MJSIR
Mountain Journal of Science and Interdisciplinary Research
PRINT ISSN: 2619-7855
ONLINE ISSN: 2651-7744
January-June 2020 • 80 (1) : 56-67

Need-Based and Participatory Approach to Extension: Case of Addressing Sweetpotato Fusarium Wilt in Kayapa, Nueva Vizcaya

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Abstract

This paper describes the process or model applied in addressing the Sweetpotato Fusarium wilt problem in Kayapa, Nueva Vizcaya. The project started with the assessment of the problem through the Participatory Rural Appraisal approach, which led to action planning and implementation of possible interventions or services needed by the farmers. Utilization of clean planting materials, soil amendments, and *Trichoderma*, a biological control agent, were likewise demonstrated in farmer's field to showcase these technologies. The process applied the participatory strategy involving the farmers, technicians, and researchers in all the stages, needs assessment, action planning and implementation, and technology demonstration.

KEYWORDS

participatory
food security
trichoderma

Introduction

The significant role of rootcrops has been highlighted in the Asian food systems, especially the crops' multiple functions across different agro-ecological and socio-economic boundaries. This role is especially true for sweetpotato (Campilan, 1996). As a secondary crop, sweetpotato has primary functions with significant contributions to the household socio-economy. In 2002, User's Perspectives with Agricultural Research and Development (UPWARD) studies have shown this contribution in three ways: first, in terms of consumption and nutrition; second, in terms of income and employment and; third, in terms of equity, it confers some sort of power (in the form of knowledge and material resource), because sweetpotato is generally a domain of marginalized sectors in agriculture, particularly the low-income households and female farmers. The contributions of sweetpotato to the household socio-economy of the farmers of Kayapa, Nueva Vizcaya is more on consumption, income, and employment. The sweetpotato is a staple and major source of livelihood among the sweetpotato farmers.

The increasing pests and diseases problem on roots and tuber crops by indigenous peoples in Benguet and Nueva Vizcaya was documented on sweetpotato, taro, tannia, and lesser yam (Gayao et al., 2014). The incidence of an emerging disease of sweetpotato, the leaf and stem rot caused by *Fusarium sp.* wilt, was likewise documented in a survey on diseases affecting economically important crops in CAR (Luis et al., 2015).

In 2011, the sweetpotato farmers in Kayapa, Nueva Vizcaya encountered a problem that is wiping out their sweetpotato crop, particularly in barangay Banao. This problem continued to spread in nearby barangays, and farmers' coping mechanisms could not contain the disease problem. The sweetpotato farmers reported their problem to the LGU-Kayapa in 2014 and this situation prompted the Local Government Unit (LGU) of Kayapa to request technical assistance from the Northern Philippines Root Crops Research and Training Center (NPRCRTC) at Benguet State University to help the farmers identify and give possible solutions to the problem.

Various modes are being adopted to address farmers' concerns adequately. One of the general approaches is the participatory agricultural extension approach, which includes demonstrations, group learning, and local sharing of appropriate technologies (Anandajayasekeram et al., 2008). Accordingly, this approach targets the expressed needs of farmer groups and is often decentralized and flexible. The participatory rural appraisal (PRA) is a major tool in this approach's needs verification phase. PRA is a flexible and time-saving approach used to collect and analyze information involving farmers and researchers. This tool empowers local people to play an active role in analyzing their living conditions, problems and potential for change (Ngailo et al., 2015). The participatory approach requires partnerships with the clients and other enablers and potential resource providers.

Agricultural research and development entail partnership as means of approach between researchers and stakeholders. It seeks to make R & D responsive to local development needs by involving major stakeholders and allowing local institutions to offer inputs in a process driven by local needs (UPWARD, 2002). For example, farmer's participation in technology demonstrations provides stakeholders with a sense of co-ownership through their involvement throughout the technology demonstration cycle.

This paper describes the process and intervention measures done to address the problem raised by the sweetpotato farmers in the highlands of Kayapa, Nueva Vizcaya. It contributes to the literature of needs-based and community-based participatory approach to agricultural extension. To some extent, it also provides on-farm observations of the benefits of clean planting materials as a management option for fusarium wilt in sweetpotato.

Conceptual Framework

Different extension approaches and methods are used or implemented in agriculture depending on the country, sector, discipline, location, or funding agency. Engle and Stone (1990) reported that on one hand, extension can be viewed broadly as a multipurpose, educational and technical advisory service for broad-based agricultural and rural development, or it can be arrowly viewed as a technology transfer mechanism, sometimes dealing with only one commodity.

Axinn (1988) as cited by Anandajayasekeram et al. (2008) identified eight different extension approaches, namely: 1) General agricultural extension approach where planning is done on a national basis by a central government, and essentially a top-down approach; 2) Commodity specialized approach where all functions related to a particular commodity are grouped together, and planning is controlled by a commodity organization; 3) Training and visit approach where planning is usually controlled centrally and the emphasis is on disseminating unsophisticated, low-cost improved practices, and teaching farmers to make best use of available resources; 4) Agricultural extension participatory approach which elicits active participation by farmers themselves, and expressed needs of farmers are targeted; 5) Project approach usually used by international development agencies, and which uses large infusions of outside resources for a few years to demonstrate the potential of new technologies; 6) Farming systems development approach, which assumes that technology which fits the needs of farmers, is not available and needs to be generated locally; 7) Cost-sharing approach which is based on local people sharing part of the extension program cost; and, 8) Educational institution approach where planning is controlled by those determining the curriculum of the educational institution and implementation is through a college or university. Each approach is usually comprised of a combination of methods, which the literature is one in classifying as individual/household; group or mass media methods.

In the Philippines, with the extension system devolved to the LGUs under the 1991 Local Government Code, the LGUs and the agricultural extension workers have been enabled to plan and implement extension strategies or approaches that they think are the best for their community. Baconguis et al. (2012) established that extension modalities in the Philippines are: largely public-driven as funding relied primarily on line agencies; mostly focused on specific crops and livestock that aimed to increase yield and income as well as the capacity of farmers; and mostly adopted combined approaches (participatory, trainings and visits) and as well as various methods (training, techno-demonstration, provision of farm and business advisory, and distribution of IEC materials).

Lopos (2008), in a study of Nueva Vizcaya agricultural extension delivery found that this devolved extension paradigm has improved agricultural extension service delivery because, along with the shift of focus from crops to farmers, the necessary political support has been achieved. It pointed out that co-management schemes and their accompanying support services greatly contributed to poverty reduction in the upland barangays.

The intervention process documented in this paper is an example of a combined approaches, multi-method process. It exemplifies both need-based and participatory approach. It is need-based because the implementation of the project was triggered by an LGU request to address specifically the sweetpotato problem of Kayapa, Nueva Vizcaya. It is participatory since the LGU, the farmers, the researchers, and extension workers worked actively from the problem verification phase to the project action planning and technology demonstration phases.

Methodology

Locale of the Study and Respondents

This research was conducted in Kayapa, the leading sweetpotato producer in Nueva Vizcaya (Nueva Vizcaya Municipal Planning and Development Office, 2010). Sweetpotato farming is a major source of livelihood among the 4572 households in Kayapa, Nueva Vizcaya. Data on sweetpotato production in Kayapa in 2011 showed that at least 495 hectares were planted to sweetpotato. Although Nueva Vizcaya's major crops are rice and corn grown mostly in plains, rootcrops like sweetpotato are grown in rainfed fields and swidden farms.

The top 14 sweetpotato-growing barangays of Kayapa (Table 1) identified to be infested with a disease that almost wiped out the sweetpotato of the highland farmers of the municipality were Banao, Binalian, Latbang, Cabayo, Nansiakan, Pinayag, Pangawan, Besong, Amelong-Labeng, Pingkian, Balangabang, Buyasyas, Talicabcab, Pampang (Meldoz et al., 2014).

Thirty-three key informants and six agricultural technologies were interviewed in this action research. They were selected by the Kayapa LGU-MAO based on the incidence of sweetpotato fusarium wilt infection in their locality/barangay.

Table 1

Sweetpotato Production Area and Number of Sweetpotato Farmers Affected by Fusarium Wilt, Kayapa, Nueva Vizcaya, Philippines, 2011

Barangay	Number of Farmers	Area (ha)
Banao	198	15
Binalian	215	3
Latbang	198	65
Cabayo	147	75
Nansiakan	242	10
Pinayag	250	15
Pangawan	101	5
Besong	128	15
Amelong-Labeng	60	36
Pingkian	72	1
Balangabang	91	5
Buyasyas	101	8
Talicabcab	86	8
Pampang	102	0.5
Total	1,991	261.5

Source: HVCC, Kayapa, Nueva Viscaya (2014)

Implementation Process

The process includes three major phases, namely the assessment of the problem, the action planning, and the technology demonstration (Figure 1). The assessment phase included the formation of a quick response team (QRT) to ascertain the reported sweetpotato problem, brainstorm and recommend solutions, and provide technical assistance to the Kayapa LGU. To ascertain the problem, on-farm visit was done in two severely affected sweetpotato-growing barangays together with the LGU agricultural technicians and selected farmers.

Based on the assessment phase results, the QRT, in collaboration with the LGU, brainstormed and planned for the necessary actions to address the problem. The plan, which included the production of clean planting materials, and field demonstration of selected technologies such as clean planting materials of selected sweetpotato varieties, soil amendments, and biological control agents, was implemented, monitored, and evaluated. For the evaluation, data were gathered in the technology demonstration farms established on-farm, which were managed by the Kayapa LGU-MAO and the farmers with guidance from BSU-NPRCRTC researchers.

Lecture seminars preceded the technology demonstrations. The lecture seminar was done in two sites. The first group was participated in by farmers from eight barangays with high incidence of fusarium wilt namely; Banao, Latbang, Cabayo, Nansiakan, Pinayag, Pangawan, Amelong-Labeng, Pingkian, Balangabang, Buyasyas, Talicabcab, Pampang, Tubongan and Acacia. Farmers from Besong barangay made up the second group with nine female sweetpotato farmers as participants. The Office of the Municipal Agriculture invited the farmer-participants and other stakeholders.

Results and Discussion

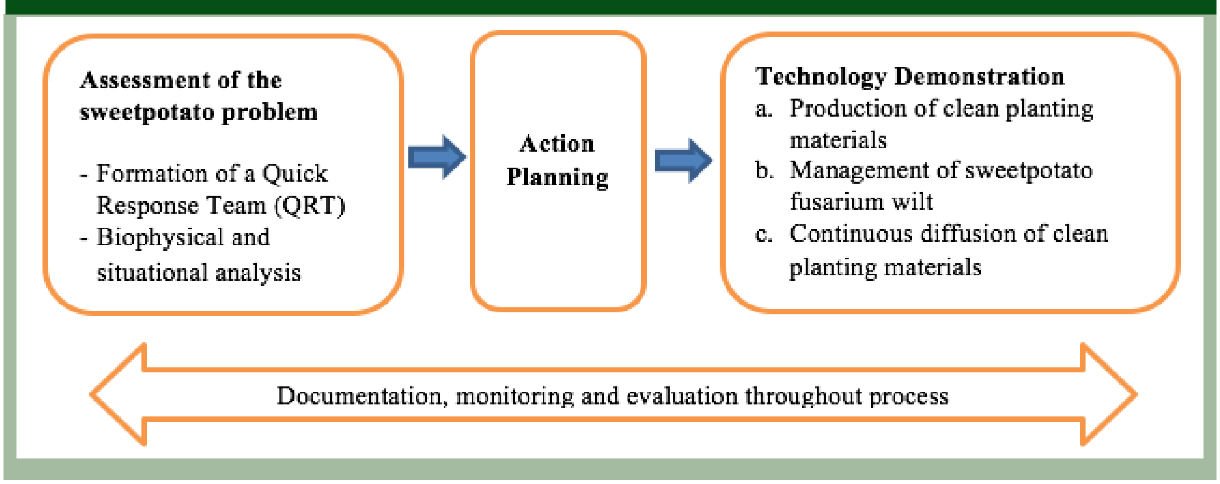
Phase 1. Assessment of the Sweetpotato Problem

Formation of Quick Response Team

Upon receiving the request letter from the municipal mayor of Kayapa, Nueva Viscaya, a multidisciplinary response team composed of specialists in rural development, crop protection, biotechnology and crop management was formed by the BSU-NPRCRTC. They were tasked to plan, execute the response, and provide technical assistance to the requesting LGU.

Figure 1

Process Implemented to Address the Problem on Sweetpotato



Situational Analysis and Verification of Reported Sweetpotato Problem

The upland residents particularly, the sweetpotato farmers in Kayapa, Nueva Vizcaya, reported that they are encountering a problem that is wiping out their sweetpotato. They reported that their sweetpotato crops are dying prematurely, even as early as one month after planting (MAP). The disease that originally infected sweetpotato crops in one barangay continued to spread and has affected 14 major sweetpotato growing areas of the municipality with a total estimated area of 275.5 has. The QRT, in collaboration with the LGU and farmers in the area, verified this reported problem (Figure 2).

Four sites were surveyed, namely; Upper and Lower Talmoy in barangay Banao, Amelong-Labeng Proper and Kinalawkaw, also in Amelong-Labeng barangay. The first technical assistance activity was to do an ocular survey in areas that were reported to be heavily affected by the disease. Table 2 presents a summary of the results of the ocular survey.

The disease incidence of fusarium wilt in Lower and Upper Talmoy, Banao was recorded at 50%. An average of 35% disease incidence was likewise recorded in two areas surveyed in barangay Amelong-Labeng. During the survey, typical fusarium wilt symptoms like interveinal yellowing of older leaves and necrosis of the stem vascular bundles with brown to purple discoloration were seen in the field (Figure 3). Soil and diseased plant samples were collected for laboratory confirmation.

Table 2

Biophysical and Cropping Information of Kayapa, Nueva Vizcaya, 2014

Climate	Mean air temperature= 15-25ºC Total rainfall = 1400-2400mm
Planting Months	April to May or onset of rainy season
Cropping System	Sweetpotato-sweetpotato or beans with tannia and sweetpotato as intercrop/border crop Sweetpotato-sweetpotato Sweetpotato-ginger (Binalian) Sweetpotato-sweetpotato-beans-tannia-cassava (Cabayo, Banao) Sweetpotato-peanut or beans (sitting beans) Sweetpotato intercropped with taro, tannia, and cassava Sweetpotato is rotated with beans, hot pepper, peanut or tomato, cabbage

The pathogen that caused the wiping out of the sweetpotato in Kayapa was positively identified as *Fusarium oxysporum* by the BSU-NPRCRTC Plant Disease Clinic. Infestation of other insect pests of the sweetpotato crop was recorded during the ocular survey in severely affected areas. Decay of the sweetpotato crop was due to infestation of stem borer and sweetpotato weevil. Typical symptoms of virus infection were observed, like stunting and

Figure 2

Courtesy Call to the Mayor (A), Consultation, Briefing and Fieldwork or Ocular Inspection (B, C)

curling of leaves of the sweetpotato crop that may have caused degeneration resulting poor growth and poor yield. Virus infection was validated when these samples were subjected to Nitrocellusoe Membrane-Enzyme-Linked Immunosorbent Assay (NCM-ELISA), a serological technique sensitive for the rapid visual detection of virus plant diseases in plants (Figure 4(R)).

The gaps/problems identified were lack of clean planting materials, varieties/seeds that are degenerated, loss of varieties, and emerging plant diseases. These factors are contributory to low yield. Degeneration of planting materials is because of repeated use of farm-saved seeds, which may have become breeding ground for insects and diseases.

Phase II. Action Planning

Based on the situational analysis and the confirmation of the disease problem, an action plan was discussed among the QRT of the BSU-NPRCRTC and the agricultural technicians

Figure 3

(a) Spore of Fusarium, (b) Interveinal Yellowing of the Older Leaves (c) Necrosis of the Stem Vascular Bundles with Brown to Purple Discoloration

Figure 4

Infestation of Sweetpotato Stem Borer (L) and Degenerated Sweetpotato Crop (R)

of the LGU of Kayapa. Each agency was tasked to come up with quick solutions. Table 3 presents the action plan indicating the gaps/practices, corresponding consequences and the agreed interventions and services needed. The topics for the lecture seminars were determined based on the assessment and field visit.

Phase III. Technology Demonstration

Among the technologies identified for the solution of the problem were the use of clean planting materials and the utilization of soil amendments coupled with the use of clean planting materials against fusarium wilt infection. The project implementers introduced these technologies to the community using the participatory extension approach, which involved the farmers and the LGU through hands-on trainings; mass propagation and diffusion of clean planting materials; and the implementation and evaluation of the demonstrated technologies for managing sweetpotato fusarium wilt.

Production of Clean Planting Materials

The use of planting materials of sweetpotato obtained from tissue culture has been demonstrated to improve household food security among smallholder farmers. Utilization of these planting materials yielded up to 25 tons/ha against a national average of 6 tons/ha. The main challenge identified was that farmers lacked adequate tissue-culture planting materials and this contributed to the declining yields over time. When there was an outbreak of the sweetpotato feathery mottle virus in the Central Luzon Provinces of Tarlac and Bataan, the use of clean planting materials of sweetpotato gave a minimal percentage in disease incidence resulting to a higher root yield. The average root yield obtained from clean planting materials was 29.5 tons/ha compared with 20.5 tons/

Table 3

Gaps/Problems Identified, Its Consequences and Interventions/Services Needed

Gaps/Practices	Consequence/result/importance	Interventions/Services needed
1. Lack of clean planting materials	Low yield and poor quality of storage roots	Lecture and seminar training on the multiplication of clean planting materials/ hands-on training
2. Degenerated planting materials/varieties	Reduced productivity due to degraded or degenerated planting materials, became breeding ground for insects and diseases	Clean-up of varieties and regeneration of planting materials.
3. Loss of varieties	No production	Application of biotechnology for clean-up and regeneration of local varieties
4. Planting of mixed varieties in one area	Loss of varieties	Teach farmers to plant varieties separately
5. Planting is done in slash and burn method	Soil nutrient depletion	Practice green manuring Have their soils analyzed
6. Emerging diseases of sweetpotato	Death of sweetpotato crop	Survey and identification of these diseases
7. No source of clean planting materials	Abandoned sweetpotato planting area and look for other source of income	Provision of training-capacity and starter kits to produce or multiply CPM

ha harvested from using farm-saved seeds or farmers' seeds (Laranang & Castillo, 2002).

In Kayapa, Nueva Vizcaya, the production of clean planting materials was demonstrated through the following activities:

Lecture Seminar and Hands-On Training. For the participants to better understand the importance of clean planting materials, a more complete and elaborated lecture on sweetpotato production, source of clean planting materials, sweetpotato diseases and its management were discussed in a lecture-seminar. The technology on Single Node Cuttings (SNC) was introduced as a method to rapidly multiply the clean planting materials.

Hands-On Training. A hands-on-training was done to enhance the ability of the farmers/technicians in the rapid multiplication of CPM through the Single Node Cutting Technology (SNC) (Figure 5). Likewise, these farmers will be able to multiply their own planting materials.

Mass Propagation of Clean Planting Materials. Initial clean planting materials of sweetpotato were provided by the Benguet State University - Northern Philippines Root Crops Research and Training Center (BSU-NPRCRTC). These plants were produced through tissue culture in-vitro. In-vitro plants were acclimatized in the greenhouse for 3 days before planting in individual pots. These were brought to Kayapa, Nueva Vizcaya, and were established as mother plants. These were rapidly multiplied through the SNC technology.

During the field survey, the farmers submitted root samples of their traditional varieties. Through the knowledge gained during the seminar, they were convinced that regeneration through tissue culture could be done to save their varieties from being lost through the application of biotechnology for clean-up. This technology is applied to regenerate plants to avoid the loss of varieties. Their traditional variety *Swerte* was cleaned-up and mass multiplied. Three varieties of sweetpotato namely; *Immitlog, Bengueta,* and *Kessey*, from NPRCRTC were utilized during the demonstration using the SNC technology.

Diffusion of Clean Planting Materials. Planting materials produced on-site under protected condition were distributed to barangays affected with the disease. The Office of Municipal Agriculture was in-charge in the multiplication and distribution of the planting materials. More than 4,590 vine cuttings were produced and distributed to farmers in five barangays affected with sweetpotato fusarium wilt. The mother plants utilized for multiplication were discarded in the fifth month.

An additional 9,200 vine cuttings were gathered from the demonstration plots and taken by farmers from the barangays affected with sweetpotato fusarium wilt. In addition, in the effort to supply the sweetpotato farmers with clean planting materials, the LGU of Kayapa requested 50,000 vine cuttings to be distributed for free to affected barangays. A total of 20,000 vine cuttings were initially distributed to supplement planting materials that were distributed earlier.

Figure 5

Lecture-Seminar and Hands-on Training for the Rapid Multiplication of Vine Cuttings

Management of Sweetpotato fusarium wilt

To provide a better understanding of how to manage the problem on fusarium wilt of sweetpotato, the project implementers established a demonstration farm for soil amendments a demo-farm on the use of soil amendments, biological control agents (BCA) coupled with clean planting materials. One-month-old vine cuttings produced were used in this experiment. The BSU-NPRCTRC provided the Generation 1 vine cuttings of varieties G*islayan, Atok, Immitlog,* and *Pakak*. Soil amendments like lime or CaO, Calcium hypochlorite, or powdered bleach were applied one month before planting. Mixing of these soil amendments was done occasionally. The *Trichoderma* previously multiplied in composted chicken dung was applied upon planting approximately at 500g/hill. Watering and weeding were done as needed during the whole cropping period.

Disease rating of incidence (Table 4) was taken at 2, 3, and 5 months after planting (MAP) or at harvest using a scale of 0-5. Even at five months after planting, the highest rating of incidence was 3, which means that some older leaves turned yellow and the length of tan vascular system is 1/3 of the total plant length. There was no incidence of fusarium wilt in plots treated with *Trichoderma* and the treatment plots planted with *Gislayan* variety. The ability of BCA to produce toxins against diseases is a plus factor in the non-incidence of fusarium wilt in plots treated with *Trichoderma*. Galian and Nagpala (2019) demonstrated a 50% reduction in the soil population of fusarium with the application of *Trichoderma* and BSU-compost coupled with clean planting materials. Likewise, soils applied with *Trichoderma* and fungicide showed a delay in disease attack resulting in a hundred days before plant infection (Masangcay & Galian, 2018). Further, in a related survey study, sweetpotato variety *Gislayan* has been identified by sweetpotato farmers to have tolerance to fusarium wilt (Backian et al., 2020). This result may help explain the zero infection of fusarium wilt .

The highest yield was obtained in plots treated with lime with a mean of 6.88 tons/ha while the lowest was harvested in plots using the *Atok* variety as shown in Table 5. The mechanism of disease control with application of calcium oxide (CaO) or lime has been demonstrated in watermelon wilt disease. The mechanism might be that the increase in soil pH changed the soil spore germination leading to the death of fungal cells of fusarium finally revealing the mechanism of prevention and control of the fusarium by calcium oxide (Ting et al., 2017).

The highest in herbage yield was obtained in plants treated with *Trichoderma* (11.93kg/10hills) but not significantly different in plants treated with powdered bleach with a mean of 11.67 kg (Table 6). Yield is affected by herbage, as reflected in the results. *Atok* variety, which had the lowest root yield, was also lowest in herbage yield but not significantly different from the herbage yield

Table 4

Mean Disease Rating of Sweetpotato Fusarium Wilt in Besong, Kayapa, Nueva Vizcaya

Treatment	2MAP	3MAP	5MAP
T1-CaO (lime)	0	2	2
T2- Trichoderma	0	0	0
T3-Powdered bleach	0	1	2
T4- Gislayan	0	0	0
T5- Atok	0	0	1
T6- Pakak	0	0	3

Descriptive meaning of rating:
1- length of tan vascular system is 5cm
2- some older leaves turned yellow and length of tan vascular system is 1/3 of the total plant length
3- older leaves became yellow and tan vascular system is 2/3 of the palnt

Table 5

Yield of Marketable Root Yield (ton/ha)

Treatments	Means
T1- Lime	6.88^{a}
T2- Trichoderma	4.9^{ab}
T3-Powdered bleach	4.38^{b}
T4- Gislayan	5.10^{ab}
T5- Atok	2.92^{b}
T6- Pakak	4.35^{b}

cv-25.5%

of the *Pakak* variety.

The above results of on-farm technology demonstration farms underscore the importance of the demonstrated success of the technologies or solutions being recommended to address the client problem. As stated by a review of extension methodologies by Engle and Stone (1990), farm demonstration projects incorporate two main attributes as an extension system, namely they recognize the importance of demonstrated success of any proposed solution and its subsequent adoption by farmers, and the importance of farmer-to-farmer communication.

Table 6

Yield of Herbage

Treatments	Weight (kg/10 hills)
T1- Lime	10.33^{ab}
T2- Trichoderma	11.93^{a}
T3-Powdered bleach	11.67^{a}
T4- Gislayan	8.23^{abc}
T5- Atok	2.92^{c}
T6- Pakak	4.35^{c}

cv-24.23%

Conclusions

Sweetpotato is considered a staple food among the upland residents of Kayapa, Nueva Vizcaya particularly the sweetpotato farmers. In 2011, farmers observed that their sweetpotato were prematurely dying, which became worst in 2014. The fear that their sweetpotato will be wiped out prompted the Local government of Kayapa, Nueva Vizcaya to request technical assistance from the BSU-NPRCRTC to solve the problem. This paper described the process and intervention measures implemented from March 2014 to June 2017 in response to the sweetpotato problem.

This study demonstrated that the need-based and participatory extension approach, in this case, comprised of an assessment of the problem, action planning, and implementation through participatory technology demonstration, hands-on trainings, and mass propagation and diffusion of technologies, is a combined approach that works in the case of client-requested action research and extension. It further confirmed the value of proper verification of a reported problem worked through a multi-disciplinary team, working closely with farmers and the LGUs to develop and promote solutions and interventions, and present evaluation results for on-farm technology demonstration farms in extension programs.

While the on-farm experiments were limited by its technology demonstration nature, the results provide on-farm evidence of the potential benefits of clean planting materials as a management option for fusarium wilt in sweetpotato. The use of clean planting materials effectively delayed the incidence of sweetpotato fusarium wilt caused by *Fusarium oxysporum f.* sp. *batatas* which was positively identified as the causal agent that almost wiped out the sweetpotato crop of the upland farmers of Kayapa, Nueva Vizcaya. The application of lime at the rate of 4t/ha, powdered bleach, and *Trichoderma* likewise demonstrated good control against the disease. These interventions showcased in the area resulted in an increase in root yield.

Recommendations

On the intervention process, further monitoring and evaluation of the introduced technologies for sweetpotato in Kayapa, Nueva Vizcaya will confirm if the project gains have been sustained. Also, in the process of ascertaining the problem, pre-test information on knowledge level is useful since one of the extension methods is lecture-seminars and trainings.

Development of resistant cultivars can be considered in research and development on sweetpotato. Continuous use of clean planting materials is also recommended as this is the cheapest way to produce sweetpotato organically because there is no chemical intervention. The LGUs should also consider establishing community-based nurseries to cater areas far from the nursery managed by the LGU-MAO.

References

Anandajayasekeram P., Puskur, R., Sindu, W., & Hoekstra, D. (2008). *Concepts and practices in agricultural extension in developing countries: A source book*. IFPRI (International Food Policy Research Institute), Washington, DC, USA, and ILRI (International Livestock Research Institute), Nairobi, Kenya.

Backian, G.S., Gayao, B.T., Ngaotoy, A.D., & Galian, J.L. (2020). Sweetpotato Fusarium Wilt (*Fusarium oxyporum f. sp. batatas*) and Other Insect Pest and Diseases Affecting Farms of Indigenous Growers in Benguet and Nueva Vizcaya. BSU Agency in-House Proceeding. Benguet State University, La Trinidad, Benguet.

Baconguis, R.D.T., Ocampo, M.T.N.P., Manalo, C.J.B., Tan, F.O. & Sulabo, E.C. (2012). Compendium of extension modalities completed. *College of Public Affairs (CPAf) News*. College of Public Affairs - University of the Philippines Los Baños. https://cpaf.uplb.edu.ph/index.php/2012-09-07-06-09-58/cpaf-updates/cpaf-news/217-compendium-of-extension-modalities-completed

Campilan, D.M. (1996). *The changing role of users in sustainable rootcrop agriculture: a second Look at UPWARD's second phase*. In: UPWARD 1996. *Into Action Research: Partnership in Asian Rootcrop Research and Development*. UPWARD, Los Banos, Laguna, Philippines.

Engle C.R., & Stone, N.M. (1990). A Review of Extension Methodologies in Aquaculture. Rome: Food and Agriculture Organization of the United Nations. http://www.fao.org/3/t8654e/t8654e00.htm#Contents.

Galian, J.L., & Nagpala, A.L. (2019). Performance of Trichoderma koningii and Bacillus sp. as Potential Biocontrol Agents against Fusarium Wilt (Fusarium oxysporum) of Sweetpotato (Ipomoea batatas). *Mountain Journal of Science and Interdisciplinary Research,* 79(2): 50-57.

Gayao, B.T., Meldoz, D.T., & Backian, G.S. (2014). Indigenous knowledge, technology, and role of roots and tubers in household food security and income among the Kalanguyas in Nueva Vizcaya, Philippines. *Traditional Roots and Tubers Knowledge Series*. #10. April 2014. NPRCRTC-Benguet State University, La Trinidad, Benguet, Philippines.

Laranang, L.B., & Basilio, C.S. (2002). Strengthening local systems for producing sweetpotato planting materials. In: *UPWARD Fieldnotes*. A publication of the Users' Perspectives with Agricultural Research and Development (UPWARD) Network. Volume 11 Numbers 1 and 2.

Lopos, B.E. (2008). Agricultural extension service delivery in the Philippines: the case of Nueva Vizcaya. *CLRG-CIE-ACIAR Reports*. 67-92 Abstract available at https://agris.fao.org/agris-search/search.do/recordID=PH2008000792

Philippine Congress. (1991). Local Government Code of the Philippines. Manila, Philippines. https://www.officialgazette.gov.ph/downloads/1991/10oct/19911010-RA-7160-CCA.pdf

Luis, J.S., Perez, J.C., Backian, G.S., Bawayan, J.T., Codod, C.B., & Kiswa, C.G. (2015). Quarantine and other important diseases affecting economic crops in the Cordillera. *Benguet State University Research Journal,*74:50-61.

Masangcay, T.D., & Galian, J.L. (2018). Management of sweetpotato fusarium using soil amendments under greenhouse condition. Unpublished. Agency In-House Review Proceedings. Northern Philippines Root Crops Research and Training Center. Benguet State University, La Trinidad, Benguet.

Meldoz, D.T., Backian, G.S., & Masangcay, T.D. (2014). A needs assessment: Sweetpotato production in Kayapa, Nueva Vizcaya. Unpublished. BSU Agency In-house review Proceeding. Benguet State University, La Trinidad, Benguet.

Ngailo, S., Shimelis, H., Sibiya, J., & Mtunda, K. (2015). Assessment of Sweetpotato farming systems, production constraints and breeding priorities in Eastern Tanzania. *South African Journal of Plant and Soil,* 33(2), 105-112.doi:10.1080/02571862.2015.1079933

Nueva Vizcaya Municipal Planning and Development Office. (2010). Nueva Vizcaya Provincial Dev't. and Physical Framework Plan. Local Government of Kayapa, Nueva Vizcaya.

Ting, Q., Yi, Z., Jiling, X., Feiying, Z., Lin, W., & Zhihuai, L. (2017). Effects of soil application with calcium oxide on control of fusarium wilt of watermelon and its preliminary mechanism research. *Plant Protection,* 43(06): 11-16. http://jtp.cnki.net/bilingual/detail/html/ZWBH201706003

User's Perspectives With Agricultural Research and Development. (2002). Engaging local government: Sweetpotato R & D in the Philippines. In: *Upward Field Notes*. Volume 11.