West Virginia State University Combined Research and Extension Plan of Work
2020-2024

Status: Final
Date: 07/17/2019

I. Plan Overview

1. Executive Summary

West Virginia State University's (WVSU) 1890 Research and Extension Services programming are under the auspices of its Research and Public Service (RPS) Unit. The WVSU's Gus R. Douglass Land Grant Institute is the arm of the RPS Unit that officially houses the University's Agricultural and Environmental Research Station (WVSU-AERS) and the WVSU Extension Services (WVSU-ES). The Institute currently supports 37 FTE full and part-time positions across research and extension. Continuous expansion of the University's research and extension programming are a result of securing of additional resources as well as the state's stakeholders' demand for programing. Institutional efforts to more efficiently integrate research and extension (and teaching) programming are also ongoing. As the University continues to build infrastructure and capacity, and is able to secure additional funding sources, existing research and extension programs are further strengthened and new programming is being developed to better serve the needs of stakeholders.

WVSU's mission and that of the Institute continue to be one of delivering educational and life-long learning opportunities by conducting research, teaching and outreach services to improve the well-being of West Virginia citizens (particularly those traditionally under-served). Federal support has been a key factor for the successful implementation for the University's and Institute missions. Along with the attainment of additional state appropriations and other non-federal resources, the University carries on efforts to strengthen and extend its research and extension programming capacity and programs.

This new Plan of Work for the University's Research (Section 1445) and Extension (Section 1444) provides renewed opportunities to align the University, State and Federal priorities. Efforts to align the outgoing plan of work proved highly beneficial because it allowed for the University to identify where programs complement each other; as well as, where there are opportunities to build greater collaboration and identify pathways for new integrated efforts.

Along with the aforementioned growth in terms of its research in extension programming, the University has also been able to further its academic endeavors. The University's Masters of Science in Biotechnology program keeps strengthening by the infusion of research activities. Implementation of new graduate (e.g. Computer Sciences) and undergraduate (e.g. Mechanical, Civil and Chemical Engineering) programs in the STEM fields, within the WVSU College of Natural Sciences and Mathematics, are also expected to translate into benefits and opportunities for research activities. The well-established institutional split appointment system, including graduate research faculty between the academic colleges and the Institute has resulted in increased participation of undergraduate and graduate students in agricultural and environmental research.

Federal support is a key success factor for the WVSU-GRDI. WVSU has recently secured a 100% match (dung its FY 2020) and additional state support, which along with other resources will permit the University to carry on efforts to strengthen and extend its research and extension programming capacity and programs. The following report provides details of the programs supported by Evans-Allen, Section 1444 Program and McIntire-Stennis formula funds appropriated to 1890 Institutions and matching funds provided by the State of West Virginia.

The WVSU's new five-year plan of work has identified six critical areas based on ongoing stakeholder input as well as identified emerging issues within the State of West Virginia:

Food Access, Security and Safety, and Sustainable Agriculture

Climate Change and Natural Resources Management

Health Disparities

Community Revitalization

Strengthening Youth and Families

Innovation and Entrepreneurship

The following narrative presents a summary of each of these identified critical areas, including more particulars of their proposed components in terms of extension services and research programs.

I. Food Access, Security and Safety & Sustainable Agriculture

Both, in urban and rural areas in West Virginia, access to healthy and safe fresh food is a challenge for vulnerable populations. Increased sustainable production of agricultural products and food, implementation of proper processing/handling of food and food products, as well as improved access to quality fresh food and food products are key issues to increase food security in West Virginia. The Appalachian Region has unique threats and opportunities as it relates to environmental, water, energy, food and natural resources management. All of these issues are interrelated and have a significant impact on agricultural and economic activities throughout the state. WVSU has already research and extension programs which address some of these concerns. The new Plan of Work provides an opportunity to continue strengthening existing programming and establishing new ones.

The number of farms is still increasing in West Virginia with the majority being owned by families or an individual. However the average farm size in WV is less than half that of the rest the country with the majority in the 1-9 acre size and farm sales of less than $2,500. Our proposed plan to work on an array of research and extension programs to support the diversity of enterprises for current and future farmers in our state. Continuing research programs to improve specialty crops such as tomatoes, peppers and melons will support farmers in the state of West Virginia.

Proposed Key Emphasis Area(s) and Programs: Sustainable agricultural production systems; plant genome, genetics, and genetic mechanisms; plant biological efficiency and abiotic stress effects; conservation systems; alternative agriculture.

A. EXTENSION SERVICES

WVSU-ES will work with local agency partnerships to deliver conservation systems training including conventional and alternative agricultural practices involving high tunnel production, season extension, pollinator habitat, composting and organic soil building. These methods provide small landholding producers with greater capacity to generate a sustainable food platform, making healthier meal options available to local and regional populations. WVSUES sustains and supports post-harvest handling training by establishing effective, inexpensive on-farm cold chain systems and fostering food safety awareness, risk management, and cold storage aggregation while bolstering technical skills necessary to improve product quality and extend market reach. Ongoing support for community gardens and the development of accessible Agriculture demonstration sites with urban, peri-urban, and disenfranchised community applications further contribute to these efforts.

B. RESEARCH PROGRAMS

1. Specialty Crop Breeding and Production (LIELD): West Virginia’s number of small farms and acreage owned by a family or individuals growing vegetables in the field has not changed between the 2007 and 2012 Agriculture Census, however the number of square feet under protection for vegetables and fresh cut herbs has more than doubled (188,580 in 2007 vs. 440,028 in 2012). Tomatoes make up the largest percentage of crops grown in protected culture at 56% compared to 86% in 2007. Even with fewer square feet in tomatoes it is still the highest value at over $3.7 million in 2012.

Most protected culture WV tomato growers are interested in the typical beefsteak types, but also grow vintage lines which lack pest resistances found in newer varieties. No public institution is breeding tomatoes for protected culture which is the fasted growing segment of the tomato industry (Calvin, Thornsbury and Cook 2013). This program has the goal of developing pest resistant fresh market tomato varieties with superior organoleptic traits for protected culture production (greenhouse and/or high tunnel). Specific Objectives are: (1) to verify existing and develop new markers for traits of interest; and (2) to incorporate identified traits into tomato breeding lines and vintage varieties with superior organoleptic qualities to be used in developing new open pollinated lines and hybrids. The following hypothesis and methodology are proposed for each objective: Objective 1: Verify existing and develop new markers for traits of interest. Details of new known markers will be obtained from published reports included primers sequence, restriction enzymes, the expected restriction products and varieties with known genotypes using methods used in the lab with Tm-2a with resistance to TMV. Other traits to interest are: tomato spotted wilt virus (Sw-5), Verticillium (Ve), Fusarium (I, I-1, I-2, I-3), and leaf mold (Cf-1, Cf-2, Cf-4, Cf-5 and Cf-9). Once markers match the criteria virtually, genomic DNA will be isolated from young leaves using a modified CTAB protocol to extract samples in a 96 well plate format. PCR will be performed depending on the primer combinations. Amplification of the PCR product will be verified by on an agarose gel and photodocumented. Digestion of amplicons will be performed using specified conditions of the restriction enzyme used. Restricted amplicons will be run on an agarose gel and will be verified by on an agarose gel and photodocumented for analysis. Objective 2: Incorporate identified traits into tomato breeding lines and vintage varieties with superior organoleptic qualities to be used in developing new open pollinated lines and hybrids. In developing a fresh market red round tomato fruit we have advanced breeding lines that will be used. We also have started adding resistances to vintage varieties (Brandywine, Cherokee Purple and Mortgage Lifter) that do not possess resistances to the main pests in protected culture. Thus, we will use markers evaluated in our lab to introduce the resistance and then backcross to the advanced or vintage line selecting for type using phenotypic and background selection as necessary. From this we will work to develop open pollinated lines or potential hybrids with superior organoleptic traits as well as insect or disease resistance traits.

The inputs requested to conduct this research include: (1) Salaries for PI, technician and graduate student'; (2) Support for the Research Station Manager and Staff: (3) funds to hire an undergraduate student during the academic year ($6,400 = 20 hr/wk x 32 weeks x $10/hr); (4) Supplies to grow plants in the greenhouse, harvest and process the fruit ($2,000/year), use leaf tissue to extract DNA and run molecular markers for associated traits (i.e. Tm-2a for TMV resistance, Mi for nematode resistance, etc), beneficial insects for trials with compounds and general lab supplies (est. $10,000/year); (5) Travel funds for myself and my graduate student to attend the 2019 Tomato Breeders Roundtable/Tomato Disease Workshop and Tomato Crop Germplasm Committee in Clearwater FL Nov 17-22 (est $4,000 for registration, flight, luggage, parking, gas, rental car, hotel and per diem). The expected outputs from this research include: (1) release of improved fresh market tomato varieties for protected culture growers; (2) training of graduate and undergraduate students; (3) publication of research results; and (4) presentations at meetings. The expected outcomes from this research include the availability of tomatoes without superior taste or resistances lead to reduced tomato production in protected culture. Development and release of tomatoes with improved taste or resistance for protected culture allows WV growers a market advantage when growing and selling tomatoes from protected culture. The expected impact of this work WV growers will produce more tomatoes and earn more per square foot in protected culture than with previous tomato cultivars.

2. Genomic Tools for Pumpkin Improvement and Utilization: Pumpkin and squash species include a variety of high value crops (summer and winter squashes) that play an important role both in local diets and as export crops in the U.S. Squash and pumpkins production worldwide exceeds 20 million tons from more than 1.5 million hectares. Despite the broad and growing importance of Cucurbita genus to various agricultural, food and industrial sectors across the U.S., public investment in pumpkin genomic research has been minimal to nonexistent in contrast to any crop genome. According to the most recent classification the genus Cucurbita comprises 20 species (2n = 2x = 40). C. pepo had two domesticated subspecies, pepo and ovifera, which are the most important for processing and culinary purposes. Incidence of cancer and diabetes is increasing alarmingly in the US. The fruits, seeds or other parts of squash and pumpkins (pumpkins) possess compounds with antioxidative, anti-inflammatory, hypoglycemic and anti-hyperglycemic actions and hence are active as anticancer and antidiabetic agents. Pumpkins for processing (pie filling, puree, and baby food) and culinary seed production are important in the U.S. This research is to develop metabolomic profiles from the flesh of ripe fruits of the association populations and use genome wide sequence based markers to identify linkages and genes for nutraceuticals. Breeders routinely use morphological markers for selection such as presence of red ?esh to improve lycopene and orange flesh to select _-carotene. A majority of traits are manifested by complex inheritance represented by multiple genes. Improvement in quantitative traits is time-consuming as the mode of inheritance is complex because of epistatic interactions. Good examples of this problem are the devastating diseases, powdery mildew and Fusarium wilt. Developing

new cultivars possessing nutraceutical traits combined with disease resistance has thus far proven dif?cult, and has been identi?ed by producers as the major problems needing identification of linked markers for the important alleles and further marker assisted selection to pyramid into the cultivars. The primary goal of our program is to use genomic assisted characterization of nutraceutically enriched pumpkin germplasm.

The hypothesis and methodology for this program focus on the lack of knowledge about the genes controlling flavor and fruit architecture in pepper germplasm that is relevant to breeding. GWAS and genomic selection involving 300 varieties to identify genes for fruit size and various phytochemicals are being currently performed at WVSU. Expected Inputs and Outputs: WVSU has already generated extensive SNP data that can make Genome-wide Association Study (GWAS) feasible to identify molecular markers linked to phytonutrients and fruit architecture. We have identified transposable elements, resistant gene analogues, transcription factors present in whole genome of pumpkin. This genomic research will aid us to develop improved and resistant pumpkin types. Inter-species mating for introgression: We also made crosses between C. moschata (Chiriman) with C. pepo (Early sugar sweet pie), argyrosperma (Crunshaw) and maxima (Blue Hubberd). We currently have F6 populations of these introgressed populations. Expected Outcomes: The most tangible outcome of this project will be improved pumpkin pre-breeding lines for phytonutrients and possess diverse shapes suitable for consumer acceptance. Cucurbita pepo genome is fully sequenced by our research team. Additionally, we identified pumpkin types that have high antioxidants and tocopherols that can be used for nutraceutical purposes. Expected Impacts: Breeding lines, Genes, markers and marker panels linked to resistant breeding program in pumpkin will be freely shared with all the researchers of pumpkin to foster new linkages and collaborations. SNP polymorphism data and associated markers and genes for various traits will be made publicly available. Prebreeding lines will be registered and shared for use in plant breeding. This resource will facilitate the selection of novel traits for the introgression of exotic germplasm into elite backgrounds. We plan to submit primer sequences, genotyping and the quantitative data related to germplasm evaluation and mapping information identified marker panels to the International Cucurbit Genomics Initiative (http://www.icugi.org/). We will also present our accomplishments at the annual meetings of the American Society of Horticultural Sciences, American Phytopathological Society, and the Plant & Animal Genome Conference. These abstracts will be developed into full, peer-reviewed manuscripts.

3. Phytochemical Screening of Pepper Germplasm for Developing Phenotypes with Enhanced Phytonutrients: Presently, little is known about the genes controlling flavor and fruit architecture in pepper germplasm that is relevant to breeding. We have already generated extensive SNP data that can make Genome-wide Association Study (GWAS) feasible to identify molecular markers linked to phytonutrients and fruit architecture. Using this data, we will be able to make conclusions about how best to use GWAS in pepper improvement and how variables such as traits under selection and existing population stratification would affect association accuracy. The most tangible outcome of this project will be improved pepper germplasm for phytonutrients and possess diverse shapes suitable for consumer acceptance. Objectives and Methodology: (1) Extraction and analysis of metabolites from cultivated species of Capsicum Semi-polar metabolites will be analyzed from 300 cultivated collections that belong to C. annuum, C. frutescence, C. chinense and C. baccatum. Metabolite extraction will be performed according to standard protocols. All extracts will be analyzed by reverse-phase liquid chromatography (Waters Alliance HPLC 2695). (2) High-throughput genotyping by sequencing an entire cultivated Capsicum complex GBS will be carried out following the protocol standardized by Elshire et al. (2011). We have already completed GBS for two pepper species. (3) Association mapping using genome-wide polymorphisms (GWAS) for location of dynamic QTLs/markers of importance across the fruit development GWAS will be performed using standard procedures developed in our laboratory.

Proposed inputs to conduct this research include greenhouse (36 x 96 feet) with temperature, humidity and light control. Expected outcomes form this program include: (1) Accessions with enhanced nutraceutical compounds will be made available to the pepper breeding community through publications and germplasm releases. (2) Information regarding novel phytochemicals and their importance, will made available through web postings, extension venues and publications. (3) Genomics databases, tools, and bioinformatics platforms to facilitate genomics-assisted breeding will be made available through workshops, publications, and the Sol genes website (http://solgenomics.net/). (4) SNPs, genes and sequence information for nutraceutical traits will be made available to the breeding community through publications and web-based databases. (5) Improved germplasm and breeding lines for use in cultivar development will be made available to seed companies through publications and germplasm releases. The expected impact of this research program will be to make available pepper pre-breeding lines with enhanced nutrients identified in this project, which will in turn are expected to have better market value than current available cultivars.

4. Effects of Alternative Feed Ingredients on Gut Microbiome, Mitochondrial Function and Fish Health: Aquaculture

production is one of the fastest growing food industries and the growth of the aquaculture industry is dependent on the availability low cost aquafeeds. The cost of aquafeeds is so high because aquafeeds are dependent on fishmeal and fish oil which are unsustainable. Plant feedstuffs are commonly utilized as key alternative protein sources because of competitive prices and relative availability. However, plant protein is unable to replace the higher amount of fish meal due to anti-nutritional factors and relatively poor protein quality, therefore there is a need to explore alternative ingredients. The development of alternative feeds and adaptation of fish to the new feed are crucial for the expansion of sustainable finfish aquaculture production and development of alternatives to fish meal and fish oil. The identification of solutions to the challenge of replacing fish meal and fish oil in future feeds requires the use of genomics to develop a better understanding of molecular mechanisms that underlie nutritional efficiencies for the utilization of such alternatives. The understanding of which gut microbiomes and genes that control important performance traits, such as disease resistance, feed efficiency, growth rate, and tolerance to environmental stressors will be critical. Such development of alternative aquafeeds for sustainable aquaculture production may require combination of different sources of alternative feed ingredient sources from both plant-based and insect world, since protein derived from insects is recognized as an alternative feed ingredient. Insects are a big source of animal protein and there is need to find ways of growing them for human and animal food. Insect meal as an alternative protein source in aquafeeds is a promising candidate both to meet the growing demand for animal protein and for increasing the sustainability of aquaculture production systems in the long run. The overall focus of the research is to evaluate different combinations of plant-based protein and oil sources, insect-based protein and oil sources, and different animal-based fats from poultry, swine and beef processing on growth, gut microbiome, mitochondrial energetic efficiency and health of cultured finfishes. Thus, WVSU aquaculture research program focuses on identifying solutions to the challenges associated with developing viable alternate protein and oil sources for aquafeeds. This main inquiry of research program is to identify the potential alternatives to feeding fish and fish oil to fish.

The specific objectives proposed for this research program include: (1) Characterize and compare effects of fish versus plant-based and insect-based oils on growth, mitochondrial energetic efficiency and gut microbiome; 2. Characterize and compare effects of feeding plant oil, insect oil, rendered animal oils, and blended oils on growth, mitochondrial energetic efficiency and gut microbiome; 3. Evaluate effects of proteins derived fish meal, plant-based and insect meal on growth, mitochondrial energetic efficiency and gut microbiome. The main hypotheses and methodology of this program are: Fish meal and fish oil are not nutritionally required for farmed fish to grow and can be replaced by alternative feed ingredients. Feeding trials and standard growth performance characteristics measurements of feed, nutrient utilization efficiency. Mitochondria enzyme complex activities function and gut microbiome functional analyses, cysteine ribosomal.

The requested inputs to conduct this research program include the required fish stock, alternative feed ingredients, research scientists, equipment. Expected outputs from this program include: (a) number of underrepresented (Minorities) undergraduates that will participate in this project and will be compensated with stipends from grant funds (Expected number 4); (b) number of graduate students participants that will be compensated with assistantships from grant funds and earning MS degree in Biotechnology (2); (c) number undergraduates participants in this project under directed student research earning credits toward their graduation (not paid) (3); number of peer-reviewed publications that will result from this project (3); number of scientific presentations at conferences (including students) (4); number of collaborations developed between scientists (7); number of workshops at which reports will be presented (3); and data for the development and potential commercialization of promising alternative dietary ingredients for aquaculture feeds that is crucial to the expansion of sustainable finfish aquaculture production. Expected outcomes (products and results) of this program include: (1) Providing an understanding of the effects of marine-free meals and oil on fish growth, mitochondrial function, gut microbiome and fish health will help guide future research and diet formulation and development of sustainable aquafeeds; (2) Advancement of the knowledge on the impact of marine-free oil on the genomics that may permanently alter the organism's physiology and metabolism that could be exploited in genetic improvement of the species; (3) It is anticipated that 2-3 out of 7 possible minorities and/or undergraduates that participated in this project will pursue their graduate education; (4) Training of 2 graduate students in aquaculture, fish nutrigenomics, oral and poster presentations, and scientific writing. The main expected impact of this research program is the development of low cost sustainable aquafeeds, which in turns can translate into increased profitability for aquaculture producers.

5. Assessing the Status of Pollinators in West Virginia: One of the most significant contemporary environmental (and economic) issues facing our planet is the decline of pollinators. Over three-quarters of the more than 350,000 species of the world's flowering plants (angiospems) rely on pollinators—animals that carry pollen from the male to the female parts of flowers for reproduction. Pollinators are vital to agriculture because most fruit, vegetable, seed crops and other crops

(that provide fiber, drugs, and fuel) are pollinated by animals. Bee-pollinated forage and hay crops, such as alfalfa and clover, also are used to feed the animals that supply meat and dairy products. Insect-pollinated crops generally provide higher yields to growers than do crops pollinated in other ways. Among the various pollinator groups, evidence for decline in North America is most compelling for the honey bee, Apis mellifera. Honey bees enable the production of no fewer than 90 commercially grown crops, and beekeeping is a large commercial industry that leases honey bee colonies for pollination services across the continent. Additionally, bumble bees (Bombus spp.), the native social pollinators of the Americas, have been experiencing an alarming decline over the past 50 years. In A. mellifera the decline has been attributed to a combination of symptoms (e.g., Varroa mites, the microsporidian fungus Nosema, viruses, pesticides) collectively referred to as colony collapse disorder or CCD. CCD is not believed to be responsible for declines in Bombus; rather, some as yet unknown environmental factor is hypothesized to have dramatically affected the distribution and abundance of several bumble bee species (e.g., B. terricola, B. affinis and B. pensylvanicus in the eastern U.S.) and in some instances leading to local extinctions. Due to the paucity of information regarding the status of pollinator insects in WV, data generated from this project will establish the foundation for our understanding of the local diversity of these insects. Additionally, it will also provide valuable information regarding the possible decline of these important insects. While there are myriad species of pollinators across a wide range of animal taxa, the proposed research will focus on insect pollinators in the Order Hymenoptera (honey bees, bumble bees, and solitary bees). Thus the main proposed research inquiries of this program include: (1) what is the composition of the pollinator fauna in WV, and has the composition of the community changed from that of previous years?

(2) While it is known that the composition of the bumble bee fauna here in WV has changed, what factors are responsible for the decline of those species that have essentially disappeared? (3) What factors influence the survival of honey bees in WV?

Proposed Methods and Rationale. In order to investigate and evaluate the status of pollinators in WV, long-term studies must be performed. Due to the ubiquity of native and agricultural host plants and their pollinators, it allows for research to be conducted using a variety of methodologies and locations. Thus, for Question 1, I plan to establish several pollinator gardens which will allow for easy sampling of visiting species either by myself or by trained student researchers. These data will allow for the establishment of a database for the pollinators of the area on native host plants. For Question 2, I have been involved in a long-term census study of the bumble bees of WV that has provided a wealth of foundational data regarding the current status of many bumble bee species as well as trends extending back over the last century. To address the question of what has caused the demographic shift in species, I will use established techniques to assess potential mortality factors and compare those across different species. Additionally, I will assess whether a shift in host plant demographics or habitat destruction may affected the declining species. For Question 3, I will set up a small number of honey bee colonies in different locations and assess them for overall colony health, growth, fecundity and mortality. Thus, the sustainability of honey bees as pollinators can be assessed for non-commercial beekeepers, but also, the data collected can be used to determine the impact of CCD here in WV, where some of the aforementioned symptomologies are not prevalent.

Expected Inputs and Outputs. Resources required for the proposed research are standard gardening supplies, including plants, insect collecting supplies and beekeeping supplies. Student workers will be used to supplement that of the PI. The outputs will data regarding the status of pollinator Hymenoptera, as well as factors that are influencing the decline of certain species of these insects. Expected Outcomes. The research questions will be answered by conducting basic field research at a number of on and off-campus locations. Laboratory work will be conducted using facilities located on the WVSU campus. Expected impacts. This research will increase our understanding of the pollinator species in WV and the factors that may be influencing their survival. Additionally, since WV lags behind other states in entomological research, the data generated with the proposed research will increase the profile of WV by contributing to the worldwide question of “Why are the bees disappearing?” Additionally, this research will enable WVSU to be at the forefront of extension activities regarding bees and beekeepers, and thus relevant stakeholders will be undergraduate and graduate students, extension agents, local farmers and beekeepers, entomologists and ecologists.

II. Climate Change, Energy and Natural Resources Management

The Appalachian Region has unique threats and opportunities as it relates to environmental, water, energy and natural resources management. On-going activities of the extractive industries and legacy of point and nonpoint sources of pollution continue to be major environmental and ecological issues affecting West Virginia’s agriculture, natural resources, its land management, and the wellbeing of its communities. Looking forward, West Virginia seeks to develop sustainable

alternative energy sources, address legacy problems, and to deal with fallout from climate change. Protection and restoration of environmental quality and ecosystem services and the development of economically effective and environmentally sound and sustainable resource management practices, while effectively mitigating the effects of climate change, are essential steps for the prosperity of the state. On-going activities of the extractive industries and legacy of point and nonpoint sources of pollution continue to be major environmental and ecological issues affecting West Virginia natural resources and communities' well-being. Looking forward, West Virginia seeks to develop environmentally sustainable energy alternative sources, address legacy problems, and to deal with fallout from climate change. WVSU research will be directed at study, protect and restore environmental quality and ecosystem services while developing economically effective and environmentally sound and sustainable management practices for bioenergy/bioproducts, agriculture, forestry, mining, and rural communities and anticipating and adapting to climate change.

Proposed Key Emphasis Area(s) and Programs: Environmental systems; bioeconomy; bioenergy; pollution prevention and mitigation; management and sustainability of forest resources; waste disposal, recycling and reuse; maintenance and resilience of watershed and river ecosystem services; water quality: impact of watershed disturbances: conversion of waste biomass into bio-products; climate change; alternative energy to production systems.

A. EXTENSION SERVICES

WVSU-ES will address climate change via application of alternative energy to production systems and through urban forestry. Emphasis on solar-powered, scalable aquaponics and hydroponics units opens production opportunities in remote areas and assists producers in managing costs and risks. Urban forestry programs aid in development of urban and peri-urban canopies to offset carbon footprints, provide remediation, and enrich aesthetics for institutions and communities. To this end, WVSUES also investigates the value and efficacy of establishing productive wildscapes on transitional lands, and continues to work with farmers to identify avenues of adaptation, appropriate crop choices, and methods in order to mitigate the negatives and find positives in climate change.

B. RESEARCH PROGRAMS

1. Land Management for Agricultural Production and Sustainability of Forest Resources in West Virginia. West Virginia is a natural resources rich state, the extraction and production thereof needs to be done in a manner that ecosystem services, such as productive lands and water quality are improved, sustained, and/or properly restored. The main goal of the natural resources management research program at WVSU is to develop knowledge, technology, and best management practices (BMP), addressing legacy, contemporary, and emerging needs and issues associated with the extractive industry and agronomic land use in the Appalachian region in both urban and rural landscapes. This also includes exploring economic opportunities associated with natural resources and land use (e.g. new crops and adaptation thereof, resource recovery, etc.), as well as evaluating environmentally sound use and management of existing and emerging contaminants in soil and water. The overarching working hypothesis is that sound understanding of underlying biogeochemical processes in the soil-water-plant-microbiome nexus is essential for proper management of natural soil systems and in developing management practices and technologies to assure agronomic beneficial and environmentally sound use of natural resources. The natural resources management research program is working closely with privet industry and landowners, as well as with local, state and federal government and agencies to identify needs and priorities of local regional and national concern. Main on-going and foresee objectives are: determine impact of surface mining reclamation on soil biogeochemical processes and soil water quality; the effect of different mine reclamation practices on soil productivity, site and watershed hydrology and water quality; Evaluate the effect of feedstock and production conditions on product properties, application, and use of biochar (a charcoal like carbon-rich solids from pyrolysis operations) as soil additive to the region's poor soils and/or as bulk sorbent to remove contaminant from surface water runoff from different land use.

Bench-top wet-chemistry assays, and incubation and greenhouse and field experiments will be employed to conduct controlled lab and field experiment to test specific objectives and achieve above stated goal. The program has land use agreements with regional landowners, providing availability and accessibility to relevant sites and land use systems to implement and establish desired research platforms. The team also have fully equipped soil and water research lab to accommodate soil, plant, and water processing handling and analysis. Expected outputs and outcomes include development of technologies and BMPs, and (biochar) products, conduct field days at demonstration sites, and presentation and publication of research findings in professional and scientific meetings and journals. We expect the impact of the applied research to result in the developed technologies, products, and BMP's to be adopted by potential

privet and public end users. We expect the basic research findings to advance our overall basic understanding of natural soil systems and their response to perturbation. We expect this basic knowledge to impact the scientific community in pursue of systematic understanding and harnessing soil biogeochemical processes to improve recovery resiliency, and sustainability of ecosystem services.

2. Molecular Mechanism of Seed storage Compounds Regulation in Plants: A combination of genomic, molecular biological and biochemical analyses will be used to explore how molecular mechanisms regulate energy storage in plants, and how those mechanisms can be manipulated to increase energy storage and thus the nutritional value of the plants. WVSU undergraduate and graduate students will get hands-on experience in mutant screens, plant transformation, seed compound analysis by gas chromatography with flame ionization detector, and next-generation transcriptome sequencing. Knowledge gained from this research will unlock new and creative avenues for enhancing the molecular engineering of energy-dense crops. With increased concentrations of seed storage compounds, these crops will help to meet the growing nutritional and fuel needs of the global population. In addition, the research will strengthen and elevate plant biotechnology as a STEM field at WVSU and in the broader academic community.

Longer-term goals of this research program include identifying the mechanisms that regulate storage compounds in seeds/biomass in order to enhance the nutritive and energy capacity of plants. The programs has three specific objectives: 1) To investigate regulatory mechanisms controlling oil biosynthesis in plants, 2) To perform functional analysis of candidate genes in model system, and 3) translate basic knowledge from model system to bioenergy crops for trait improvement. This program proposes to study the morphological, physiological and metabolic indicators of model /energy crops coal mine soils tolerance. Data on plant height, leaf length, leaf width, leaf sheath length, leaf relative water content (RWC), electrolyte leakage (EL), photosynthetic rate (Pn), stomatal conductance (gs), water use efficiency (WUE), and plant yield will purse to understand the mechanism underlying coal mine tolerance and identify genes that can be used for future molecular breeding. We will use candidate approach to increase seed storage accumulation in model/energy crops using candidate genes. Changes in metabolites such as oils, starches, free sugars and glucose will be measured in the transgenic lines expressing fatty acids, and TAG/oil biosynthesis genes or enzymes alone or in combination.

The expected inputs of this program include salary support for faculty and staff, research assistantships for graduate and undergraduate students, materials and supplies, travel and equipment. Some of the expected outcomes of this program include scientific expertise in molecular biology and lipid biochemistry, plant genomic and genetic resources, academic/industry expertise, students and grower participation, facilities (plant growth chambers, greenhouse and field space). This program is expected to generate multiple transgenic plants expressing candidate genes/transcription factor will allow us to develop a crop with enhanced storage compounds in seeds without growth penalty and with higher proteins, total fatty acids, TAGs, and calorific value. It will also contribute to the field of plant biotechnology by characterizing, previously unidentified mechanisms regulating seed storage compounds in the model/ energy crops metabolic process. Finally this program is also expected to yield regionally adopted, higher yielding storage compounds plant varieties and student hands on research experience. The expected impact of this research program is the identification of critical mechanisms to significantly increasing storage compounds in energy crops growing on marginal soils may provide the key to alleviating global food and fuel/bio product shortages, reducing greenhouse gas emissions, and mitigating the detrimental effects of agriculture on the environment.

3. Managing Stability, Stress and Recovery in Anaerobic Digester Microbiomes: One approach for industrial-scale bioenergy production is to use microbial energy conversion processes. Microorganisms are the master biomass conversion machines because of their incredible metabolic versatility and the modular design of microbial communities which cooperate and subdivide multi-step processes. Converting complex organic wastes into energy requires microbial communities that are functionally stable and able to withstand environmental stress. The most fully developed microbial biomass-to-bioenergy process is anaerobic digestion (AD). AD is a biotechnology that uses mixed cultures of thousands of bacteria and archaea to breakdown high-strength organic wastes and simultaneously produce bioenergy. Anaerobic digesters vary considerably in design and operation. Two major variations in design are mesophilic versus thermophilic operating temperatures. While the overall metabolic steps for these two temperature classes are the same, considerable variation exists in microbial diversity and process performance. Mesophilic digesters are generally considered to be more stable than thermophilic, and in the United States the majority of full-scale digesters are mesophilic. However, thermophilic digestion has advantages including shorter retention times, greater solubility of substrates, higher methane production per volume of reactor, and higher pathogen kill. Unfortunately, reduced stability has hindered their implementation.

This research program’s main aim is a greater understanding of stability, stress and recovery in AD systems will improve

process control during unexpected operational disturbances. Its specific Objective include: (1) to measure stress, recovery and stability with regard to microbiome diversity, metabolism, and environmental variability using replicate lab-scale reactors; and (2) to evaluate recovery from extreme stress in a pilot-scale thermophilic digester. In order to advance our understanding of recovery from stress, long-term studies must be undertaken that measure microbial diversity and metabolism along with environmental and operational parameters. We have several long-term replicate digester experiments that have been in operation for several years. These replicate reactors represent a rare resource in the field of environmental biotechnology and can provide a wealth of data concerning the factors affecting stress and recovery in biomass-to-energy conversion processes. Objective 1. This project will measure differences in stress and recovery in relation to environmental conditions using small-scale replicate reactors and a large pilot-scale reactor. The Huber Laboratory currently has several sets of five-liter and ten-liter thermophilic reactors that have been running for several years. These will be used as experimental replicates. Objective 2. We recently completed construction of a 1000 gallon pilot-scale bioprocessing reactor facility. We will start this digester using microbial inoculum from a previous pilot digester operated at WVSU. The microorganisms from that digester were stored at ambient temperature without feed from two years. We will evaluate whether the digester microbiome can recover from this extreme stress. This study has theoretical value in terms of understanding digester stress-recovery processes, but it also has practical value because full-scale digesters do experience stress during periods of shut-down or input of toxic materials. Stakeholders will be students (undergraduate and graduate) at WVSU, and environmental engineers and biotechnologists who use anaerobic digestion or produce bioenergy with microbial consortia. The requested inputs for the program include standard chemical analysis supplies for anaerobic digestion, maintenance of digesters will be done including replacement of pumps, thermocouples, plumbing and electrical components, as needed, part-time student labor will be used. The outputs will be data concerning digester performance during stress-recovery experiments. Collaborator in the project will be Sridhar Malkaram (bioinformatics). The main expected outcome of this research program an improved process control during unexpected operational disturbances through the elucidation of stability, stress and recovery in AD systems. The expected impact of this program is increased understanding of best-management practices for handling anaerobic digesters during operational stresses.

4. Linking Microbiome Functions to Kanawha River Water Quality: Watersheds are a critical natural resource but heavily exploited throughout the United States. Watersheds provide freshwater that is needed for both consumption as well as agricultural and industrial processes. Although West Virginia lacks natural lakes, it nevertheless supports a remarkable number of rivers and streams that comprise the primary headwaters of the Kanawha River and are an important contributor to the Ohio River basin. The Kanawha watershed is therefore essential for the citizens of the Charleston metropolitan area. The watershed also represents the Appalachian Mountain physiographic province which has distinct properties compared to other regions. However, the Kanawha River has been heavily industrialized since World War I. During the post WWII period and through the 1970s, the Kanawha was even considered to be one of the most polluted rivers in the country. This was primarily due to waste from the chemical industry which greatly expanded during this time. The primary water quality processes that occur in watersheds are based on microbial functional diversity. Ecosystem services, including water quality, depend on diverse microbiomes which harbor an amazing metabolic and physiological repertoire that enables them to live in extreme environments and breakdown harmful chemicals. The diversity of functions in microbiomes also depends on environmental characteristics such as redox chemistry, pH, etc, which are affected by both natural and human inputs. Understanding how microbial diversity affects water quality requires integrating these variables through time and space. Rivers and watersheds are extremely dynamic environments because of the continuous influx of chemicals and microorganisms from the surface and subsurface. Therefore, determining the effects of anthropogenic processes (municipal discharge, agriculture, surface mining) on river water quality is challenging. To address the broad goal of understanding human-impact on river water quality, this program proposes two objectives: (1) To make long-term measurements of Kanawha River water chemistry in order to understand how terrestrial inputs from the regional landscape affect water quality; and (2) To Measure how riverine microbial processes in the Kanawha watershed are affected by human-caused environmental disturbances. In terms of proposed methodology, this research will require the coordinated sampling of microbial diversity and environmental chemistry of water and sediment. The Huber Laboratory is equipped for conducting environmental microbial diversity analyses; our current successful protocols will be used. Microbe diversity in the Kanawha watershed will be sampled using Illumina sequencing of whole metagenomes or targeted-metagenomics of specific genes. Water quality analysis will be done using deployed, automated, multi-probe sondes. Chemical analysis of sediment will be done using the facilities of the Soil Laboratory at WVSU. Stakeholders will be the West Virginia Department of Environmental Quality, students (undergraduate and graduate) at WVSU, and ecological engineers who are interested in managing watersheds to minimize the detrimental effects of pollution.

The required resources will be standard chemical analysis supplies used for soils. Water hydrology will be measured using

five automated Eureka sondes that are present in the Huber Lab. DNA sequencing will be done with a commercial vendor following competitive pricing. In addition, maintenance of sondes will be required including routine replacement of sensors, occasional replacement of entire probes as needed, and general maintenance due to deployment in the field. Part-time student labor will be used. The experimental objectives will be reached using our water quality instrumentation (sondes) and molecular environmental microbiology equipment. The outputs will be data concerning the relationship between Kanawha watershed hydrology, chemical variability, and microbiome diversity. Collaborators in the project will be Amir Hass (chemical analysis), Sridhar Malkaram (bioinformatics), and Fernando Rojano (hydrology modeling). Data will be available to WVDEP and USGS. The expected outcome is to increase our understanding of Kanawha River watershed properties that naturally maintain water quality. The impact of this programs is aimed at an increased understanding how microbial diversity affects water quality which can translate in a more secure water supply and increased quality.

5. Use of Water Modeling to Enhance Management of Agriculture Production Systems: The efficient use of water resources for agriculture activities demands research efforts which can enhance strategies for water management. Variable and high demands of water for different prevailing activities in a State or region may challenge ecosystem services in the long term. In addition to securing a reliable water supply, water usage in agriculture must comply with water quality standards that can assure safe and secure food production. The intensive and increased demand for water supply in agriculture, in the last decades, have also resulted in changes to water quality and security in diverse ecosystems. Furthermore, the increased use of fertilizers and pesticides have further deteriorated the water quality of key streams, reservoirs and estuaries; which is turn had also negatively affected the drinking-water supplies in many communities. Within this framework of complexity, sustainability of water resources must be considered with the aim to resolve adequately water quantity and quality demands by means of fundamental knowledge across various disciplines such as hydrology, ecology, water chemistry and biology. In this way, research on water for agriculture can be addressed by using process-based models combined with heuristic algorithms that may serve to elucidate optimal solutions.

This research program proposes the study of hydrologic and water quality models, using a process-based approach (widely used), as well as heuristic models. Furthermore, this research program will explore a combination of the two model systems as a promising proposition to enhance the modeling capabilities and overcome current limitations within each individual system. Emerging sciences fields, such as artificial intelligence and heuristic optimization, are planned to be integrated to assist in a forward step of complex models that can be solved by parallel computing. The expected outcome and impact o this program is the development of hybrid models, which will be fed by reliable existing data sources and sensing systems, to develop and provide a decision support system capable to guarantee water supply for agriculture. The major aimed impact of this program is to assist farmers managing more effectively their agriculture practices through the use of these modeling tools and associated technologies.

III. Health Disparities

People living in both rural and urban communities in WV experience disparities related to physical and behavioral health which has a significant impact on their overall well-being. These health disparities are often a result of poverty, lack of gainful employment, and poor or no access to basic resources. Furthermore, the current opioid epidemic, affecting families in urban and rural communities, compounds these problems. National statistics reflect that in West Virginia the diabetes mortality rate is 53% higher than the rest of the nation, the average adult feels mentally unhealthy 31% more often than the average American , and the years of potential life lost is 47% higher than the rest of the country. Focused research and outreach programing can assist in tackling health disparities and improving the well-being of WV communities.

Many people living in both rural and urban communities in WV experience disparities related to physical and behavioral health and well-being. These disparities are often a result of poverty, lack of gainful employment, and lack of access to resources. The opioid epidemic compounds these issues further.

Proposed Key Emphasis Area(s) and Programs: Family & Consumer Sciences, Human Nutrition; EFNEP- Adult (Target population – recovering addicts); EFNEP – Youth (Target population – minority and underserved children)

A. EXTENSION SERVICES

WVSU-ES currently delivers the federal funded Expanded Food and Nutrition Education Program (EFNEP) designed to assist limited-resource children and families in improving nutritional well-being and health through a series of practical

lessons on basic nutrition and healthy lifestyles, resource management and food safety. Our Adult EFNEP program will continue to target recovering addicts with a special emphasis on new mothers in addiction recovery services. Our Youth EFNEP program will target middle school children in low social economic areas of the Kanawha Valley. Additionally, our patient-physician communication program, “Can You Repeat That Please?,” teaches participants how to effectively manage their health care visits and includes a comprehensive health history journal to take along. WVSU-ES plans to expand the portfolio of programs addressing health disparities in West Virginia over the next five years and as such will hire a new Nutrition Specialist/Assistant Research Professor for Human Nutrition. This new position will support current health related programs, develop new Extensions programs addressing human health concerns for the people of West Virginia and will develop a complementary research program focused on human health.

B. RESEARCH PROGRAMS

There is currently no proposed research programs within the critical area. As this Plan of Work enfolds, future opportunities to embed research programing will be explored.

IV. Community Revitalization

Several communities in WV continue suffering from economic hardship brought on by the decline of its extractive (e.g. coal), chemical and other industries. The lack of economic opportunities in these communities result in them losing their sense of purpose and identity, making it more difficult to attract new businesses to empty storefronts. Moreover, these communities also have a difficult time to attract new residents or gradually lose their existing ones. Organization and revitalization efforts are needed to restore a sense of community to these locations and attract new businesses and residents for a future of economic prosperity.

Many communities in WV suffer from economic hardship brought on by the exit of extractive (e.g. coal) and other industries. These communities lose a sense of purpose and identity making it difficult to attract new businesses to empty store fronts.

Proposed Key Emphasis Area(s) and Programs: Community revitalization, Public Art, Street Scaping; Green Space Development.

A. EXTENSION SERVICES

The southern coal field communities of West Virginia have been adversely impacted by the decline of coal mining. Once thriving towns have been reduced to abandoned store fronts and empty main streets. WVSU-ES has developed partnerships with organizations in several southern West Virginia counties in order to provide targeted community revitalizations efforts. Projects include beautification through public art, street scaping and green space development, community event organization, outdoor recreation development, and placemaking/heritage initiatives.

Suggested Science Emphasis Area(s): Community development through public art projects; Tourism development; Placemaking; Business development

B. RESEARCH PROGRAMS

There is currently no proposed research programs within the critical area. As this Plan of Work enfolds, future opportunities to embed research programing will be explored.

V. Strengthening Youth and Families

Poverty and the opioid epidemic are two critical issues which are changing the dynamic of families in WV and negatively impacting the future of its youth. The changing family structure resulting in more non-parental relatives raising children in WV results in mental and financial stress for those individuals impacted. Youth living in low socioeconomic areas are academically disadvantaged and at increased risk of behavioral health issues. These issues are especially pronounced for youth impacted by the opioid (and other drugs) epidemic who tend to experience frequent traumatic events.

Poverty and the opioid epidemic are two issues which are changing the dynamic of families in WV and negatively

impacting the future of our youth. The changing family structure resulting in more non-parental relatives raising children in WV results in mental and financial stress for the individuals impacted. Youth living in low socioeconomic areas are academically disadvantaged and at increased risk of behavioral health issues. These issues are especially pronounced for youth impacted by the opioid (and other drugs) epidemic.

Proposed Key Emphasis Area(s) and Programs: Youth Development; Healthy Grandfamilies; Hands on STEM Activities for youth; Youth Mentoring; Mental health first aid for youth

A. EXTENSION SERVICES

The WVSU-ES 4H Youth Development team is focused on enhancing personal and professional development in youth statewide by following the 4-H mission of hands-on learning and education programs for kids to build skills like responsibility, resiliency and hard work, which will help them succeed in life. In order to meet the needs of these individuals, we engage in adaptive programming that adjusts to the changing times. Our programming consists of hands-on experiences that allow k-8 students to learn about science, nutrition, technology and entrepreneurship utilizing curriculum that is research based. In addition, we also train preschool and primary school educators in order to improve their science content knowledge and their ability to teach science, agriculture and other STEM subjects. Moving forward, our program will also engage in new efforts to address the increase of youth who are forced to cope with parents who are dealing with substance abuse issues. As such, local community leaders in the school system need assistance with understanding how to best help these individuals. In order to help youth across the state we will be focusing on developing programs for mental health first aid. In addition to improving student's mental health toolbox, our programs will help youth recognize their potential by teaching entrepreneurship, connect to nature and nutrition through youth agriculture, and prepare for the next step by developing life skills and college readiness. Some specific efforts which will be supported during this cycle are:

1. 4-H Family GROWTH
The 4-H Family GROWTH literacy program represents (G)ardening, (R)eading, (O)pportunity, (W)ellness, (T)eamwork and (H)ealth. It provides youth in grades K-5 the opportunity to be involved in gardening during and after school with parents and other adults, reading books that relate to health and gardening, exploring the world with outdoor activities, and enhancing wellness through physical activity, nutrition and teamwork.

2. The SCRATCH Project: The Sustainable Community Revitalization Through Children's Hands (SCRATCH) Project brings together inquiry-based science, real-world technology and outdoor education at the elementary level to prepare children to become problem-solvers, entrepreneurs and live a sustainable lifestyle. SCRATCH youth actively participate in the Junior Master Gardener program and receive various levels of certification based on JMG curricula. The SCRATCH Project also includes development and implementation of several backyard edible gardens, greenhouse production, hydroponic/aeroponic growing and a specialization in high-yield urban gardening for end-product production in support of local foods initiatives in Cabell County. As their garden crops are harvested, youth are learning about business and entrepreneurship by selling their products to local farmers markets and restaurants.

3. Youth Mentoring Program
The 4-H Mentoring Program targets youth ages 10-14 and their families. We use culturally appropriate, early-intervention strategies during interactions such as one-to one and group mentoring, involvement in 4-H clubs and family activities. The program is designed to increase youths' interpersonal competence, improve their academic performance and strengthen family relationships.

The WVSU Healthy Grandfamilies Program (HGP) seeks to strengthen families impacted by the opioid epidemic by connecting grandparents raising grandchildren to social services and other resources. West Virginia is second in the nation in the percentage of children being raised by grandparents. Topics covered in the program include parenting in the 21st century, family dynamics, communication in a technology driven society, technology and social media pros and cons, balancing health diets with a busy lifestyle, legal issues, navigating the public school system, etc. Additionally, participants receive one-on one consultations with local social workers. During this cycle the HGP will expand to provide services to all 55 counties in West Virginia.

B. RESEARCH PROGRAMS

There is currently no proposed research programs within the critical area. As this Plan of Work enfolds, future opportunities to embed research programing will be explored.

VI. Innovation and Entrepreneurship

The Gus R. Douglass Land-Grant Institute operates a collaborative Center for the Advancement of Science, Technology, Engineering, and Mathematics (CASTEM) which mission is that of encouraging West Virginia's youth to pursue careers in STEM fields and inspire them to become future engineers, scientists, researchers, teachers and leaders. We accomplish this by providing STEM education activities, programs, and research opportunities starting at K-12 grades and extending to the university level. WVSU CASTEM offers academic year science classes, summer day camps, and loan programs for educators to borrow equipment and supplies. Academic year classes focus on STEM topics that are offered in five class modules such as ecology, robotics, astronomy, forensic science, physics, chemistry, and computer science. Summer camps are often done in collaboration with the Health Sciences and Technology Academy (HSTA) and the Summer Transportation Institute (STI). These programs give students a chance to learn and gain experience in the biomedical field and STEM professions related to transportation. CASTEM staff also travels to local schools within the community to deliver STEM curriculum enhancement activities. In order to assist undergraduate students, we help place them with faculty mentors in our Research Rookies program during their freshman and sophomore years. Collaborative efforts with universities across WV and KY allow us to work together to create, enhance, and expand programs designed to broaden participation and increase the quality and quantity of students from underrepresented populations who receive degrees in STEM.

Proposed Key Emphasis Area(s) and Programs: Economic Development Center; The Opening Soon, Inc.

A. EXTENSION SERVICES

WVSU-ES also operates an Economic Development Center (EDC) which provides low cost office rentals, voice and capture studios and business services. The EDC will continue to assist early-stage startups in technology, creative and interactive media industries through a peer-based mentoring system with additional support from business mentors, community and state organizations. The Opening Soon, Inc program will work within the EDC to support early stage entrepreneurs to take their idea to market.

B. RESEARCH PROGRAMS

There is currently no proposed research programs within the critical area. As this Plan of Work enfolds, future opportunities to embed research programing will be explored.

2. FTE Estimates

Year	1890 Extension	1890 Research
2020	20.0	17.0
2021	21.0	18.0
2022	22.0	19.0
2023	23.0	20.0
2024	24.0	21.0

II. Merit / Peer Review Process

All research proposals in relation to projects sponsored through the Evans-Allen program (and associated state match) undergo a structured peer review by an external panel. The reviewers for the external panel are selected nationally and include prominent and active scientists with research expertise on the associated respective fields of study. Reviewers provide valuable and detail feedback for these projects based on an established review format, including relevant suggestions for improvement. Their input is then reviewed internally and incorporated to the proposals prior to their

submission to NIFA.

The University's Research and Public Service (RPS) unit will invite faculty members from all academic Colleges to submit proposals that are congruent with the University's Plan of Work and associated USDA-NIFA strategic research areas. Eligible proposals will undergo an internal merit evaluation (e.g. participating faculty in Evans-Allen programs, research associate and research directors). Proposals are evaluated for its intellectual merit as well as proposed broader impacts. Successful proposals will be further expanded into a full proposal for external peer review.

1890 Extension funds (and associated state match) are typically used to enhance, expand, or otherwise complement funds that have been successfully obtained through a competitive grant process and as such, the associated projects have been approved by and deemed relevant and appropriate by the funding agency.

All external grant submissions for both Research and Extension must complete an internal review process prior to submission to the sponsored agency. All 1890 Research and Extension programs conducted by employees are subject to annual performance evaluations.

III. Stakeholder Input

1. Actions to Seek

Stakeholder input is collected on a continual basis for both Research and Extension programs.

During this new Plan of Work, WVSU will explore opportunities to reenergize its external stakeholder's advisory group (Research and Extension Advisory Committee -REAC) in order to extract and continue securing valuable formal feedback. New Advisors will be officially invited to be part of this endeavor through a formal invitation. Advisors can remain for up to 5 years (e.g. Plan of Work five-year cycle). Advisors will be asked to provide stakeholder input through two semiannual surveys (e.g. January and June) as well as via one face-to-face annual campus visit. During the annual campus visit (June of July), all the Advisors will come together for the first part of the meeting (first 1.5 hours). During this general session, Advisors will be presented with a summary of all inputs derived from their individual advice. During the general session, Advisors will also be given the opportunity to voice their input related to potential integration activities between the research and extension programming they may have identified. During the second part of the meeting (last 2 hours), Advisors will go into smaller groups based on their relevant fields of expertise of areas of engagement (or advising). During the small group sessions, Advisors will be presented with specific given input or advice for further recommendation. Stakeholder inputs will be collected, reviewed, and incorporated into research and extension programs, whenever feasible. This advice and the ways in which was incorporated will be reported annually through the Annual Report of Accomplishments.

Within the research side, each scientist participating in the Evans-Allen program will also have at least one annual meeting with specific stakeholder groups. This annual meeting can be carried on via existing formats, such as field day meetings, or other formats which may be more suitable for the research area under consideration. The stakeholder input will be collected by the individual scientists and reported to the Associate and Research Directors, 30-days after the activity has taken place (by June 30 of each year).

WVSU-ES develops smaller program based advisory committees which typically meet on a biannual basis. These advisory committees are populated with local program stakeholders to help inform the direction of the targeted program on a continual basis.

Other stakeholder input and feedback is also collected informally through community meetings, at public events, during WVSU Day at the Legislature, at the state fair, through web-based surveys, and in more formal advisory committee meetings which are convened quarterly. WVSU Extension professionals work very closely with local stakeholders to ensure impactful relevant program is being delivered to the communities of WV. Program participants are given the opportunity to submit feedback through formal evaluation forms.

2. Methods to Identify

Stakeholders, including the advisory committee membership, are selected from diverse sources and represent different fields.

On the research side, each research faculty participating in the Evans-Allen program will identify and propose up to five stakeholder members. For the REAC, a list of potential stakeholders (up to five) will be required to be submitted by

Research faculty and Extension personnel. Administrators will also further identify and propose possible stakeholder participants. The final list for the REAC membership will be assembled, based on the membership acceptance, and distributed to all research and extension personnel. Typical stakeholders may include: Community leaders; Program partners; Program recipients; Collaborators Research and extension professionals at other Universities; and Local business/industry.

When stakeholders and/or advisors are lost due to relocation, lack of participation, or by request, a new advisor must be appointed within 30 days. Similarly, in the event advisors complete their 5-year terms, they can either be reappointed or replaced by new stakeholders within 30 days.

3. Methods to Collect

Stakeholder input will be collected through the advisory committees, as aforementioned proposed. Inputs from various advisors will be collected every at least 2 times a year (every 6 months) via a formal survey. The information received will be gathered and stored in a database (Digital Measures Software). Before the annual meeting (30 days prior) the advisory group will be asked to provide their 2nd survey. At the annual meeting the advisors will be presented with a summary of all their inputs for further discussion, as previously described.

Stakeholder input collected through informal means and conversations will also be collected and stored in the database.

4. How Considered

Collected input from stakeholders will be carefully reviewed and discussed among the research and extension personnel comprising the different programing areas. On the Extension side, the Extension Director and Program Leaders will lead the discussions and document the input along with their discussions. On the Research side, the Associate Research Director will meet with the research faculty engaged in all the different research areas and collectively discuss the stakeholder input received. The Associate Director will document the input along with the discussions. The goal of the group discussions is to ensure that all the stakeholder input is reviewed and understood by all the research and extension personnel. The discussions will also be useful to understand how the stakeholder input will be embedded into their programs and program improvement. This exercise will be conducted at least once annually.

IV. Critical Issues

1 Food Access, Security and Safety / Sustainable Agriculture

Description:

Both, in urban and rural areas in West Virginia, access to healthy and safe fresh food is a challenge for vulnerable populations. Increased sustainable production of agricultural products and food, implementation of proper processing/handling of food and food products, as well as improved access to quality fresh food and food products are key issues to increase food security in West Virginia.

Term: Long

Science Emphasis Areas

Environmental Systems
Food Safety
Sustainable Agricultural Production Systems

2 Climate Change and Natural Resources Management

Description:

The Appalachian Region has unique threats and opportunities as it relates to environmental, water, energy and natural resources management. On-going activities of the extractive industries and legacy of point and nonpoint sources of pollution continue to be major environmental and ecological issues affecting West Virginia's natural resources, its land management, and the wellbeing of its communities. Looking forward, West Virginia seeks to develop sustainable alternative energy sources, address legacy problems, and to deal with fallout from climate change. Protection and restoration of environmental quality and ecosystem services and the development of economically effective and environmentally sound and sustainable resource management practices, while effectively mitigating the effects of climate change, are essential steps for the prosperity of the state.

Term: Long

Science Emphasis Areas
Agroclimate Science
Bioeconomy, Bioenergy, and Bioproducts
Environmental Systems

3 Health Disparities

Description:
People living in both rural and urban communities in WV experience disparities related to physical and behavioral health which has a significant impact on their overall well-being. These health disparities are often a result of poverty, lack of gainful employment, and poor or no access to basic resources. Furthermore, the current opioid epidemic, affecting families in urban and rural communities, compounds these problems. National statistics reflect that in West Virginia the diabetes mortality rate is 53% higher than the rest of the nation, the average adult feels mentally unhealthy 31% more often than the average American , and the years of potential life lost is 47% higher than the rest of the country. Focused research and outreach programing can assist in tackling health disparities and improving the well-being of WV communities.

Term: Long

Science Emphasis Areas
Education and Multicultural Alliances
Family & Consumer Sciences
Human Nutrition
Youth Development

4 Community Revitalization

Description:
Many communities in WV continue suffering from economic hardship brought on by the decline of its extractive (e.g. coal), chemical and other industries. The lack of economic opportunities in these communities result in them losing their sense of purpose and identity, making it more difficult to attract new businesses to empty storefronts. Moreover, these communities also have a difficult time to attract new residents or gradually lose their existing ones. Organization and revitalization efforts are needed to restore a sense of community to these locations and attract new businesses and residents for a future of economic prosperity.

Term: Long

Science Emphasis Areas
Education and Multicultural Alliances

5 Strengthening Youth and Families

Description:
Poverty and the opioid epidemic are two critical issues which are changing the dynamic of families in WV and negatively impacting the future of its youth. The changing family structure resulting in more non-parental relatives raising children in WV results in mental and financial stress for those individuals impacted. Youth living in low socioeconomic areas are academically disadvantaged and at increased risk of behavioral health issues. These issues are especially pronounced for youth impacted by the opioid (and other drugs) epidemic who tend to experience frequent traumatic events.

Term: Long

Science Emphasis Areas
Education and Multicultural Alliances
Family & Consumer Sciences

Youth Development

6 Innovation and Entrepreneurship

Description:

53% of working aged adults in West Virginia are either unemployeed or have stopped pursuing viable emplyoyment opportunitites. Some of the unemployment can be addressed through boosting economic viability in West Virgia through support of a strong innovation economy. Training and business start up assistance is needed to help current or aspiring entreprenuers reach their goal of gainful emplpyeement through new business creation. A robust innovation economy requires the availability of a workforce skilled in the STEM disciplines. Many West Virginia youth come from economically and academicaly disadvantaged areas which translate into difficult entry in and sustainability of matriculation through STEM curricula.

Term: Long

Science Emphasis Areas

Education and Multicultural Alliances
Youth Development