Implementation of the Internationalization Program of the Visayas State University

Project Proposal Template

Delivering Department Unit	Philippine Root Crop Research and Training Center
Project Title	High-Throughput Field-Phenotyping (HTFP) of Major Rootcrops Using Unmanned Aerial Vehicle (UAV)
Project Proponents (name, designation, affiliation and email address). Include project staff.	**Lisa I. Arce (project leader)** MSc Plant Sciences Philippine Root Crop Research and Training Center, VSU lisa.arce@vsu.edu.ph **Alan B. Loreto (co-project leader)** MSc Ag.Eng'g- Precision Agric. PhilRootcrops, VSU alan.loreto@vsu.edu.ph **Mae Ann A. Bravo (co-project leader)** MSc Soil Science PhilRootcrops, VSU maeann.bravo@vsu.edu.ph Study 1: Assessment of Agroclimatic Conditions on the Growth and Yield of Cassava and Sweetpotato **Geleca Ignanes-Maranan** (study leader) MSc Agronomy PhilRootcrops, VSU **Dioscoro M. Bolatete** (co-study leader) MSc Agronomy PhilRootcrops, VSU Study 2: Multispectral and Hyperspectral Imaging (HIS) of Cassava and Sweetpotato Plants at Different Stages of Growth **Alan B. Loreto** (study leader) PhilRootcrops **Juztine Jane L. Rebuyas** (co-study leader) MSc Remote Sensing Department of Geodetic Engineering (DGE) **Martin Jan E. Mercurio** (expert on call) MS in Geomatics Engineering-Geodesy Department of Geodetic Engineering (DGE) **Jannet C. Bencure** (expert on call) PhD in Remote Sensing and Geographic Info. Sys. Department of Geodetic Engineering (DGE)

	Study 3: Agro-Morphological Characterization of Cassava and Sweetpotato Varieties **Lisa I. Arce** (study leader) PhilRootcrops **Marissa B. Barbosa** (co-study leader) MSc Plant Breeding- Plant Phenomics Department of Plant Breeding and Genetics (DPBG) Study 4: Nutrient Uptake and Yield of Cassava and Sweetpotato Varieties in Response to Soil Management and Fertilization **Mae Ann A. Bravo** (study leader) PhilRootcrops **Suzette B. Lina** (co-study leader) PhD Soil Science- Nutrient Uptake Department of Soil Science (DSS) Study 5: Monitoring and Evaluation of Pest and Disease Incidence of Different Cassava and Sweetpotato Varieties **Rochelle B. Cagadas** (study leader) MSc Plant Pathology PhilRootcrops **Erlinda A. Vasquez** (co-study leader) PhD Entomology PhilRootcrops
Project International Partners (name, designation, affiliation and email address)	**Prof. Tran Dang Xuan** Associate Professor Graduate School of Advanced Science and Engineering Hiroshima University tdxuan@hiroshima-u.ac.jp
Rationale	The Visayas State University (VSU) houses the national agency for rootcrop research: Philippine Root Crop Research and Training Center (PhilRootcrops). The research center has an existing crop improvement program aiming to boost productivity of rootcrops through improved varieties, proper production, nutrient, and pest management practices. Major contribution has been made by the center throughout the years. In fact, two of the major agricultural commodity of the country, cassava and sweetpotato, are among the priority crops of the center. One important aspect of any crop improvement program is the genetic resources management and utilization. Currently, germplasm collections are maintained and characterized using conventional techniques. Phenotyping activities are done through visual scoring of quantitative and qualitative measurements of phenotypic traits throughout the crop's growing period and such activities can be destructive or non-destructive in nature.

	Conventional phenotyping methods are both labor intensive and time-consuming. High-throughput phenotyping (HTP) has been gaining interest in recent years (Furbank and Tester, 2011; Fiorani and Schuur, 2013). Developing HTP systems will facilitate non-destructive and non-invasive characterization of individual plants at a larger scale with high efficiency and precision (Furbank and Tester, 2011). This will not only fast track the breeding process, but will also facilitate monitoring and assessment of nutrition and health status of crops in large production areas. Studies using remote sensing techniques in assessing crop growth by monitoring the biophysical attributes were conducted by Sahoo, et.al., 2015. Though a lot of studies on the application of Remote Sensing to Agriculture were already conducted, Multispectral and Hyperspectral Imaging (HSI) also known as imaging spectrometer, is the least explored application for measurement of plant disease (Bock, et al. 2010). HSI is a spectral imaging acquisition where each pixel of the image was used to acquire a set of images within certain spectral bands (Schelkanova, et al. 2015). Each pixel of the image contains spectral information as a third-dimension of values to the two-dimensional spatial image, thus generates a 3D data cube or a hypercube (Vasefi et al., 2016). Hyperspectral image has hundreds to thousands of bands and can be obtained using imaging spectrometer. Hence, having a higher level of spectral detail gives better capability to see plant's attributes that can't be observed by the naked eye. One of the most popular platforms of remote sensing nowadays is the use of unmanned aerial vehicle(UAV) with different camera on-board for specific purpose. UAV are used to represent a power-driven reusable airplane or multi-copter operated without a human pilot on board and normally equipped with RGB camera or multi-spectral camera for agricultural applications. Multiple UAVs can be flown in agricultural areas to gather real-time measurements of different parameters useful for crop health monitoring. Studies have been done on citrus greening, best harvest time of wine grapes, monitoring the ripeness of coffee and many other crops except for rootcrops such as cassava and sweetpotato. This research therefore is developed to assess the correlation of spectral bands to key phenotypic traits, crop yield and in monitoring pest and diseases incidence on cassava and sweetpotato Establishing this aerial phenotyping system with UAV and sensor technologies will help the breeders manage and utilize the vast genetic resources available for the development of new varieties with better genetic qualities

	such as high yield and can withstand agro-climatic pressures and incidence of pest and diseases. In the long-run, this technology can be expanded for the advantage of the rootcrop industry. It should be noted that nowadays. rootcrop production has expanded and production areas are becoming bigger and pose more challenges to monitor and assess the health of the cassava plant. Also, large plantation owners encounter challenges in estimating the yield of the crops until during harvest time. In as much as many farms in the Philippines still do the manual harvesting it has always been a problem to provide the needed manpower to be able to harvest and primary process rootcrops in a short period of time. A well-developed HTP platform will enable estimation of crop yield prior to harvest, thus, hiring of enough manpower can be done ahead of time. While utilizing remote sensing platforms for precision agriculture is still an emerging field here in VSU, other universities outside the country have already been engaging in the interdisciplinary field of agriculture and engineering thru RS platforms. In fact, several universities have been in collaboration with international research centers such as the International Center for Tropical Agriculture (CIAT), International Potato Center (CIP), Climate Change, Agriculture and Food Security (CCAFS), etc., in developing high throughput phenotyping platforms for crop improvement programs. This initiative of developing the technology in the university will open possibilities of partnerships or collaborations with other universities engaging in this research.
Project Duration	Three (3) years
Total Budget • **VSU** • **Collaborating partner**	**Total - 4,928,4 60.00** **Year 1- 1,302,820.00** -

I. **Proposal Details.** *Please state your objectives following the principle of SMART (Specific, Measurable, Attainable, Relevant and Time-bound)*

Logical Framework *(use separate rows)*					
Objectives	**Activities**	**Outputs**	**Verifiable Indicators**	**Means of Verification**	**Assumptions**
Establish the hyperspectral signature of rootcrop varieties	Spectral imaging of rootcrops using UAV with NIR and RGB cameras	Hyperspectral images of rootcrops gathered at different stages of growth	Compilation of hyperspectral images at different stages of growth	Publication	Efficient image processing techniques are available
Assess the correlation of	Agro-morphological	Ground truth measurements	Identified the spectra or	Handbook	Unbiased characterizatio

the spectra and the key phenotypic traits of rootcrop varieties	characterization (ground-truth measurements) Statistical correlation analysis using GIS software	of key phenotypic traits scored and recorded Relationship of agro-morphological traits with UAV-derived spectra assessed	range of spectra that is correlated to the phenotypic trait	(Characteristics of NSIC Registered Rootcrop Varieties) Publication	n of phenotypic traits
Assess the effect of agroclimatic factors on the growth and yield response of different rootcrop varieties	Field set-up and management of the growing crops Gathering of agro-climatic data (AWS and PAGASA)	Agro-climatic data encoded Yield and yield components of rootcrop varieties monitored	Growth and yield response of rootcrop varieties correlated with changes in agro-climatic conditions	Publication	Localized agro-climatic data are available from PAGASA
Determine the nutrient uptake and yield of rootcrop varieties in response to fertilization	Yield and yield component analysis, soils, plant and tissue analysis	Agronomic characters, plant nutrient uptake, and yield data recorded	Agronomic and yield data correlated to crop health and nutrient uptake per variety assessed	Publication	Baseline information on the amount of organic and inorganic fertilizers to be applied for the different rootcrops is established
Monitor incidence and severity of pest and disease infestation prevalent in the experimental area	Monthly data collection on the prevalence of pest and disease incidence and severity Monitoring of changes in crop morphology in relation to pest and disease incidence Statistical correlation analysis using GIS software	Pest and disease incidence identified and characterized Correlation of spectral bands and pest and disease status assessed	Identified the spectra or range of spectra that is correlated with pest and disease incidence	Publication	Severity of pest and disease incidence is sufficient to create changes in key phenotypic traits

II. Project Details

Target Beneficiaries	• researchers • students • commercial growers • starch mills

	• Department of Agriculture • LGU's
Discipline *(check all that apply)* Phenomics and Emerging Technology	
☐ Education Science, Teacher Training ☐ Fine, Applied Arts ☐ Humanities ☐ Religion, Theology ☐ Social, Behavioral Sciences ☐ Business Administration Related ☐ Law, Jurisprudence ■ Natural Science ☐ Mathematics ☐ IT-Related	☐ Mass Communication, Documentation ☐ Medical, Applied Professions ☐ Trade, Craft, and Industrial Engineering ■ Engineering ☐ Architectural, Town Planning ■ Agricultural, Forestry, Fisheries ☐ Home Economics ☐ Service Trades ☐ Maritime ☐ Others (specify) ___________
Priority Area *(Check all that apply).*	
■ Health, Life Sciences ☐ Improving environmental resilience ☐ Improving energy security	☐ Future cities ■ Agritech ■ Digital, innovation, and creativity
Responsiveness to UN Sustainable Development Goals *(Depending on the research type and platform, you may check more than one (1) SDG)*	
☐ **SDG 1**. End poverty in all its forms everywhere. ■ **SDG 2**. End hunger, achieve food security, and improved nutrition and promote sustainable agriculture. ☐ **SDG 3**. Ensure healthy lives and promote well-being for all at all ages. ☐ **SDG 4**. Ensure inclusive and equitable quality education and promote lifelong learning opportunities at all. ☐ **SDG 5**. Achieve gender equality and empower all women and girls. ☐ **SDG 6**. Ensure availability and sustainable management of water and sanitation for all. ☐ **SDG 7**. Ensure access to affordable , reliable, sustainable and modern energy for all. ☐ **SDG 8**. Promote sustained , inclusive and sustainable economic growth, full productive employment, and descent work for all.	☐ **SDG 10**. Reduce inequality within and among other countries ☐ **SDG 11**. Make cities and human settlements inclusive, safe, resilient, and sustainable ☐ **SDG 12**. Ensure sustainable consumption and production patterns ☐ **SDG 13.** Take urgent action to combat climate change and its impacts ☐ **SDG 14.** Conserve and sustainably use the oceans, seas, and marine resources for sustainable development ☐ **SDG 15.** Protect, restore and promote sustainable use of terrestrial systems, sustainable manage forests, combat desertification and reverse land degradation and halt biodiversity loss. ☐ **SDG 16.** Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective,

☐ **SDG 9**. Build resilient infrastructure , promote inclusive and sustainable industrialization and foster innovation.	accountable, and inclusive institutions at all levels. ☐ **SDG 17**. Strengthen the means of implementation and revitalize the global partnership for sustainable development.
Explain how the project responds to SDG selected above.	The proposed project which aims towards establishing a high-throughput phenotyping platform for rootcrops responds to UN's sustainable development goal on ending hunger, achieve food security and promoting sustainable agriculture HTPs can provide avenue for rapid and accurate selection of plants thereby fast tracking breeding activities. Superior varieties developed can possess qualities such as resistance to emerging pests and diseases, tolerance to abiotic stresses, and high yielding. Quality traits of the new and improved varieties can help secure food productivity for the future generations. Furthermore, one of the project's long-term goal is to create a phenotyping system that will facilitate monitoring of incidence of pest and diseases in wide scale production areas. This will encourage sustainable management of pest and diseases. Effective monitoring and estimation of pest and disease incidence will help pest managers in deciding which control measures are to be employed. Less invasive measures such as mechanical and biological controls can be done when pest and diseases are detected early and still in a manageable level. Nevertheless, at higher incidence rate, chemicals will be used but at the minimum level required based on the assessment made thru the HTP platform. This is also true in the case of nutrient management. Assessment of field and crop status can be facilitated by HTP. Spectral bands can be correlated to specific nutrient deficiency. This will guide farmers in fertilizer application and will minimize the excessive use of inorganic fertilizer which can cause environmental degradation.
Explain how the project responds to the *Ambisyon* 2040.	Ambisyon Natin 2040 envisions that by 2040, Filipinos enjoy a strongly rooted,

	comfortable, and secure life. One of the aspirations of the program is for the Filipinos to be comfortable: free from hunger and poverty. The project indirectly contributes to this aim by targeting an important agricultural commodity in the country- rootcrops. The rootcrop commodity has been gaining interest from different industry sectors (processors and direct consumers), creating a high for rootcrops. By developing and utilizing HTP technologies breeders can develop high yielding varieties and farmers can further enhance productivity thru efficient crop health monitoring. Improving productivity of land per unit area planted with rootcrop entails an improvement of a farmer's economic status and living conditions.
Explain how the project responds to Internationalization Plan of VSU	The proposed project will enable the university to venture into an advanced technology used by different universities and research centers for crop improvement and crop management programs. This in turn will facilitate possible partnership/collaboration between VSU and international universities who've been conducting this particular field of research. The partnership can allow exchange of faculty or student involved in the research in order to strengthen knowledge and develop international relations.

III. Schedule of Activities.

Activities	YEAR 1				YEAR 2				YEAR 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Procurement of supplies												
Field set-up and maintenance of rootcrop varieties												
Cassava			1st cropping				2nd cropping					
Sweetpotato							1st cropping			2nd cropping		
Spectral imaging of cassava and sweetpotato using UAV												
Cassava			1st cropping				2nd cropping					
Sweetpotato							1st cropping			2nd cropping		
Agromorphological characterization of cassava and sweetpotato varieties												
Cassava			1st cropping				2nd cropping					
Sweetpotato							1st cropping			2nd cropping		
Gathering of agroclimatic data (AWS and PAGASA)												
Cassava					1st cropping				2nd cropping			
Sweetpotato								1st cropping		2nd cropping		
Yield and Yield and yield component analysis, soils, plant and tissue analysis												
Cassava			1st cropping				2nd cropping					
Sweetpotato							1st cropping			2nd cropping		
Data collection on the prevalence of pest and disease incidence and severity												
Cassava			1st cropping				2nd cropping					
Sweetpotato							1st cropping			2nd cropping		
Data processing and statistical correlation analysis												
Writing of publications												

IV. Work and Financial Plan

I. Work Plan for the Project *(Provide additional sheets if necessary)*		
Activity	**Output**	**Date**
Field set-up and management of the growing crops Cassava Sweetpotato	 Established experimental area Established experimental area	 Y1-Q2; Y2-Q2 Y2-Q3; Y3-Q1
Spectral imaging of rootcrops using UAV with NIR and RGB cameras Cassava Sweetpotato	 Hyperspectral images of cassava varieties Hyperspectral images of sweetpotato varieties	 3rd, 6TH, 9TH, 12TH MAP Monthly collection (Y2-Q3-Q4; Y3-Q1-Q2)
Agro-morphological characterization Cassava Sweetpotato	 Key phenotypic traits of cassava varieties Key phenotypic traits of sweetpotato varieties	 3rd, 6TH, 9TH, 12TH MAP Monthly collection (Y2-Q3-Q4; Y3-Q1-Q2)
Gathering of agro-climatic data (AWS and PAGASA) Cassava Sweetpotato	 Agro-climatic data during the growing period of crops Agro-climatic data during the growing period of crops	 Y2-Q1; Y3-Q1 Y2-Q4; Y3-Q2
Yield and yield component analysis, soils, plant and tissue analysis Cassava Sweetpotato	 NUE and yield data of cassava varieties NUE and yield data of sweetpotato varieties	 Y2-Q1; Y3-Q1 Y2-Q4; Y3-Q2
Data collection on the prevalence of pest and disease incidence and severity Cassava Sweetpotato	 Pest and disease incidence of cassava Pest and disease incidence of sweetpotato	 Monthly collection Monthly collection
Statistical correlation analysis using GIS software	Relationship of agro-morphological traits with UAV-derived spectra assessed Correlation of spectral bands and pest and disease status assessed	Y2-Q2 to Y3-Q4

II. Line Item Budget

	Year 1 (starting Q2)	Year 2	Year 3	Total
II. Maintenance and Other Operating Expenses				
Traveling Expenses				
Local	40,000.00	80,000.00	85,000.00	**205,000.00**
International (Plane fare, allowance, insurance, etc)	-	350,000.00	350,000.00	**700,000.00**
Communication Expenses				
Postage and Deliveries, Telephone Expenses, Internet Expenses, etc.	25,000.00	25,000.00	25,000.00	**75,000.00**
Supplies and Materials Expenses				
Food and Accommodation (Inbound faculty and student exchange)	-	210,000.00	210,000.00	**420,000.00**
Office Supplies Expenses, Gasoline, Oil and Lubricants Expenses	50,000.00	50,000.00	50,000.00	**150,000.00**
Agricultural Supplies Expenses, etc.	80,000.00	80,000.00	80,000.00	**240,000.00**
Other Professional Services				
1 Science Research Assistant (SRA) @P22,515.00/mo x 12 mos	202,635.00	270,180.00	270,180.00	**742,995.00**
Resource Persons	70,000.00	100,000.00	100,000.00	**270,000.00**
Other Professional Services (statistician, soil and plant tissue analysis, etc.)	30,000.00	120,000.00	120,000.00	**270,000.00**
Labor and other fees				
3 Laborers @ P9,000.00 x 12 mos	243,000.00	324,000.00	324,000.00	**891,000.00**
4 Emergency Laborers @ P603/day x 22days	53,064.00	53,064.00	53,064.00	**159,192.00**
Repairs and Maintenance (UAV calibration, batteries, etc.)	100,000.00	50,000.00	50,000.00	**200,000.00**
Tractor Operations and Hauling Expenses	35,000.00	35,000.00	35,000.00	**105,000.00**
Representation Expenses (inception and quarterly consultation meetings)	50,000.00	50,000.00	50,000.00	**150,000.00**
Printing and Binding Expenses	-	50,000.00	50,000.00	**100,000.00**
Subscription Expenses (Zoom, other conference and business software)	50,000.00			**50,000.00**
GRAND TOTAL	**1,028,699.00**	**1,847,244.00**	**1,852,244.00**	**4,728,187.00**

III. Scholarships / Fellowships for Undergraduate and Graduate Studies and Faculty Mobility Inbound and Outbound and International Relations

FULL NAME	INSTITUTION	POSITION
I. Inbound		
a. Undergraduate		
b. Graduate	one (1)	
c. Faculty	one (1)	
II. Outbound		
a. Undergraduate		
b. Graduate	two (2)	
c. Faculty	one (1)	

IV. Summary of Expected Outputs

Category / Item/ Description	Quantity
People Capacitate the researchers on the operation, integration and use of UAV in research *Seminar/Orientation on UAV operations that will be used in the project* Faculty/student exchange *Send/receive students to/from collaborating universities for training/conduct of research*	One (1) Two (2) students One (1) faculty
Place PhilRootcrops propagation area *This will serve as a nursery/propagation of NSIC registered rootcrop varieties with monitored agro-climatic conditions*	One *(1)*
Product, process, and services Compilation of hyperspectral images of different rootcrops recorded at different stages of growth *Recorded hyperspectral images will be placed in a structured directory with appropriate filenames* Copyright of the spectral images *Filed at the National Library* Technical information on the production of rootcrops *Provision of technical support on rootcrop production including proper cultural practices, IPM, and INM*	Three (3) Three (3) per request
Publication Scientific papers Handbook *Crop production management guides* *Characteristics of Rootcrop Varieties*	Five (5) Two (2)

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