FY 2020 Annual Report of Accomplishments and Results

West Virginia
West Virginia State University Agricultural and Environmental Research Station (WVSUAERS)
West Virginia State University Extension Service (WVSUES)

I. Report Overview

The NIFA reviewer will refer to the executive summary submitted in your FY 2020 Plan of Work located in the Institutional Profile. Use this space to provide updates if needed.

1. Executive Summary (Optional)

II. Merit and Scientific Peer Review Processes

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Process	Updates ONLY
1. The Merit Review Process	No Current Updates
2. The Scientific Peer Review Process	No Current Updates

III. Stakeholder Input

The NIFA reviewer will refer to your 2020 Plan of Work. Use this space to provide updates as needed or activities that you would like to bring to NIFA's attention.

Stakeholder Input Aspects	Updates ONLY
1. Actions taken to seek stakeholder input that encouraged their participation with a brief explanation	No Current Updates
2. Methods to identify individuals and groups and brief explanation.	No Current Updates
3. Methods for collecting stakeholder input and brief explanation.	No Current Updates
4. A Statement of how the input will be considered and brief explanation of what you learned from your stakeholders.	No Current Updates

IV. Critical Issues Table of Contents

No.	Critical Issues in order of appearance in Table V. Activities and Accomplishments
1.	Food Access, Security and Safety/Sustainable Agriculture
2.	Climate Change and Natural Resources Management
3.	Health Disparities
4.	Community Revitalization
5.	Strengthening Youth and Families
6.	Innovation and Entrepreneurship

V. Activities and Accomplishments

Please provide information for activities that represent the best work of your institution(s). In your outcome or impact statement, please include the following elements (in any order): 1) the issue and its significance (e.g. who cares and why); 2) a brief description of key activities undertaken to achieve the goals and objectives; 3) changes in knowledge, behavior, or condition resulting from the project or program's activities; 4) who benefited and how. Please weave supporting data into the narrative.

No.	Project or Program Title	Outcome/Impact Statement	Critical Issue Name or No.
1.	**Characterization of phytochemicals in pepper germplasm for developing phenotypes with enhanced phytonutrients (WVSUAERS)**	In this study, around 1,000 accessions of diverse *capsicum species* (*C. annuum, C. frutescens, C. baccatum and C. chinense*) are genotyped using GBS (genotyping by sequencing) technology. We have archived 20,000 single nucleotide polymorphisms (SNPs) that are common for all the pepper species and individual species groups have about ~50,000 SNPs each with 70% call rate and 0.05 minor allele frequencies. We resolved population structure and selective sweeps important for various fruit traits and nutraceutical traits. Capsaicin and dihydrocapsaicin was estimated for two seasons and study of conserved genetic mechanisms underlying capsaicinoids has been elucidated. We have estimated volatile compounds for 225 accessions of *C. chinense* for use in GWAS. We developed 43,081 SNPs from diverse collections of *C. chinense* to unravel the genetic mechanism underlying fruit shape variation. All these resources are available for public use. Two graduate students recently submitted thesis on fruit shape variation in pepper species. We also used 131 genotypes of *C. baccatum* L.	Food Access, Security and Safety/Sustainable Agriculture

		for vitamin C content, Carotenoids (Carotene, Cryptoxanthin, Zeaxanthin, Violaxanthin, Capsanthin, Capsorubin, Neoxanthin and Cryptoxanthin), Flavonoids (Quercetin, Kaempferol, Myricetin, Quercetin and Luteolin), and their relationship with reducing sugars in fruit pericarp. For the first time, this study provided a comprehensive data on phytochemicals in the world collection of Capsicum spp. genotypes that can serve as a key resource for functional food research in future.	
2.	**Genomic Tools for Pumpkin Improvement and Utilization (WVSUAERS)**	Multiple insert libraries were prepared for short read sequencing with insert size of 170 bp, 500 bp, 800 bp, 5000 bp, 10000 bp and 20000 bp. Genome size of the jack-o-lantern was estimated based on the kmer distribution of 380 Mb. The short read sequencing with different insert size have produced about 75 GB of data which accounts for about 200x coverage to the estimated genome size. The short read sequencing data was preprocessed and assembled *de novo* using different de novo assemblers and which have resulted in the genome assembly with more than 10,000 scaffolds with total size of about 370 Mb accounting 97% of the estimated genome size. These scaffolds were repeat masked and annotated. This genome sequence will be of immense use for identifying genes underlying various horticultural traits.	Food Access, Security and Safety/Sustainable Agriculture
3.	**LD mapping of fruit traits in combination with transcriptomics of ploidy levels in watermelons to develop high yielding seedless cultivars (WVSUAERS)**	Polyploidy has played a crucial role in plant evolution, development, and function. Synthetic autopolyploid represents an ideal system to investigate the effects of polyploidization on transcriptional regulation. In this study, we deciphered the impact of genome duplication at phenotypic and molecular levels in watermelon. Overall, 88% of the genes in tetraploid watermelon followed a >1:1 dosage effect, and accordingly, differentially expressed genes were largely upregulated. In addition, a great number of hypomethylated regions (1,688) were identified in an isogenic tetraploid watermelon. These differentially methylated regions were localized in promoters and intergenic regions and near transcriptional start sites of the identified upregulated genes, which enhances the importance of methylation in gene regulation. These changes were reflected in sophisticated higher-order chromatin structures. The genome doubling caused switching of 108 A and 626 B compartments that harbored genes associated with growth, development, and stress responses. This study provided the molecular basis for superior growth and enhanced resistance in tetraploid watermelons, which are progenitors for production of seedless watermelons. Genome-wide interacting maps revealed that A compartments were positively related to gene density and gene expression and B compartments were associated with transposable elements, and DNA methylation in CG and CHG context. Changes in	Food Access, Security and Safety/Sustainable Agriculture

		genome organization in tetraploid watermelon showed the effect of polyploidy in the rearrangement of genome compartments, which were linked to the DNA methylation and gene expression differences identified in this study.	
4.	**Genomic Tools for Watermelon Improvement and utilization (WVSUAERS)**	Grafting has been used as a sustainable alternative for watermelon breeding to control soil-borne pathogens and to increase tolerance to various abiotic stresses. However, some reports have shown that grafting can negatively affect the quality of fruits. Despite several field studies on the effects of grafting on fruit quality, the regulation of this process at the molecular level has not been revealed. The aim of this study was to elucidate various molecular mechanisms involved in different tissues of heterografted watermelon and bottle gourd plants. Grafting with bottle gourd rootstock increased the size and rind thickness of watermelon fruits, whereas that with watermelon rootstock produced bottle gourd fruits with higher total soluble solid content and thinner rinds. Correspondingly, genes related to ripening, softening, cell wall strengthening, stress response and disease resistance were differentially expressed in watermelon fruits. Moreover, genes associated mainly with sugar metabolism were differentially expressed in bottle gourd fruits. RNA-seq revealed more than 400 mobile transcripts across the heterografted sets. More than half of these were validated from PlaMoM, a database for plant mobile macromolecules. In addition, some of these mobile transcripts contained a transfer RNA-like structure. Other RNA motifs were also enriched in these transcripts, most with a biological role based on GO analysis. This transcriptome study provided a comprehensive understanding of various molecular mechanisms underlying grafted tissues in watermelon. Transcriptome changes in reciprocal grafts involving watermelon and bottle gourd reveal molecular mechanisms involved in increase of the fruit size, rind toughness and soluble solids. Altered chromatin conformation and transcriptional regulation in watermelon following genome doubling.	Food Access, Security and Safety/Sustainable Agriculture
5.	**Improving Fresh Market and Vintage Tomatoes for Protected Culture Production (WVSUAERS)**	Improving three vintage tomato lines by incorporating several resistant traits continued using the first backcross generation (BC1) to create a second backcross generation (BC2). The best cross success and average seed per fruit was found only when the vintage parent is used as the male parent in all three vintage varieties for the second backcross just as what was observed with the thirst backcross. Due to the low number of backcross seed available, self-seed from the first backcross (BC1S1) were also grown and screened for two traits, tobacco mosaic virus (TMV) and root knot nematode (RKN). Two markers were assessed for RKN, Mi23 and REX-1. Both markers gave identical results for all populations	Food Access, Security and Safety/Sustainable Agriculture

		studied. Almost all of the BC2 populations showed a reduction in heterozygotes for the TMV and RKN traits. In the BC1S1 populations there were more plants carrying both alleles for the RKN trait than expected, but no such trend was found for the TMV trait. A subset of 192 of the 384 fresh market tomato SNP panel was used to assess the similarity between the vintage varieties, the donor parent and the BC2 and BC1S1 populations. Skewed SNP markers were found on chromosomes 2, 6, 7 and 9. Skewing of SNP markers on chromosomes 9 and 6 were not unexpected as the TMV and RKN traits are found on these respective chromosomes. An increase in the percent vintage type SNP markers for both the BC2 and BC1S1 populations as compared to the BC1 was observed. Variation existed in these populations for plant morphological traits and fruit characters. In general, the BC2 plant and fruit traits were closer to the vintage type compared to the BC1S1 populations as expected. Future work should focus improving backcrossing success. An evaluation of floral traits in two vintage varieties, donor parent and four F1 hybrids was undertaken. Inflorescence types differentiated between the donor parent, a simple cyme, and the other lines, dichotomously branched cymes. Here was significant effect of the donor parent on the F1 hybrids with the vintage varieties and their reciprocal hybrids for the majority of the traits studied. However, the F1s and their reciprocal hybrids were not statistically different from one another. Principle component analysis identified five principal components that explained 85% of the total floral phenotypic variation. Two clusters were identified for the floral traits using k-means cluster analysis, which grouped the two vintage varieties into Cluster 1 and the donor parent and the four F1 hybrids in to a second cluster, this suggests the donor parent has a strong effect on the floral traits of the F1 hybrids. While the plan is to create improved vintage varieties via backcrossing, it may be worthwhile to integrate some VFNT Cherry traits such as anther length and stigma exertion to improve self-pollination and fruit formation. Because there was little variation between the F1 and reciprocal hybrids of the vintage varieties studied, future research should look at floral traits in the advanced lines to identify the reproductive barriers encountered. Evaluation was made on the use of three previously developed markers for the two Verticillium wilt genes (Ve1 and Ve2). Examining the SNP data from the current and prior generations suggests that at least one of the families may be varying a Ve resistance gene.	

6.	**Metagenomics Study of Gut Microbiome in Farmed Finfishes (WVSUAERS)**	Two feeding trials using a factorial experiment design were conducted: first study feeding trial comprised of evaluating the effects of dietary protein sources (fish meal and plant-based protein), two dietary lipid sources (100% vegetable oil [Camelina oil] and a mixture of 50% fish meal & 50% vegetable oil), and two water temperature regimens (14°C and 18°C); and the second feeding trial comprised of a mixture of animal- and vegetable-based protein sources with a mixture of animal-and vegetable-based fat, and all vegetable based fat; and only plant-based protein source with a mixture of animal-and vegetable-based fat, and all vegetable-based fat reared at three water temperatures (14, 18 and 20 C). Their effects on the growth performance, nutrient utilization efficiencies, whole-body proximate composition, mitochondrial enzyme complex activities, and gut microbiome diversity and function were evaluated in rainbow trout. Results showed that growth performance parameters such as feed efficiency (FE), and feed intake (FI) were significantly affected by diet ($P<0.05$). Nutrient utilization efficiency parameters such as protein efficiency ratio (PER), lipid efficiency ratio (LER), and protein productive value (PPV) were all significantly affected by diet ($P<0.05$). The results show that temperature had a significant main effect on complexes I, II, IV, V and citrate synthase in the intestine; complexes I, II, and citrate synthase activities in the muscle; and complexes I, II, and III activities in the liver ($P<0.05$). Diet had a significant main effect on complexes I, II, IV, V, and citrate synthase activities in the intestine; complexes I, II, III, IV, V, and citrate synthase activity in the muscle; and complexes I, II, IV, V, and citrate synthase activities in the liver. Temperature x diet interaction had significant interactive effects on citrate synthase activity in the intestine, complex II activity in the muscle, and complexes I and II activities in the liver. The results indicate that temperature affect the gut microbiome diversity and some functions ($q<0.05$). In the gut of fish reared at 18°C, there was a higher abundance of genes involved in environmental information processing, metabolism, and cellular processes. The dominant phyla were Proteobacteria and Firmicutes. The most dominant order was Mycoplasmatales. The results also show that temperature x diet interactions affected microbial functional diversity, higher temperature and higher inclusion of dietary plant ingredients correlated a higher abundance of functional genes involved in carbohydrate metabolism, virulence & diseases, and regulation & cell signaling. The results did not show any consistent significant effect of diet on the diversity and function of the rainbow trout gut microbiome. The higher enzymatic activities and numerically lower growth performance and nutrient utilization	Food Access, Security and Safety/Sustainable Agriculture

		efficiency (not significant at $p<0.05$) observed in fish reared at 18°C could suggest that the rainbow trout used in this experiment were generating significantly higher energy to maintain homeostasis or cope with stress. This same temperature effect was observed in the gut microbiome diversity and function where fish reared at 18°C displayed higher heterogeneity between samples, were enriched with more abundant taxa, and had higher abundance of genes involved in adapting to the host environment.	
7.	**Fresh to Market: Cold Chain Support for Market Expansion (WVSUES)**	West Virginia's small farms have difficulty marketing their products safely and effectively due to topography, distance to market centers, and limited resources. Nearly 90% of the state's farms gross less than $25,000 in annual sales (2017 Census of Agriculture). Although in-person workshops ceased during the pandemic, WVSUES continued to support small farms and cooperatives by providing and seasonally scheduling four mobile cooling units among program participants and three large stationary coolers on a no-cost lease basis. The Fresh to Market program directly served five small farms and four multi-farm cooperatives (consisting of 6-7 farms), primarily handling fresh fruits and vegetables, eggs, and poultry for farmers markets and CSAs. Each unit averaged $12,000-$17,000 in sales for participating farms. One cooling trailer additionally served as a means for a non-profit organization to deliver 3,000 meals to more than 1,500 adults and 3,000 youths during the pandemic at an estimated market value of $15,000. WVSUES acquired six new insulated trailers that will expand the cold chain fleet by 150 percent in 2021.	Food Access, Security and Safety/Sustainable Agriculture
8.	**Conservation Systems Training for Production Management (WVSUES)**	The USDA NRCS provided funds to aid WVSUES' transition to digital content delivery and outreach during the pandemic. WVSUES developed on-demand training modules to help producers manage their resources to improve production outputs and efficiencies and implement conservation strategies. Training sessions also introduced new farmers to agribusiness concepts to better prepare them for starting successful ventures and to share basic agricultural methods aimed at growers with limited space and financial resources in a monthly series. A total of 20 in-person and live-streamed workshops and webinars reached 143 individual attendees across at least 47 of West Virginia's 55 counties and participants in Ohio, Maryland, Virginia, Alabama, and South Carolina, and more than 212 on-demand viewers. Over 70 participants have enrolled in two pilot on-demand courses through WVSUES' online eLearning platform at wvstateu.edu/ExtensionOnline. WVSUES brought together farmers, food manufacturers, and Extension and agency personnel in multi-speaker	Food Access, Security and Safety/Sustainable Agriculture

		workshops that oriented new producers to available support sources. Speakers addressed how to avoid common startup pitfalls and how to navigate marketing and regulation processes. Workshops also offered training in season extension, native pollinator support, alternative agriculture, and agribusiness planning.	
9.	**Urban Farming for Socially Disadvantaged Farmers: Securing Food and Economic Opportunity (WVSUES)**	High unemployment or underemployment rates discourage minority and economically depressed West Virginians from taking a risk to farm. State and local boards of education devote few resources to agricultural education, which leads to little exposure to agriculture. WVSUES workshops promote the adoption of urban agriculture practices in urban, peri-urban, and rural settings with limited arable land across the state to increase food security through self-reliance. WVSUES activities targeted new and beginning producers among minority, veteran, disabled, and other historically underrepresented communities. Five in-person workshops instructed 35 individuals in agribusiness training to encourage agricultural entrepreneurship. Topics included production planning, risk management, marketing and regulations, and alternative agricultural methods, such as hydroponics and raised bed gardening. Eight virtual workshops reached an additional 55 unique participants in agribusiness and alternative or urban farming techniques.	Food Access, Security and Safety/Sustainable Agriculture
10.	**Agribusiness Development for Veterans (WVSUES)**	The Veteran's Administration Office of Mental Health and Suicide Prevention (OMHSP) reports that rural veterans have a 20% higher suicide rate than others due to lower incomes, higher unemployment rates, and reduced social connection. OMHSP created the Veterans Affairs Farming and Recovery Mental Health Services (VA FARMS) program to support Veterans through agritherapy—integrating behavioral health care services with agricultural vocational training to overcome these effects. While primarily intended as therapy, the program equipped participants with skills to grow produce and potentially start agricultural enterprises. WVSUES, retained through the WV Department of Agriculture (WVDA), assisted with curriculum development and content delivery from April through mid-December. WVSUES delivered four workshops to four veteran participants between October and mid-December, all of whom expressed increased interest in agriculture and planned to continue production independently. Extension agents offered training in cold chains, food safety/post-harvest handling, hydroponics, and irrigation and water management. WVSUES further engaged veterans during the pandemic through hybrid live-streamed and on-demand delivery of a 10-week series of Urban Agriculture Business classes as part of the WVDA's Veterans and Heroes to Agriculture	Food Access, Security and Safety/Sustainable Agriculture

		program intended to help support veterans, first responders, and their spouses' transition into agricultural enterprises. The course brought together 17 veterans/spouses with successful farmers and subject matter experts and allowed participants to craft a functional business plan for an urban farm through worksheet prompts.	
11.	**Spatial Mapping Training and Production Management Services for Farm Sustainability (WVSUES)**	Vagaries in regional and local microclimates challenge West Virginia's producers to adopt new production schedules and methods, change plant varieties and pest mitigation strategies, and maintain habitat for native pollinators. WVSUES addresses these issues through programs targeting range and forest landholders and agricultural producers, with outreach aimed towards limited-resource and underrepresented populations, disabled veterans, and new or beginning farmers. Webinars and self-paced online modules focused on applying spatial mapping and precision imaging tools to conservation systems to enhance environmental quality and productive capacity. These helped producers and land managers identify available resources to realize their monetary and conservation value, connected participants to conservation and forestry experts, and provided a management toolkit for planning purposes. Participants who completed training became eligible to receive technical support and spatial mapping services by WVSUES agents via Unmanned Aerial Vehicles and precision mapping and spatial analysis software. The program makes technology available to limited-resource farmers and landholders who would otherwise find it cost-prohibitive. WVSUES reached 61 individuals through seven workshops and enrolled 53 participants in the five-unit online class. Class sessions and supplemental online lessons cover spatial mapping basics; identification, application, and implementation of mapping resources; preparation of comprehensive management and production plans; and data collection through remote sensing and digital mapping equipment to improve sustainability through better management decisions.	Food Access, Security and Safety/Sustainable Agriculture
12.	***Fresh to Market:* Safe Post-Harvest Handling (WVSUES)**	Topography, distance to consumer centers, and lack of an established on-farm cold chain challenge West Virginia's vegetable producers' ability to market products effectively and safely, and they limit the variety of produce grown and revenue potential. WVSUES delivered two in-person Post-Harvest Handling/Cold Chain workshops to four veteran participants before the pandemic. WVSUES postponed additional sessions until 2021.	Food Access, Security and Safety/Sustainable Agriculture

13.	**Agripreneurship and Food Manufacturing Series: Food Quality, Safety, and Marketing (WVSUES)**	A thriving agricultural enterprise must have the ability to ensure, to the extent possible, the safety of its product for consumers. Knowledge gaps in disease prevention, good agricultural practices, post-harvest handling, and temperature control of products prior to market sales reduce product quality, safety, and market share. WVSUES brought agency partners and successful producers together with new agricultural entrepreneurs to discuss strategies for risk reduction for produce, meat, and poultry through production, harvesting, processing or manufacturing, and market storage. Efforts targeted producers and landholders enrolled in or interested in the Natural Resources Conservation Service's EQIP program or those who plan to implement conservation systems in their operation independently. Other targeted audiences include budding agricultural entrepreneurs, military veterans, and members of socially disadvantaged or underrepresented populations seeking to start an agricultural venture. WVSUES served 25 individual participants through two in-person workshops. Participant feedback indicated 98% of participants considered the training impactful in terms of skills learned, applicability to their situation, and overall value of information obtained.	Food Access, Security and Safety/Sustainable Agriculture
14.	**Improving the versatility and adaptability of thermophilic anaerobic digestion and microbiome functional diversity driving plant biomass decomposition in engineered environments (WVSUAERS)**	Surface mining is important for the economy of West Virginia. When mining is completed, regulations require that soil restoration is done. Two related research projects pertaining to the use of microbiomes for sustainable energy management were addressed. The first project focused on the effectiveness of soil restoration methods following surface coal mining with regard to soil microbiome functions. Research showed that the microbial functions in these highly disturbed soils do recover over time. Analysis of triplicate metagenomes from a series of progressively older restored soils showed that carbon, nitrogen and sulfur cycle genes were highly depleted in the recently disturbed soils but became increasingly similar to the control forest soil over time. Secondary metabolism functions, which are indicative of healthy soils, also recovered over time. The second project concerned the capacity of thermophilic digesters to adapt to new substrates (organic wastes). Experiments were done with thermophilic digesters that were previously adapted to poultry litter waste, which has high plant biomass content in order to test their capacity to adapt to other organic wastes. Co-digestion with crude glycerol (derived from biodiesel production) was done, and we found that the digester could adapt to low levels (2%) of crude glycerol but the microbiome was sensitive to additional increases which caused significant inhibition. Recovery of methane production following	Climate Change and Natural Resources Management

		inhibition did occur and was associated with the restoration of the original microbiome structure. This research provides guidance for digester operators who plan to mix different types of wastes in thermophilic digestion.	
15.	**Watershed Hydrology and Water Quality at a Reforested Valley-fill Mine Site (WVSUAERS)**	Better understanding of the long-term impact of management practices on reclamation of previously mined lands is essential in order to improve recovery and restoration of site ecosystem services. In this study we monitored and collected in-stream grab-water samples from a paired-watershed system to characterize spatial and temporal changes in stream flow and water quality 25 years after secession of mining activity and 15 years after final bond release. The study includes previously mountaintop removal/valley-fill headwater (MTR-VF) and adjacent native, undisturbed headwater watershed of similar size and aspect. Results from the first year shows that the impact of the MTR-VF on headwater water quality persist 15 years after reclamation. Water quality indices and composition fluctuated both temporally and spatially, and at a much higher magnitude at the MTR-VF compared to the native headwater watershed. Albeit exceeding regulatory conductivity threshold levels (> 300µS cm^{-1}) closer to the toe of the VF during summer months of high evaporation demand, elevated levels above the native headwater benchmark levels were evident throughout the year. The elevated levels and fluctuation thereof seemed to subside markedly downstream from a beaver-reconstructed abundant sediment pond along the MTR-VF watershed. Going forward an emphasis will be given to isolate and further decipher the role of the reconstructed sediment pond/wetland on the headwater water quality, especially as the removal of such ponds during final stages of bond release is encouraged by regulatory agencies.	Climate Change and Natural Resources Management
16.	**Forestry Reclamation Approach Effect on Subsurface Spoil and Water Quality. (WVSUAERS)**	Proper reclamation of surface mine lands in central Appalachia is essential for timely and sustainable restoration of soil function and role in support of essential ecosystem services. Inherently placed at the headwaters of a given watershed, the impact of mountaintop removal surface mining operations extends far beyond the mining area. In this study we evaluate the effect of different Forestry Reclamation Approach reforestation practices on soil biogeochemical processes and soil water quality. Several vulnerabilities were found during the study, emphasizing redox-promote dissolution processes as a dominant factor controlling subsoil solution soluble salts levels. Temporal observations over the 3-year study pointed towards susceptibility of such processes to drastic fluctuation and magnitude of change in soil moisture regime due to extreme weather events and conditions. For example, heavy precipitation following prolonged dry	Climate Change and Natural Resources Management

		conditions (during the summer and late fall of 2019) at an otherwise compacted and saturated landscape resulted in drastic fluctuation in moisture and redox potential (and subsequently in pH) leading to release of elevated levels of manganese and associated heavy metals. The study emphasizes the importance of development and implementation of proper reclamation practice, especially amid expected increase in intensity and frequency of extreme weather events, and the inherent vulnerability and susceptibility of mine soils.	
17.	**Understanding the Genetic Control of Seed Storage Compounds Regulation in Plants (WVSUAERS)**	We have cloned full-length cDNA corresponding to two seed storage compound (SSC) gene 1 and into binary vectors consisting seed specific promoter and DsRed with Hygromycin selection marker gene. We have also introduced RNAi cassettes for these genes under seed specific promoter to inactivate the function of these proteins in seeds. We have generated transgenic Arabidopsis lines using Agrobacterium-mediated transformation. Homozygous lines were established and selected high expression lines using Q-RTPCR. Subsequent experiments on growth physiology and biochemical analysis of storage compounds in these transgenic lines is in progress. To study in vivo tissue specific expression of SSC1 and SSC2 genes in developing seeds and vegetative tissues of Arabidopsis, we cloned around 2 kb size promoters of these genes in binary vector consisting of intron-GUS reporter genes. Generated 10-15 independent transgenic lines consisting SSC1: GUS and SSC2: GUS lines. Using homozygous lines, we confirmed the expression of these genes in the seedlings, leaves, flowers, siliques and developing seeds. The promoters of both SSC1 and SSC2 expressed strongly in the flowers, siliques and developing seeds proving their role in the seed storage compound synthesis or storage. We have selected few additional genes/enzymes potentially involved in the oil biosynthesis pathway. The preparation for the RNA-Sequencing of these selected T-DNA lines is in progress. Camelina sativa (Camelina), an established oilseed crop of the mustard family, has been used largely for vegetable oil-derived biofuels. Through conversion methods such as hydroprocessing, Camelina oil is used as a feedstock for jet fuel production. Among oilseed crops, Camelina offers the greatest opportunity for the rapid engineering of multigene traits. Camelina can be genetically transformed by floral vacuum infiltration with Agrobacterium tumefaciens harboring desired transgenes, a method used for rapid RNAi-based evaluation of gene candidates. We are using Camelina as a platform for testing SSC1 and SSC2 gene constructs. Selection of transgenic plants and subsequent isolation of homozygous lines are in progress.	Climate Change and Natural Resources Management

18.	**Renewable Forest Resources (WVSUES)**	Increased seasonal rainfall combined with warmer-than-average winter temperatures and extended periods of heat challenge West Virginia's forest owners and orchardists to consider new tree species, production schedules, and pest mitigation. WVSUES provided virtual and hybrid workshops and technical assistance targeting forest landholders, homeowners, producers, farmers, NGOs, and urban growers, with outreach aimed towards limited-resource and underrepresented populations, disabled veterans, and new or beginning farmers. Topics included tree care basics, land management plans, invasive species, and the ecosystem benefits that urban trees deliver. Ten workshops drew 94 individual participants in varied-format programming focusing on urban areas where the built environment constrains tree planting and care. Two in-person workshops occurred locally in Kanawha County, but virtual programming reached participants from 43 counties across the state and from neighboring states, as well as more than 83 additional on-demand viewers. WVSUES also helped recruit up-and-coming Tree City USA communities who demonstrate basic urban tree care principles and gain recognition by the Arbor Day Foundation.	Climate Change and Natural Resources Management
19.	**USDA Forest Service Climate Hub: Farm Resilience through Climate Adaptation (WVSUES)**	Climate changes have resulted in a need for West Virginia's producers to adapt to increased rainfall, warmer-than-normal temperatures, and killing frosts that decimate harvests from fruit varieties forced into early bloom. Increased production loss from northward migrating pests and increased fungal growth requires changes in observation patterns and mitigative applications to achieve sustainable harvests. WVSUES worked with the WV Division of Forestry to update two urban and community forestry publications and make them more readily available to the public. These publications give succinct and vital information on native and cultivated species of trees adapted for West Virginia's climate and are tolerant of the urban environment. Additionally, WVSUES educated the public on the role urban and community trees can play in alleviating climate change effects such as urban heat islands and flood mitigation, the latter of which is critical to the state. Perhaps this program's greatest success is an ongoing WV Weather Data Collection project that has equipped producers, farmers, homeowners, schools, and NGOs throughout the state with personal professional-quality weather stations. In exchange for their involvement in opening up dialogue in schools on climate change, collecting data from microclimates not represented by regional stations, and painting a more complete picture of changing weather patterns across the state, participants keep the stations. This weather data collection project has drawn an audience from across the state into WVSUES	Climate Change and Natural Resources Management

		programming, establishing more networks in counties with underserved populations. WVSUES will use aggregated weather data from the three-year project to create interactive GIS-based story maps and educational tools. Three virtual workshops drew 61 individual participants and 60 additional on-demand viewers.	
20.	**Forest Resource Management (WVSUES)**	Competing land uses and increased urbanization, introductions of invasive forest pests and disease (both exotic and native), and wildfire risks threaten West Virginia's forests and woodlands. Additionally, limited municipal funding and a need for individual training in primary tree care diminish the full realization of ecosystem benefits provided by urban canopies. WVSUES directed programming toward communities and organizations, small-scale producers, forestland owners, and community urban orchards operated and maintained by WVSUES and other NGOs to address these issues. To reach a wider audience, WVSUES also began making much of its programming virtual or hybrid with hands-on demonstrations. Through these virtual and hybrid workshops, combined with publications and pre-recorded instructional videos, over 100 workshop participants completed training on such topics as tree planting, tree care, management, and species selection. An additional 139 participants were exposed to fruit tree grafting techniques, mushroom production, and maple syrup production basics through live webinars and pre-recorded instructional videos. Orchard and urban tree management data continue to be managed by WVSUES in GIS to keep track of trees across the state and provide such data to the public, such as in the form of a virtual campus tree tour that includes information on specimen trees.	Climate Change and Natural Resources Management
21.	**Health Literacy "Can You Repeat That Please?" (WVSUES)**	Health Literacy is fundamental to reducing health disparities among Americans. Ninety million American adults have limited health literacy skills. Low health literacy costs the health care system $106-$238 billion dollars each year. Improving health communication reduces health care costs and increases the quality of care. Patients and providers must work together to ensure effective communication, giving the patient a feeling of confidence to take a more active role in health decisions and an awareness of health care information. To address these issues, WVSUES's "Can You Repeat That Please?" program focuses on improving communication between patients and health care providers in order to remove problems and barriers in the communication process; help patients with an understanding of outcomes and expectations; and develop methods and resources for improved medical appointments. Participants receive a comprehensive health history journal to track their full health records, with	Health Disparities

		options for both adults and a parents' guide for tracking children's health history. In 2020, the program was delivered statewide in conjunction with the WVSU Healthy Grandfamilies program, and 2,750 health literacy journals were distributed to adults in all 55 West Virginia counties. As a result of usage of the health literacy journals, participants were able to improve personal health management and understanding and expand communication skills with their health care team.	
22.	**One-On-One Assistance for Southern West Virginia-Mingo, Logan, Lincoln, Wyoming, McDowell, Wayne and Mercer Counties (WVSUES)**	West Virginia continues to adapt to rapidly changing local economies. The primary economic drivers of many local communities have traditionally been based on the coal industry or other extraction industries. As the coal industry continues a rapid decline, there is an increase in displaced workers, who are unemployed due to layoffs, shutdowns or other industry-related changes who are actively seeking new employment or other entrepreneurial opportunities. With depressed economies and changing industries, many local businesses lack the skills and capacity for sustainability. With the lack of general or specialized business assistance, many businesses have been forced to shut their doors with no hope of growth. These individuals lack the skills and resources required to start a new business or to enter emerging, alternative industries such as tourism development. Within the last few years, the tourism industry has seen subtle growth but has so much more potential to expand. One-on-one business assistance services were delivered to local, existing businesses who support the tourism industry in Mingo, Logan, Lincoln, Wyoming, McDowell, Wayne and Mercer counties. The support services included general business assistance, marketing services, technical assistance and funding opportunities. One-on-one sessions were held virtually throughout a multi-county footprint that WVSUES serves through a partnership with the Hatfield McCoy Regional Recreation Authority. The training opportunities were geared to strengthen existing and potential new businesses within the tourism industry such as lodging facilities, restaurants, machine rental companies and ancillary businesses. During the past year, 152 businesses have taken advantage of support services. Despite experiencing a pandemic, 14 of these businesses were new investments. Many of these support conversations have led to technical assistance opportunities on various topics. These opportunities resulted in an increased knowledge in the areas of website mechanics, entrepreneurship, grant writing, QuickBooks, Google Analytics and social media. With the support received, these businesses were	Community Revitalization

		able to strengthen their workforce capacity and work toward sustainability and even growing their operations.	
23.	**The Creators Program (WVSUES)**	Storytelling is vital to our communities and their history. Traditional storytelling has been a way communities and cultures have passed down history, education, and entertainment from one generation to the next. Today, many communities are exploring ways to tell the story through visual media. Through monthly workshops, the WVSU Economic Development Center (EDC), through its Creators Program, a series of community workshops and trainings on digital media and the arts, taught participants how to engage and capture their audiences by creating a space that will bring the community together through the art form they are delivering. In addition, this series developed a creative environment that not only taught the history and processes of storytelling, but also stimulated an entrepreneurial spirit among participants to create opportunities that can preserve history, entertain, and promote community and development. In 2020, the Creators Program delivered a total of 15 workshops, trainings, and panel discussions on topics such as Creating Poetry during the Pandemic, Street Photography, Capturing Memories and Publishing to more than 265 individuals. Out of the 265 participants, the demographic make-up of the workshops consisted of: 106 females & 50 males (missing data for 109 due to workshop being livestreamed on YouTube due to Covid-19); 40 African Americans; 2 Asians; 10 more than one race; and 91 Caucasians. Through post-surveys, participants reported an increase in acquired new skills and knowledge that enabled them to develop, strengthen and effectively communicate their thoughts, ideas and work. Seventy percent of the participants found that the workshops improved social bonds by being able to network with fellow artists.	Community Revitalization
24.	**Local Government Leadership and Resource Development (WVSUES)**	In rural southern West Virginia, elected leaders often have little or no experience in public service. This issue, compounded by the systemic poverty of the region that effects the ability to hire qualified employees to manage municipalities or counties, creates a need for individual education and resource development. Many individuals are unfortunately embarrassed by their ignorance, which requires a more hands-on approach to education. In the town of Oak Hill, WVSU staff have assisted the city in rewriting their zoning, which was enacted in 1977 and had changed very little in 40 years. This created many frustrating issues that were not easily solved due to the lack of detail or modernization. The clearly defined zoning that now exists will help the city, its residents and potential future	Community Revitalization

		developers make the best use of their property and in a way that leaves little room for discrimination. Staff also discovered procedures that violated state codes and worked with the city to have them corrected. This new zoning has allowed the city to quickly respond to questions from residents, building owners and potential businesses. In the town of Rainelle, WVSUES is currently working with a Planning Commission that has recently formed. While energetic, staff is working closely with the members to help them focus their vision in a way that can help them to develop a realistic comprehensive plan. In addition, one member along with a group of other residents is interested in finding ways to connect to existing ATV trail resources or to create their own. WVSUES staff are using their knowledge and resources to help guide this group to success. A better educated leadership with more connections to resources can build more successful communities. Without some of the connections made by WVSU, these leaders might never connect to the resources they really need to assist their communities.	
25.	**Virtual STEM Programming (WVSUES)**	Most of the 30 fastest-growing occupations in the next decade will require science, technology, engineering, and mathematics (STEM) skills, including an estimated 2.8 million STEM jobs that will be created in just four years. However, only 16% of American high school seniors are interested in a STEM career, and the problem is worse for girls and minority youths, who are significantly under-represented in STEM degrees and careers. Underserved learners lag far behind their peers in STEM preparedness and, on average, first-generation college students who are from a racial/ethnic minority group and a low-income family are 16 times less likely to be ready for credit-bearing STEM coursework in college than students who are not considered underserved. In addition to these statistics, we are yet to see the long-term impact that the global COVID-19 pandemic will have on our youths, as academic performance has seen a drop across the state of West Virginia. In order to help students increase their STEM confidence, work on skills needed for success as a STEM major in college, and expose students to STEM pathways, WVSU rolled out multiple virtual STEM programs that targeted middle and high school students. During these programs, students reported a 40% increase in STEM knowledge and content, a 74% increase in STEM engagement outside of the class, and an 82% increase in their interest in pursuing STEM careers. These programs reached underserved and rural middle and high school youths across 13 counties. The students participating in these programs	Strengthening Youth and Families

		benefited from engaging in these immersive virtual experiences by being exposed to new STEM concepts, careers, and methods.	
26.	**STEM Scholars Academy (WVSUES)**	In a state of 1.8 million people, more than 362,000 West Virginians live in poverty, including more than 120,000 children according to the American Community Survey from the U.S. Census Bureau. West Virginia has the 10th highest poverty rate among the 50 states. Poverty in West Virginia is much higher among African Americans and other minorities, who have a lower per capita income than the national average ($23,450 to $28,930). This data is more troubling when considering that students who come from households with an average annual income of $33,000 or less have a 1-in-10 chance of earning a college degree. Investing in future generations of West Virginians is necessary to move forward and improve the lives of our citizens. If action is not taken to reverse or profoundly impact these trends, it is highly probable that the economic gap, achievement gap, college degree attainment gap, and the number of students, especially low income and underrepresented groups, earning STEM degrees and entering STEM careers, will continue to decline. The STEM Scholars Academy aimed to comprehensively address the barriers and obstacles faced by these students and provide a supportive pathway to enable student success by achieving three main goals: 1) exposing high school juniors to opportunities in STEM fields, 2) increasing interest in attending college and studying STEM, and 3) preparing students to succeed by providing purposefully structured resources and mentorship to address students' needs. This involved a combined approach, with thoughtfully structured information, resources, and opportunities. High school students were paired with undergraduate STEM majors who served as their peer mentors as students were guided through structured mentoring sessions that focused on topics such as time management, communication skills, goal setting, transitioning to college, study skills, and dealing with adversity. In addition, before the onset of COVID-19, students attended professional development sessions on campus where they met STEM professionals from around the community and conducted hands-on science activities. Of the high school students who participated in the program, 66% reported having the skills they needed to be successful studying science in college, 87% were interested in pursuing a STEM career, and 80% reported an improvement in their STEM confidence. High school and undergraduate students benefited by participating in this program by increasing their overall view of STEM careers as well as an	Strengthening Youth and Families

		improvement in their self-awareness of the personal competencies they needed to succeed in college.	
27.	**Sowing Young Sprouts (WVSUES)**	The southern coalfields of West Virginia are a region stricken with high rates of poverty, food insecurity, and health-related disease. Raleigh County has a higher-than-average amount of people living below the poverty line at 17.6%. Many children do not have access to fruits and vegetables, and some may not have access to supplies to grow their own. It has been shown that children who grow their own food are more likely to eat fresh fruits and vegetables. But first, they need a place where they can learn. Sowing Young Sprouts (SYS) is a youth agriculture program that utilizes Junior Master Gardner (JMG) curriculum to teach children to the garden, cook their produce, and sustain the garden by selling produce and value-added products to the community. Before the onset of COVID-19, youths participated in the construction of two garden sites at their elementary school, with a third site getting a wildlife habitat addition. Students participating in the program displayed ownership of the gardening sites and even took the additional initiative to request permission for the creation of an orchard in addition to their raised beds. After restrictions were implemented due to COVID-19, the SYS team transitioned by partnering with local libraries and community centers to distribute activities to the youths in the community. The activities were geared to keep the students engaged with JMG material as well as doing container gardening at home. Early data so far has shown that 80% of the students reported learning something new, 75% reported wanting to grow more vegetables at home, and 71% of students reported wanting to plant pollinator gardens. The rural elementary-aged youths that participated in this program experienced multiple benefits. They benefited by gaining knowledge about agriculture, taking ownership of their gardens, increasing their appreciation of the natural world, and having a better understanding of sustainability.	Strengthening Youth and Families
28.	**Logan STEAM (WVSUES)**	Logan County schools are rurally located in the southern coalfields, where the population and wealth have declined alongside the coal industry, and students' experiences are circumscribed by their financial situation. Logan STEAM aims to mitigate those circumstances by supporting teachers with resources and by providing direct programming as a collaboration with the schools. Broadening horizons and creating positive STEM experiences sets the K-8 participants up for success. Area high school students acted as volunteer assistants and gained from their experience as well. This program has supplied owl pellets, display boards,	Strengthening Youth and Families

		science fair judges, as well as gardening supplies and star talks. Participants have made pocket solar systems, moon phase flip charts, constellations, star charts, and participated in star talks and scavenger hunts. These events introduced the program to several schools the program has since partnered with, expanding the program to nearly 800 regular participants prior to COVID-19. Since the onset of the pandemic, WVSU 4-H has been working with the local educators to identify and purchase resources that would assist them in delivering their online science content, such as Generation Genius. As quoted by a participating school principal, a majority of their students come from low-income homes, so they are not provided exposure to museums and science centers. This program has provided some of these opportunities to extend learning beyond basic curriculum.	
29.	**Healthy Grandfamilies (WVSUES)**	The prevalence of grandfamilies – households in which grandparents are providing fulltime care for one or more of their grandchildren – is on the rise throughout the United States. While the reasons behind this growing issue are multiple, research points to the issues such as the rising rates of opioid addiction as being one of the leading factors behind how grandparents come into custody of their grandchildren. Often called Ground Zero of the opioid epidemic, West Virginia ranks second in the nation for the number of grandfamily households. Studies have shown that as many as 1 in 14 children is being raised by a grandparent, and the overwhelming majority of cases in the state are the result of one or both parents being impacted by opioid addiction. While grandparents are rising to the challenge of once again becoming fulltime caregivers, they have reported feeling overwhelmed with the issues and challenges they face as 21st century parents, including changes in education, behavior, technology, and so on. To address this issue, WVSU Healthy Grandfamilies provided programming through discussion sessions and social work services to grandparents raising their grandchildren. Topics included navigating the school system, communications, social media, family relationships, healthy lifestyles/managing stress, family response to addiction, parenting, legal issues, nutrition, and health literacy/self-care. Curriculum modules were developed specifically through this project to address the above-mentioned topics. The program provided education to grandparents in all 55 West Virginia counties during FY 2020. This is a significant expansion of reach since the program's inception.	Strengthening Youth and Families
30.	**Opening Soon Inc. Entrepreneurial Program (WVSUES)**	Small businesses are critical to a healthy economy in any community. Studies have shown that minority and economically challenged communities face numerous hurdles in starting and sustaining a business. Addressing disparities in	Innovation and Entrepreneurship

		skills, knowledge, and access to resources to develop small businesses is necessary in helping minority and low-income individuals create wealth. In an effort to mediate these challenges and to increase employment opportunities, investment and economic development within the city of Charleston, the WVSU Economic Development Center (EDC) created a pilot of the Opening Soon Inc. (OSI) entrepreneurial program. This pilot expanded the curriculum of the program to include technical assistance with partners of WVSU EDC, such as the WV Small Business Development Center. The OSI program was a 10-week business and product development program for entrepreneurs, start-ups and micro-enterprises in Kanawha County and surrounding areas that provides education and guidance in launching participants' business idea into a viable product or service through a series of workshops, peer meetings and technical assistance. From April to June 2020, the OSI program had a total 23 participants in various stages of starting, opening, and running a business. At the conclusion of the program, a post survey was given to participants to capture what was learned, what needed to be improved and did the OSI program/workshops meet their expectations. From the post survey, participants not only acquired new skills and knowledge in business and product development, but also the OSI program enhanced competencies in the field of entrepreneurship and increased awareness of opportunities and resources available to the participants, especially to the minority and low-income participants. Seventeen participants found the workshops to be beneficial to their businesses and increased their skills and knowledge in the areas of product development, marketing, opening a business and available resources and five registered their product/service with the Secretary of State.	

I. Signature Page for Annual Report

The Directors for Research and Extension for each institution must sign this document. You may submit this form to NIFA as a PDF. Electronic signatures are acceptable.

Institution(s) name	West Virginia State University
Date Submitted:	3-31-2021
Submitted by:	Ami M. Smith

Director Approvals (Duplicate the table as needed)	
Name: Jose Ulises Toledo	**Date:** 03/31/2021
Title: Director of Research	
Signature: Jose U. Toledo	

Director Approvals (Duplicate the table as needed)	
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