Tawangan, Kabayan
5. Ernesta Alicnas	41-50	F	Tawangan, Kabayan
6. Noemi Lomesio	41-50	F	Tawangan, Kabayan
7. Victoria Flores	41-50	F	Tawangan, Kabayan
8. Hermina Laquito		F	Tawangan, Kabayan
9. Delin Nemo	51-60	F	Tawangan, Kabayan
10. Arsenia Cariño	30 - <	F	Tawangan, Kabayan
11. ryan Lestino	31-40	M	Tawangan, Kabayan
12. Linda Himbadan	41-50	F	Tawangan, Kabayan
13. Arlyn Molitas		F	Tawangan, Kabayan

14. Liza Dukis	31-40	F	TARC MPC
15. Sarcelia B. Bugtong	51-60	F	
16. Racquwl Masing	31-40	F	TARC MPC
17. Lolling Dimot	51-60	F	
18. Presilla Cospeh	31-40	F	TARC MPC
19. Rebecca Legligen	31-40	F	TARC MPC
20. Clara Adcasa	51-60	F	TARC MPC
21. Tito Himbadan	51-60	M	TARC MPC
22. Marjury S. Nemo	51-60	F	TARC MPC
23. Ana Dipo	30 - <	F	TARC MPC
24. Mary Claire P Pataras	31-40	F	OMAG - MLGU
25. Jedona M. Colongey	31-40	F	OMAG - MLGU

Group interview with farmers in Tawangan, Kabayan, Benguet

C. Sagubo, Kapangan		
Name	**Sex**	**Agency/ Address**
1. Dino Dimas Jr.	M	Bileng, Sagubo
2. Janette Ligao	F	Bileng, Sagubo
3. Melia Alcino	F	Landing, Sagubo
4. Brigida Awidan	F	Bileng, Sagubo
5. Jean Lamngad	F	Bileng, Sagubo
6. Dulnuan Apot	M	Bileng, Sagubo
7. Adela Awidan	F	Bileng, Sagubo
8. Agusta Alutang	F	Landing, Sagubo
9. Ana Fermin	F	Bileng, Sagubo
10. Zenaida Dennis	F	Bileng, Sagubo
11. Rosa Tawe	F	Bileng, Sagubo

Workshop interview with farmers in Sagubo and field count of infected plants

D. Kibungan, Benguet		
Name	**Sex**	**Agency/ Address**
1. Brenda Fianza	F	Poblacion, Kibungan
2. Sonia Lid-ayan	F	Poblacion, Kibungan
3. Evelyn Tiw-ec	F	Poblacion, Kibungan
4. June Bilango	M	Badeo, Kibungan
5. Cadang Bagaste	M	Badeo, Kibungan
6. Olivia Baoad	F	Badeo, Kibungan
7. Grace Padino	F	Poblacion, Kibungan
8. Netzie Bacante	F	Badeo, Kibungan
9. Dolinda Banta	F	Poblacion, Kibungan
10. Cobita Oide	F	Polis, Poblacion
11. Susan Landican	F	Poblacion, Kibungan

Group interview and field work in Kibungan, Benguet

E. Cabiten, Mankayan		
Name	**Sex**	**Agency/ Address**
1. Maribel M. Pina	F	LGU, Mankayan
2. Malone A. Olanio	M	Cabiten, Mankayan
3. Regina B. Tanacio	F	Cabiten, Mankayan
4. Benilda W. Martin	F	Cabiten, Mankayan
5. Nena Aguinas	F	Cabiten, Mankayan
6. Mariana Compas	F	Cabiten, Mankayan
7. Aser M. Gayag-o	M	Cabiten, Mankayan
8. Helen Libag	F	Cabiten, Mankayan
9. Marta Olanio	F	Cabiten, Mankayan
10. Nora Canggat	F	Cabiten, Mankayan

F. Sablan, Benguet		
Name	**Sex**	**Agency/ Address**
1. Maria Valles	F	Kamog, Sablan
2. Mary Valles	F	Tenekey, Kamog, Sablan

G. San Pascual, Tuba			
Name	**Age**	**Sex**	**Agency/ Address**
1. Ricardo P. Jose	64	M	San Pascual, Tuba
2. Noemi Payuso	58	F	San Pascual, Tuba
3. Bernardo Benawe	57	M	San Pascual, Tuba
4. Alejandro B. Placido	60	M	San Pascual, Tuba
5. Myrna Sahoy	51	F	San Pascual, Tuba
6. Jocelyn Lay-on	47	F	San Pascual, Tuba
7. Paula B. Amolot	62	F	San Pascual, Tuba
8. Corazon B. Balanag	52	F	Tarong, San Pascual, Tuba
9. Jimmy Basilio	49	M	Tarong, San Pascual, Tuba
10. Romeo L. Ente	58	M	Apni, San Pascual, Tuba
11. Olivia B. Ayupan	60	F	Taba-ao, San Pascual, Tuba
12. Roberto M. Quero	46	M	Golo, San Pascual, Tuba
13. Rebeca C. Cariño	59	F	Ana-ao, San Pascual, Tuba
14. Denia F. Marigza	42	F	Payacpac, San Pascual, Tuba
15. Samuel K. Carintas	68	M	Apni, San Pascual, Tuba
16. Lorna S. Runas	46	F	Colon, San Pascual, Tuba
17. Michelle T. Saingan	36	F	Mago, Tuba
18. Flordelizo B. Abanes	48	M	Mago, Tuba

H. Taloy Norte, Tuba			
Name	**Age**	**Sex**	**Agency/ Address**
1. Nilda Wakat	54	F	Beles, Taloy Norte, Tuba
2. Marjorie Bad-ey	36	F	Bet-ang, Taloy Norte, Tuba
3. Greg Ortiga	44	M	Beles, Taloy Norte, Tuba
4. Lorna Milo	42	F	Bet-ang, Taloy Norte, Tuba
5. Charity Dapyawen	17	F	Bet-ang, Taloy Norte, Tuba
6. Cristina Dao-anes	51	F	Bet-ang, Taloy Norte, Tuba
7. Catalina W. Ortega	44	F	Bet-ang, Taloy Norte, Tuba
8. Lanie M. Pal-iwen	25	F	Bet-ang, Taloy Norte, Tuba
9. Helen M. Milo	67	F	Bet-ang, Taloy Norte, Tuba

I. Taloy Sur, Tuba			
Name	**Age**	**Sex**	**Agency/ Address**
1. Hilda B. Galosi	61	F	Asinan, Taloy Sur, Tuba
2. Sonia W. Loquitan	64	F	Ba-wek, Taloy Sur, Tuba
3. Elesia T. Alilis	62	F	Caucalan, Taloy Sur, Tuba
4. Julita A. Paran	56	F	Asinan, Taloy Sur, Tuba
5. Lolita J. Lopez	60	F	
6. Ellen Q. Calawen	57	F	Asinan, Taloy Sur, Tuba
7. Cristola A. Alilis	80	M	Palina, Taloy Sur, Tuba

J. Basil, Tublay			
Name	**Age**	**Sex**	**Agency/ Address**
1. Evangline Cando	39	F	Pangablan, Basil, Tublay
2. Marcelene Subdi	55	F	Pangablan, Basil, Tublay
3. Prescilla Contino	31	F	Pangablan, Basil, Tublay
4. Letecia Godio	32	F	Pangablan, Basil, Tublay
5. Sylvia Cayso	32	F	Pangablan, Basil, Tublay
6. Flora Baguling	54	F	Pangablan, Basil, Tublay
7. Nemesia C. Godio	76	F	Pangablan, Basil, Tublay
8. Merilyn L. Anas	49	F	Pangablan, Basil, Tublay
9. Prescela Albaro	48	F	Pangablan, Basil, Tublay
10. Brigida Mendoza	63	F	Pangablan, Basil, Tublay
11. Aurelia Cancho	49	F	Pangablan, Basil, Tublay
12. Bernadeth Subdi	60	F	Pangablan, Basil, Tublay
13. Marciana Cando	61	F	Pangablan, Basil, Tublay
14. Florentina Anas	60	F	Pangablan, Basil, Tublay
15. Emilia Alejandro	51	F	Pangablan, Basil, Tublay
16. Valeria Dampulay	63	F	Pangablan, Basil, Tublay
17. Serafina Busoy	44	F	Pangablan, Basil, Tublay
18. Carmen Basit	47	F	Pangablan, Basil, Tublay
19. Elizabeth Cayap	60	F	Pangablan, Basil, Tublay
20. Sofia Pataras	63	F	Pangablan, Basil, Tublay
21. Godofredo Rimando	43	M	Pangablan, Basil, Tublay
22. Marciana Zarate	47	F	Pangablan, Basil, Tublay
23. Josie A. Carpio	22	F	Pangablan, Basil, Tublay
24. Carmen C. Dampulay	47	F	Pangablan, Basil, Tublay

K. Bambang, Nueva Vizcaya			
Name	**Age**	**Sex**	**Agency/ Address**
1. Elio C. Docio	51	M	Pallas, Bambang, Nueva Vizcaya
2. Vecinte Luyaman	68	M	Pallas, Bambang, Nueva Vizcaya
3. Warlit B. Denon	43	M	Pallas, Bambang, Nueva Vizcaya
4. Tinang Bugtong	40	F	Pallas, Bambang, Nueva Vizcaya
5. Loleng Santos		F	Pallas, Bambang, Nueva Vizcaya
6. Delia D. Calpasi	46	F	Pallas, Bambang, Nueva Vizcaya
7. Astrella D. Banih	42	F	Pallas, Bambang, Nueva Vizcaya
8. Sonia O. Dinggas	37	F	Pallas, Bambang, Nueva Vizcaya
9. Tessie D. Campoy	41	F	Pallas, Bambang, Nueva Vizcaya
10. Shonie Denon	36	F	Pallas, Bambang, Nueva Vizcaya
11. Beninda L. Luyaman	40	F	Pallas, Bambang, Nueva Vizcaya
12. Aida D. Decoran	49	F	Pallas, Bambang, Nueva Vizcaya
13. Angeline K. Bagiw	40	F	Pallas, Bambang, Nueva Vizcaya

14. Sabina D. Luyaman	41	F	Pallas, Bambang, Nueva Vizcaya
15. Jose Denon	72	M	Pallas, Bambang, Nueva Vizcaya
16. Padoni N. Dalmase	68	M	Pallas, Bambang, Nueva Vizcaya
17. Alfonso G. Gano	59	M	Pallas, Bambang, Nueva Vizcaya
18. Allones Apondi	50	M	Pallas, Bambang, Nueva Vizcaya

L. Kasibu, Nueva Vizcaya			
Name	**Age**	**Sex**	**Agency/ Address**
1. Martha B. Orencia	30	F	Cordon, Kasibu, Nueva Vizcaya
2. Jean C. Nang-is	28	F	Cordon, Kasibu, Nueva Vizcaya
3. Sabina S. Ponhal	38	F	Cordon, Kasibu, Nueva Vizcaya
4. Arsenia A. Carlos	40	F	Cordon, Kasibu, Nueva Vizcaya
5. Alfredo Bungubung	56	M	Cordon, Kasibu, Nueva Vizcaya
6. Sheila May D. Orenia	28	F	Cordon, Kasibu, Nueva Vizcaya
7. Ronalyn N. Ramos	24	F	Cordon, Kasibu, Nueva Vizcaya
8. Mary Jane P. de Vera	42	F	Cordon, Kasibu, Nueva Vizcaya
9. Rosita B. Mencias	44	F	Cordon, Kasibu, Nueva Vizcaya
10. Janis B. Sabado	39	F	Cordon, Kasibu, Nueva Vizcaya

Group interview workshop in Cordon, Kasibu, Nueva Vizcaya

M. Kayapa, Nueva Vizcaya		
Name	Sex	Agency/ Address
1. Melto Cupaac	M	Pinayag, Kayapa
2. Juaqina Colas	F	Banao, Kayapa
3. Dorina Balahyak	F	Latbang, Kayapa
4. Lilia Abiadew	F	Latbang, Kayapa
5. Juaqin Alfredo	M	Nansiakan, Kayapa
6. Wilfredo Sibaen	M	Cabayo, Kayapa
7. Adne Bugtong	M	Amelong-Labeng
8. Jose Rhani Lagundino	M	Acacia, Kayapa
9. Pio Sinacay	M	Talecabcab, Kayapa
10. Santos Pawisan	M	Cabayo, Kayapa
11. Conia Antonio	F	Cabayo, Kayapa
12, Anderson Tomas	M	Banao, Kayapa
13. Danny Pacia	M	Buyasyas, Kayapa
14. Herson Tactac	M	Pangawan, Kayapa
15. Welhilmina Nisperos	F	Pampang, Kayapa
16. Teresa Litawan	F	Binalian, Kayapa
17. Adelina Panas	F	Binalian, Kayapa
18. Franklin Eliseo	M	Tubongan, Kayapa
19. Dario Bugtong	M	Buyasyas, Kayapa
20. Julios Dudon	M	Besong, Kayapa
21. Lorena, Bencio	F	Tubongan, Kayapa
22. Helen Bugnay	F	Kayapa Proper East, Kayapa
23. Vilma Wakit	F	Besong, Kayapa
24. Celia Gumangan	F	Besong, Kayapa
25. Percilyn Dodon	F	Besong, Kayapa
26. Nagey Macasling	M	Besong, Kayapa
27. Linda Nayusan	F	Besong, Kayapa
28. Talen Cabangon	F	Besong, Kayapa
29. Conching Gumbatan	F	Amelong-Labeng, Kayapa
30. Lita Luis	F	Amelong-Labeng, Kayapa
31. Martina Balacay	F	Amelong-Labeng, Kayapa
32. Delia Luis	F	Amelong-Labeng, Kayapa

N. Sta. Fe, Nueva Vizcaya			
Name	**Age**	**Sex**	**Agency/ Address**
1. Delia B. Cagunao	62	F	MAO
2. Adelma F. Cayap	45	F	ATBU
3. Minerva E. Litawan	65	F	ATBU
4. Processo B.Mallna	65	M	Buyasyas, Sta. Fe, Nueva Vizcaya
5. Antonio C. Dumalo	68	M	Bantina, Sta. Fe, Nueva Vizcaya
6. Ben L. Balalong		M	Canabuan, Sta. Fe, Nueva Vizcaya
7. Liwan B. Wasit	39	M	ATBU
8. Marivis S. Alfonso	50	F	Zigzag, Poblacion, Sta. Fe, Nueva Vizcaya
9. Erminio K. Mallana	54	M	Buyasyas, Sta. Fe, Nueva Vizcaya
10. Cadongga L. Ceghan	60	M	Bacneng, Sta. Fe, Nueva Vizcaya
11. Alex B. Tindaan	63	M	ATBU
12. Charity M. Casem	40	F	Baliling, Sta. Fe, Nueva Vizcaya
13. Roy Alos		M	Buyasyas, Sta. Fe, Nueva Vizcaya
14. Gydabelle B. Liwan		F	Tactac, Sta. Fe, Nueva Vizcaya
15. Porfirid C. Yasay Jr.	42	M	
16. Wilma B. Bataan	62	F	Bacneng, Sta. Fe, Nueva Vizcaya
17. Bella S. Acheta	61	F	Villaflores, Sta. Fe, Nueva Vizcaya

Group interview workshop and field count of infected sweetpotato plants in Bambang, Nueva Vizcaya