

# 2011 University of the Virgin Islands Research Plan of Work

Status: Accepted

Date Accepted: 07/13/2010

## I. Plan Overview

### 1. Brief Summary about Plan Of Work

The Agricultural Experiment Station (AES) is located on the St. Croix Campus of the University of the Virgin Islands. AES is part of the Research and Public Service Component. The U.S. Virgin Islands are semiarid, subtropical islands in the Lesser Antilles. The islands are marked by easterly trade winds which provide a nearly constant breeze and alternating periods of drought and heavy rain. A long tradition of agriculture in St. Croix provides an ideal location for our research mission. AES conducts basic and applied research to meet the needs of the local agricultural community in increasing production, improving efficiency, developing new enterprises, preserving and propagating germplasm unique to the Virgin Islands, and protecting the natural resource base. AES has research programs in animal science, aquaculture, biotechnology, forage agronomy, and fruit, ornamental and vegetable crops. Our vision is to generate information that leads to improved agricultural practices in the Virgin Islands and the Caribbean Region by conducting scientific research. Our research programs will be increasingly influenced by the needs of the public and the farming community and by research conducted by other agricultural research institutions. Using new technologies, the results of our research will be disseminated more widely to farmers and the international scientific community.

#### Estimated Number of Professional FTEs/SYs total in the State.

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	13.0	0.0
2012	0.0	0.0	13.0	0.0
2013	0.0	0.0	13.0	0.0
2014	0.0	0.0	13.0	0.0
2015	0.0	0.0	13.0	0.0

## II. Merit Review Process

### 1. The Merit Review Process that will be Employed during the 5-Year POW Cycle

- Combined External and Internal University External Non-University Panel

### 2. Brief Explanation

A merit review process is followed. Scientists submit a copy of their proposal to the Director to ensure that the projects are in alignment with the University's strategic plan, the Research and Public Service Component's Master Plan and the AES strategic plan. The Director then attaches evaluation forms and sends the proposal to three people who are qualified to judge the proposal. At least one of the reviewers is selected from CES and others may be from the community. The reviewers are asked to rate the proposals on a scale of 1 to 5, 5 being the highest score, as to relevance of the proposed project to the agricultural sector (justification). The evaluated proposals are then returned to the Director who gives the reviews to the scientist for any needed revisions. The revised proposal is then returned to the Director who verifies the improvements in writing and gives final approval.

### III. Evaluation of Multis & Joint Activities

#### 1. How will the planned programs address the critical issues of strategic importance, including those identified by the stakeholders?

AES faculty are participating in four multi-state research projects: 1) Plant Genetic Resource Conservation and Utilization (S-009), 2) Stress Factors of Farm Animals and Their Effects on Performance (W-1173), 3) Genetic Considerations for Beef Cattle Production in Challenging Environments (S-1045), and 4) Reducing Barriers to Adoption of Micro-irrigation (W1128). The forage Agronomy Program is a participant in the Southern Consortium for Small Ruminant Parasite Control. In addition, AES continues to work closely with the University of Puerto Rico and the University of Florida in the Tropical and Subtropical Agricultural Research Program (T-STAR). The Animal Science faculty is collaborating with CES faculty from the University of Hawaii to provide assistance and workshops to ranchers in Guam and the Northern Marianas islands through a grant from the USDA-NIFA Funding Outreach and Assistance for Socially Disadvantaged Farmers and Ranchers. Faculty in AES mentor students supported by funds from a grant from the USDA-NIFA Resident Instruction Grants Program for Institutions of Higher Education in Insular Areas. All of these projects address issues that are of concern to our stakeholders as evidenced by input obtained from our Advisory Council as well as our informal contacts with producers, students and other faculty.

#### 2. How will the planned programs address the needs of under-served and under-represented populations of the

Almost all of the farming community in the USVI can be considered small scale and limited resource farmers. The limitations include land, water, infrastructure support, available markets and the high cost of production in the islands. Most of our projects focus on evaluating or developing production methods that can be adopted by small scale farmers with limited resources with minimal financial input. The ethnic makeup of the farming population is predominantly African-American and Hispanic.

#### 3. How will the planned programs describe the expected outcomes and impacts?

Faculty involved in each program establish a set of outcomes for the program. The outcome may consist of the number of local farmers who adopt a new technology or farming practice or how many use a new variety of plant or breed of livestock. The impacts are reported as to how these new technologies, varieties or breeds improve the overall operation of individual stakeholders.

#### 4. How will the planned programs result in improved program effectiveness and/or efficiency?

Effectiveness will be enhanced by targeting issues that are highly relevant to tropical agriculture. The programs will address local needs identified by stakeholders through various forms of input. The information generated by the research projects will be disseminated to the appropriate audience in the appropriate format so that it can have the most impact.

Efficiency of programs will be improved by using stakeholder input to develop research projects that are relevant to the local community and can eventually have an impact. Issues that are relevant to the USVI, as well as other locations, will also be included in research projects. Encouraging faculty to develop cooperative efforts with scientists outside the region will provide access to technology or assistance that is not available locally.

### IV. Stakeholder Input

#### 1. Actions taken to seek stakeholder input that encourages their participation

- Use of media to announce public meetings and listening sessions
- Targeted invitation to traditional stakeholder groups
- Targeted invitation to non-traditional stakeholder groups
- Targeted invitation to traditional stakeholder individuals
- Targeted invitation to non-traditional stakeholder individuals
- Targeted invitation to selected individuals from general public

##### Brief explanation.

Due to the small geographic area of the Virgin Islands, AES scientists work in close contact with the local agricultural community, which fosters considerable communication and responsiveness to farmers' needs. AES programs hold field days that are advertised in the local media (print, TV, radio). Virgin Islands farmers and interested citizens tour current projects and have an opportunity to comment on the work that is being performed.

Selected farmers are invited to AES seminars when the topic is relevant to their operations.

**2(A). A brief statement of the process that will be used by the recipient institution to identify individuals and groups stakeholders and to collect input from them**

**1. Method to identify individuals and groups**

- Use Advisory Committees

**Brief explanation.**

The Agricultural Experiment Station's Advisory Council consists of farmers that represent a cross-section of the Virgin Islands farming community (plants, aquaculture and livestock). All AES Program Leaders sit in on the meetings as well as a representative from the Cooperative Extension Service. The farmers are given the opportunity to raise their concerns. AES scientists try to incorporate researchable issues into their research programs. Non-researchable concerns are referred to CES or appropriate federal or state agencies for action.

**2(B). A brief statement of the process that will be used by the recipient institution to identify individuals and groups who are stakeholders and to collect input from them**

**1. Methods for collecting Stakeholder Input**

- Meeting with traditional Stakeholder groups
- Meeting with traditional Stakeholder individuals
- Meeting with the general public (open meeting advertised to all)
- Other (Clients contact AES with specific requests)

**Brief explanation.**

In addition to our formal stakeholder meeting we are in contact with the wider stakeholder community frequently. When we assist with workshops we get feedback that we incorporate into our research programs.

**3. A statement of how the input will be considered**

- To Identify Emerging Issues
- Redirect Research Programs

**Brief explanation.**

AES scientists try to incorporate researchable issues into their research programs. Non-researchable concerns are referred to CES or appropriate federal or state agencies for action.

**V. Planned Program Table of Content**

<b>S. No.</b>	<b>PROGRAM NAME</b>
1	Aquaculture - Biofloc Systems
2	Aquaculture - Aquaponic Systems
3	Animal Science - Small Ruminants
4	Animal Science - Beef Cattle
5	Plant Biotechnology
6	Plant Germplasm Conservation and Enhancement
7	Horticulture
8	Irrigation
9	Agronomy - Mixed Cover-Crop Livestock Systems

**V(A). Planned Program (Summary)****Program # 1****1. Name of the Planned Program**

Aquaculture - Biofloc Systems

**2. Brief summary about Planned Program**

Research will continue on the development of biofloc technology. The facilities for this work consist of three 11.8-m<sup>3</sup> biofloc systems, six 30-m<sup>3</sup> systems, one 70-m<sup>3</sup> system, seven 80-m<sup>3</sup> systems and one 200-m<sup>3</sup> system. These systems will be used for the production of tilapia. All systems will be equipped to aerate and mix the culture water and remove solid waste. The 200-m<sup>3</sup> system include external channels to remove inorganic nitrogenous waste (i.e., nitrate ions) and recycle nutrients into aquatic plants. Conditioned water from previous experiments will be reused to expedite the development of an active biofloc (biofilter) at the start of subsequent experiments. Tilapia will be fed a complete diet two times daily until they reach harvestable size. Water quality will be monitored and base will be added to maintain a suitable pH. At harvest the fish will be weighed and counted to determine growth rate, average body weight, total production level, survival and feed conversion ratio. Power consumption, water use and sludge production will be measured. Effluent from the systems will be filtered through bags composed of a geotextile membrane (Geotube®) to produce a clear filtrate and organic solids. The use of the filtrate for field crop irrigation water or system makeup water will be evaluated. Alternative cheaper membranes will be evaluated. The solid waste will be evaluated as an organic fertilizer for field crop production or a composted media for producing vegetable seedlings. When a system has reached a satisfactory level of development, an enterprise budget will be prepared.

**3. Program existence :** Mature (More than five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
307	Animal Management Systems			80%	
403	Waste Disposal, Recycling, and Reuse			20%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

The U.S. has a multibillion dollar deficit in seafood and fishery products. Most of the major fisheries in the world are in a perilous state. Some have collapsed, many are in danger of collapsing, and one dire prediction states that all marine fisheries will collapse by 2050. Another major problem with wild fish stocks is contamination with PCBs, mercury and other heavy metals. Aquaculture is increasingly called upon to meet the growing shortfall in wild fish stocks and produce a safer product. However, aquaculture has been criticized for its use of environmentally delicate coastal land and its pollution of natural water bodies with nutrients and organic waste. Nearly a third of the feed given to cultured species goes toward the formation of sludge on a dry weight basis. However, on a wet weight basis the volume of sludge is considerably higher than its dry weight volume. Sludge can blanket the bottom sediments of water bodies, killing natural organisms that sustain wild fish populations and depleting dissolved oxygen. The waste nutrients from aquaculture operations cause the excessive growth of algae (eutrophication), which can drastically alter ecosystems and even precipitate total collapse. While the supply of seafood is under assault due to overfishing, environmental degradation and population growth, the need for a low-fat diet that seafood

provides has never been greater, as attested by the rampant obesity in American and proliferation diet-induced diseases such as high blood pressure and adult onset diabetes. Therefore, methods need to be developed for producing more seafood while reducing environmental impacts and these methods must be applied locally to meet demand as the high cost of fuel is making shipping prohibitively expensive. Recent results of the UVI biofloc system show that it is 37 times more productive than ponds culture. This means that the production of fish through biofloc technology reduces land and water use by more than 97%. Adoption of this technology will lead to greater availability of seafood, utilize fewer resources than current pond technology and minimize environmental impact. Solid and nutrient wastes, which are recovered from biofloc systems, can be used to fertilize and irrigate field crops and improve soil structure.

## 2. Scope of the Program

- In-State Research

### V(D). Planned Program (Assumptions and Goals)

#### 1. Assumptions made for the Program

The facilities for this program are in place. In addition to the present experimental biofloc systems, all ancillary support systems are in place such as electricity, water, storage, feed, chemicals, laboratory, computers and office space. The program is capable of breeding tilapia and producing fry and advanced fingerlings. There is capable staff of four trained and experienced aquaculturists, of which one has a PhD degree, two have MS degrees and one has a BS degree. The Aquaculture Program has a successful history of conducting research and disseminating the results through publications, conference presentations, seminars, workshops and short courses. There is considerable interest in biofloc technology. In 11 years, a 1-week short course has attracted 418 participants from 42 states and territories and 47 other countries. The Aquaculture Program in conjunction with the Cooperative Extension Service offers an additional short course during evenings and weekends to local farmers and the general public. The Aquaculture Program has been inundated with requests for information about biofloc systems and has received several requests to speak at conferences about these systems, which are seen by many in the aquaculture industry as a significant advance.

#### 2. Ultimate goal(s) of this Program

The ultimate goal of this program is to develop a highly productive, cost effect biofloc production system that is widely adopted by the aquaculture industry, which in turn leads to an increased supply of fish, a reduction in the seafood trade deficit, increased seafood consumption and improved health.

### V(E). Planned Program (Inputs)

#### 1. Estimated Number of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	2.0	0.0
2012	0.0	0.0	2.0	0.0
2013	0.0	0.0	2.0	0.0
2014	0.0	0.0	2.0	0.0
2015	0.0	0.0	2.0	0.0

### V(F). Planned Program (Activity)

#### 1. Activity for the Program

- Conduct research
- Conduct training

- Present data at conferences
- Publish results in scientific journals

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

Direct Methods	Indirect Methods

**3. Description of targeted audience**

The audience for this research consists of local farmers as well as national and international farmers, entrepreneurs, researchers, extension agents, development workers and teachers.

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:0                      2012:0                      2013:0                      2014:0                      2015:0**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	0	0	1
2012	0	0	1
2013	0	0	1
2014	0	0	1
2015	0	0	1

## V(H). State Defined Outputs

### 1. Output Target

- Abstracts presented at conferences

**2011:1**

**2012:1**

**2013:1**

**2014:1**

**2015:1**

- Journal articles

**2011:1**

**2012:1**

**2013:1**

**2014:1**

**2015:1**



**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Number of new farmers anywhere adopting biofloc technology

**Outcome # 1**

**1. Outcome Target**

Number of new farmers anywhere adopting biofloc technology

**2. Outcome Type : Change in Action Outcome Measure**

**2011:2**

**2012:2**

**2013:3**

**2014:3**

**2015:3**

**3. Associated Knowledge Area(s)**

- 307 - Animal Management Systems
- 403 - Waste Disposal, Recycling, and Reuse

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes

**Description**

Due to our location the Virgin Islands is subject to hurricanes which can hinder research projects. The local economy can also have a negative influence on state appropriations to the University.

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- During (during program)

**Description**

Program evaluation will be conducted informally based on the number of short course participants and reports of the application of the technology developed at the University of the Virgin Islands.

**2. Data Collection Methods**

- Observation

**Description**

We are generally contacted by people who set up commercial biofloc operations using the technology developed at the University of the Virgin Islands.

## V(A). Planned Program (Summary)

### Program # 2

#### 1. Name of the Planned Program

Aquaculture - Aquaponic Systems

#### 2. Brief summary about Planned Program

The UVI Aquaculture Program has been the vanguard for the development of aquaponic technology in the U.S. The impetus for this area of research has been the dry conditions in the Virgin Islands and the need to produce fish intensively and reuse the culture water. However, the accumulation of nutrients in the culture water in recirculating systems requires a greater water exchange (5%) rate than is feasible with limited water supplies. Incorporating hydroponic vegetables into the system reduces the exchange rate to 1.5%, recovers nutrients that would otherwise be wasted, and produces a valuable crop of vegetables. Additional aquaponic research is required to develop enterprise budgets for different plant crops, to assess fish stocking rates and feeding rate ratios, to test alternative feed sources, to evaluate component options, to recycle effluent, and to design a backyard system capable of providing enough fresh fish and vegetables for a family's needs. The facilities currently available are a small hobby-scale system, six replicated experimental raft aquaponic systems with a 14.3-m<sup>2</sup> plant growing area and one commercial-scale aquaponic system with a 214-m<sup>2</sup> plant growing area. The systems will be stocked with advanced tilapia fingerlings (~50 g), which will be fed three times daily *ad libitum* with a complete diet of floating pellets. After 24 weeks of culture, the fish will be harvested, weighed and counted to determine daily growth rate, average body weight, final rearing tank biomass, feed conversion ratio and survival. Vegetables will be seeded in trays to produce seedlings, which will be transplanted into net pots supported by floating polystyrene rafts. Biological methods will be used to control pests and diseases. At harvest the vegetables will be sorted into marketable and non-marketable categories and weighed. Production results for the best variety of each type of plant crop along with fish production results will be used to develop enterprise budgets for the commercial-scale aquaponic system. The UVI system currently employs clarifiers for settleable solids removal, filter tanks for fine solids removal and raft hydroponic tanks. To reduce the space requirements of clarifiers and filter tanks and their cost, compact swirl separators, parabolic filters and bead filters will be evaluated. The optimum feeding rate ratio for maximum plant growth will be determined for swirl separators and parabolic filters if they prove to be better than clarifiers and filter tanks. With more efficient solids removal the need for the addition of a moving bed biofilter will be evaluated. Nutrient film technique (NFT) is a viable option to rafts for the hydroponic component. Experiments will be conducted to determine NFT aquaponic design criteria and the advantages and disadvantages of NFT over raft culture. Effluent from the systems will be filtered through bags composed of a geotextile membrane (Geotube®) to produce a clear filtrate and organic solids. Alternative cheaper membranes will be evaluated. The use of the filtrate for field crop irrigation water or system makeup water will be evaluated. The solid waste will be evaluated as an organic fertilizer for field crop production or a composted media for producing vegetable seedlings in a greenhouse. Finally, a small hobby scale system will be tested for home use with the emphasis on producing a continuous supply of fish and vegetables for a family of four.

**3. Program existence :** Mature (More than five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)**

## 1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
205	Plant Management Systems			40%	
307	Animal Management Systems			30%	
403	Waste Disposal, Recycling, and Reuse			30%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

The Virgins Islands are semi-arid due to the relatively even the distribution of rainfall, constant trade winds, warm temperatures and high solar radiation. There are no rivers or streams and a very limited supply of fresh ground water. Vegetables are under water stress most months of the year, and there is a shortage of irrigation water available for producing them. Consequently, more than 95% of vegetables are imported. Likewise, the majority of seafood is imported. Local fish stocks have declined due to the overfishing of fragile reef ecosystems with traps and prices are skyrocketing. The discovery of the invasive and very predatory red lion fish poses another threat to the sustainability of the reef fishery. Consuming reef fishes poses another problem &ndash fish poisoning. Large predator reef fish often bioaccumulate a naturally occurring toxin known as ciguatera. Many people who consume large quantities of locally caught seafood have experienced fish poisoning, which often deters them from further seafood consumption and thus eliminates an important dietary source of nutrients and the health benefits associated with them. Imported frozen fish lack the quality of fresh fish and are not as appealing to consumers. Importation of most food items drains money from the local economy, which relies precariously on tourism. Agricultural development, including aquaculture, would help diversify and stabilize the economy and provide healthy food options. The Virgin Islands government is interested in expanding the agricultural sector and has increased funding. Health care providers are encouraging Virgin Islanders to adopt better diets, including the consumption of more fresh vegetables and fish, to stem the crisis of obesity, high blood pressure and adult onset diabetes. To overcome environmental constraints and increase local food supplies new production technology such as aquaponics is needed. The UVI Aquaculture Program has developed small and commercial aquaponic systems that are reliable, productive and well suited for the Virgin Islands. The UVI aquaponic commercial-scale system is capable of producing more approximately 25,000 lbs. of fish and vegetables on 1/8<sup>th</sup> acre of land with water supplied solely through rainwater harvesting. Adoption of aquaponic technology in the Virgin Islands would increase the local supply of fish and vegetables, improve the economy and provide health benefits to consumers.

**2. Scope of the Program**

- In-State Research

**V(D). Planned Program (Assumptions and Goals)****1. Assumptions made for the Program**

Facilities for this program are in place. In addition to present experimental and commercial aquaponic systems, all ancillary support systems are in place such as electricity, water, storage, feed, nursery, chemicals, laboratory, computers and office space. The program is capable of breeding tilapia and producing fry and advanced fingerlings. The program is also capable of producing vegetable seedlings in planting trays in a greenhouse. There is capable staff of four trained and experienced aquaculturists, of which one has a PhD degree, two have MS degrees and one has a BS degree. The Aquaculture Program has a successful history of conducting research and disseminating the results through publications, conference presentations, seminars, workshops and an annual short course. There is considerable interest in aquaponics. In 10 years, a 1-week short course has attracted 418 participants from 42 states and territories and 47 other countries. The Aquaculture

Program in conjunction with the Cooperative Extension Service offers an additional short course during evenings and weekends to local farmers and the general public. The program leader has written a quarterly question and answer column for 9 years for Aquaponics Journal, a trade publication with a circulation of 2,500. The Aquaculture Program is inundated with requests for information about aquaponic systems and receives numerous requests to speak at conferences about aquaponic systems.

**2. Ultimate goal(s) of this Program**

The ultimate goal of this program is to develop profitable aquaponic systems that are adopted by Virgin Islands farmers and used to increase the local supply of fresh fish and vegetables.

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	2.0	0.0
2012	0.0	0.0	2.0	0.0
2013	0.0	0.0	2.0	0.0
2014	0.0	0.0	2.0	0.0
2015	0.0	0.0	2.0	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

- Conduct research project
- Provide training
- Present data at conferences
- Publish results in scientific journals

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

Direct Methods	Indirect Methods

**3. Description of targeted audience**

The audience for this research consists of local farmers as well as national and international farmers, entrepreneurs, researchers, extension agents, development workers and teachers.

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:0                      2012:0                      2013:0                      2014:0                      2015:0**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	0	0	1
2012	0	0	1
2013	0	0	1
2014	0	0	1
2015	0	0	1

**V(H). State Defined Outputs**

**1. Output Target**

- Abstracts presented at conferences

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

- Journal articles

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Number of new farmers anywhere adopting aquaponic technology

**Outcome # 1**

**1. Outcome Target**

Number of new farmers anywhere adopting aquaponic technology

**2. Outcome Type : Change in Action Outcome Measure**

<b>2011:3</b>	<b>2012:3</b>	<b>2013:4</b>	<b>2014:4</b>	<b>2015:4</b>
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**3. Associated Knowledge Area(s)**

- 205 - Plant Management Systems
- 307 - Animal Management Systems
- 403 - Waste Disposal, Recycling, and Reuse

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes

**Description**

Due to our location the Virgin Islands is subject to hurricanes which can hinder research projects. The local economy can also have a negative influence on state appropriations to the University.

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- During (during program)

**Description**

Program evaluation will be conducted informally based on the number of short course participants and reports of the application of the technology developed at the University of the Virgin Islands.

**2. Data Collection Methods**

- Observation

**Description**

We are generally contacted by people who set up commercial aquaponic operations using the technology developed at the University of the Virgin Islands. We do not receive feedback on the number of hobby systems that are set up using UVI technology.



**V(A). Planned Program (Summary)****Program # 3****1. Name of the Planned Program**

Animal Science - Small Ruminants

**2. Brief summary about Planned Program**

The use of crossbred lambs in the USVI has increased dramatically. Unfortunately the outside breeds that are being used are not well suited to the local environment and conditions. The Dorper breed has been used extensively but the lambs produced do not have the high level of parasite tolerance that is found in the indigenous breeds of hair sheep. The lamb mortality after weaning at 63 days of age is quite high (up to 30%). This study will evaluate the effect of early vs. late weaning (63 vs. 90 d) on lamb survival and growth as well as ewe reproductive performance under an accelerated lambing system and extensive management.

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** No

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
301	Reproductive Performance of Animals			40%	
303	Genetic Improvement of Animals			10%	
307	Animal Management Systems			50%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

Farmers in the US Virgin Islands have purchased Dorper sheep to incorporate into their hair sheep flocks and interest about the performance of the breed under local conditions is increasing. By crossbreeding hair sheep with a large frame breed, such as the Dorper, it has been possible to increase the rate of gain of lambs produced. This has resulted in lambs that can be slaughtered at a younger age and require less resource input by the farmer. The crossbred lambs do not possess the same level of parasite tolerance as the indigenous hair sheep and mortality due to parasites is high (> 30%). Getting these lambs to survive to market is a top priority for the producers and they need to be able to do this to take advantage of the increased production traits.

**2. Scope of the Program**

- In-State Research

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

By weaning the crossbred lamb at a later age they may have a better chance of surviving. Their immune systems will be stronger and they will be getting more nutrition from the dams. When the lambs are weaned later they may be better able to adapt to a forage based diet and have a better tolerance of the potentially high parasite burdens.

**2. Ultimate goal(s) of this Program**

This project will evaluate a low cost management technique that has the potential to increase lamb survival. This will result in producers being able to get more lambs to market and increase their revenue.

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	1.0	0.0
2012	0.0	0.0	1.0	0.0
2013	0.0	0.0	1.0	0.0
2014	0.0	0.0	1.0	0.0
2015	0.0	0.0	1.0	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

- Conduct Research Experiments
- Publish results
- Present data at conferences

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

Direct Methods	Indirect Methods

**3. Description of targeted audience**

The target audience is hair sheep producers in the tropics and the southern US.

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:0                      2012:0                      2013:0                      2014:0                      2015:0**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	0	0	1
2012	1	0	1
2013	0	0	1
2014	1	0	0
2015	0	0	0

**V(H). State Defined Outputs**

**1. Output Target**

- Abstracts presented at conferences

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

- Journal articles

**2011:0                      2012:1                      2013:0                      2014:1                      2015:0**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Number of local farmers weaning sheep at 90 days of age

**Outcome # 1**

**1. Outcome Target**

Number of local farmers weaning sheep at 90 days of age

**2. Outcome Type : Change in Action Outcome Measure**

**2011:10                      2012:10                      2013:10                      2014:10                      2015:10**

**3. Associated Knowledge Area(s)**

- 301 - Reproductive Performance of Animals
- 303 - Genetic Improvement of Animals
- 307 - Animal Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes

**Description**

Due to our location the USVI is subject to hurricanes which can hinder research projects. The local economy can also have a negative influence on state appropriations to the university.

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- Other (Informal discussions)

**Description**

Feedback will be obtained from discussions with local farmers either as part of informal meetings or formal meetings (Advisory Board, Field Days, Ag Fair).

**2. Data Collection Methods**

- Other (informal discussions)

**Description**

Information obtained through informal discussions with farmers, as well as sales of crossbred animals from the research flock to farmers will be used.

**V(A). Planned Program (Summary)****Program # 4****1. Name of the Planned Program**

Animal Science - Beef Cattle

**2. Brief summary about Planned Program**

Managing cattle production cycles to take advantage of seasonal forage production has not been evaluated under the conditions found in the US Virgin Islands. Historically cattle producers bred cows at all times of the year which resulted in calves being born at all times of the year. Production information is needed on growth and reproductive characteristics of these tropically adapted cattle when they are managed more intensively than what has been done in the past. Even though one of the traits that are emphasized for this breed is a mild temperament, there is little information on the relationship between temperament and production traits in this breed. The heat tolerance of Senepol cattle makes them very well suited to the tropics. Evaluation of the genetic, physiologic and phenotypic traits that add to this heat tolerance will be evaluated. This information will allow cattle producers in the southern U.S. and Caribbean regions to make informed breeding decisions to profitably produce cattle under their environmental challenges found in the region.

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
301	Reproductive Performance of Animals			20%	
305	Animal Physiological Processes			10%	
306	Environmental Stress in Animals			30%	
307	Animal Management Systems			40%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

The Senepol breed originated on St. Croix in the early 1900's as a result of the efforts of local cattlemen to increase the meat and milk production of N'Dama cattle, originally from Senegal, that were being raised on St. Croix. The N'Dama cows were crossed with a Red Poll bull and with careful selection for specific traits such as red color, early maturity, no horns, gentle disposition and heat tolerance, the breed of cattle that is now known as Senepol was developed. The College of the Virgin Islands played a role in the establishment of the breed association in 1977 when the Virgin Islands Senepol Association was formed and the breed was officially classified. Since that time the Senepol breed has been recognized around the world for its ability to be productive under tropical conditions. The breed is found in the United States, Central and

South America, the Caribbean, Africa and Australia. The University of the Virgin Islands acquired a herd of Senepol cattle in January 2006 as a donation from a local ranch. This is a unique opportunity to utilize these cattle in a research program that could influence the selection goals of cattle populations throughout the tropical and subtropical areas of the country.

**2. Scope of the Program**

- In-State Research
- Multistate Research

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

Senepol cattle in the tropics can be managed to produce a calf every year. Selecting against animals that do not have a yearly calving interval will move the entire herd to a more productive level. Selecting animals based on temperament can also have a positive impact of growth and fertility. Introducing heifers to the breeding herd at an earlier age can increase lifetime productivity, assuming that they can have a second calf on schedule with the rest of the herd. Characterizing the traits that provide heat tolerance will allow selection or these traits to maximize the benefits under tropical conditions.

**2. Ultimate goal(s) of this Program**

The objectives of this project are to 1) evaluate production traits of Senepol cows managed for spring and fall calving in the tropics, and 2) evaluate the relationship between temperament and production traits of Senepol cattle, 3) increase the amount of information on what makes Senepol heat tolerant.

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	2.0	0.0
2012	0.0	0.0	2.0	0.0
2013	0.0	0.0	2.0	0.0
2014	0.0	0.0	2.0	0.0
2015	0.0	0.0	2.0	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

- Conduct research
- Publish results
- Present data at conferences
- Collaborate with other members of multistate project

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

<b>Direct Methods</b>	<b>Indirect Methods</b>
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**3. Description of targeted audience**

Beef producers in the tropics, greater Caribbean, Central and South America and the southern US.

**V(G). Planned Program (Outputs)****1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

2011:0

2012:0

2013:0

2014:0

2015:0

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	0	0	0
2012	1	0	1
2013	0	0	1
2014	1	0	0
2015	0	0	0



## **V(H). State Defined Outputs**

### **1. Output Target**

- Abstracts

<b>2011:2</b>	<b>2012:1</b>	<b>2013:1</b>	<b>2014:1</b>	<b>2015:1</b>
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- Journal articles

<b>2011:0</b>	<b>2012:1</b>	<b>2013:0</b>	<b>2014:1</b>	<b>2015:0</b>
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**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Number of cattle producers in the VI using managed breeding program
2	Number of cattle producers in the VI incorporating temperament into their selection criteria

**Outcome # 1**

**1. Outcome Target**

Number of cattle producers in the VI using managed breeding program

**2. Outcome Type : Change in Condition Outcome Measure**

**2011:1                      2012:1                      2013:1                      2014:1                      2015:2**

**3. Associated Knowledge Area(s)**

- 301 - Reproductive Performance of Animals
- 305 - Animal Physiological Processes
- 307 - Animal Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 2**

**1. Outcome Target**

Number of cattle producers in the VI incorporating temperament into their selection criteria

**2. Outcome Type : Change in Action Outcome Measure**

**2011:1                      2012:1                      2013:1                      2014:1                      2015:2**

**3. Associated Knowledge Area(s)**

- 305 - Animal Physiological Processes
- 306 - Environmental Stress in Animals
- 307 - Animal Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes

**Description**

Due to our location the USVI is subject to hurricanes which can hinder research projects. The local economy can also have a negative influence on state appropriations to the university.

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- Other (informal producer feedback)

### **Description**

During workshops and field days, input will be sought from local producers as to how they are adopting the result of the research.

## **2. Data Collection Methods**

- Unstructured

### **Description**

**V(A). Planned Program (Summary)****Program # 5****1. Name of the Planned Program**

Plant Biotechnology

**2. Brief summary about Planned Program**

Plant biotechnology will involve the use of molecular biology, tissue culture and conventional breeding for the development of tropical crop plants with enhanced characteristics. The characteristics to be focused on are disease resistance in papaya and grapes, starch modification of cassava and micropropagation systems for pineapple. Focus will be on breeding virus resistance in early bearing large fruited papaya varieties. Genetically enhanced cassava will be developed and evaluated for the starch quality. Transgenic grapes have been developed for disease resistance; however they have not been grown under field conditions. Trials in a vineyard will be undertaken to determine the level and consistency of the imparted disease resistance. An efficient low tech system will be developed for the micropropagation of virus free sweet potato that can be utilized throughout the Caribbean and developing countries.

**3. Program existence :** Mature (More than five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** No

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
201	Plant Genome, Genetics, and Genetic Mechanisms			20%	
204	Plant Product Quality and Utility (Preharvest)			40%	
206	Basic Plant Biology			40%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

Papaya ringspot virus is a devastating disease plaguing papaya production throughout the tropical growing regions. Tolerance is possible through simple plant breeding. Cassava starch production has potential as a value added commodity as well as use in biofuels. Cassava is drought tolerant and productive on poor soils. Both situations are found in the U.S. Virgin Islands. Table as well as wine-making grapes are beset upon by three major diseases which limit their growth and production in the Caribbean. These diseases include powdery mildew, downy mildew and Pierce's disease. To curb the total import of table grape for local consumption disease resistant varieties need to be developed. Micropropagation has the potential to quickly increase the number of plants in a short amount of time.

**2. Scope of the Program**

- In-State Research

**V(D). Planned Program (Assumptions and Goals)****1. Assumptions made for the Program**

A major assumption is that genes, inserted through genetic engineering will result in plants with the characteristics desired that are stable over multiple generations. Our results have indicated that genetic stability can be maintained for at least three generations. Transgenic plants have not been a concern to farmers and consumers that have seen the benefits that disease resistance, obtained through molecular techniques, can have on production and fruit quality. They have been supportive of this work and have seen the potential benefits that result from it. The public will be kept informed of the research being conducted, and their questions will be answered regarding any concerns they may have. Sweet potato has been grown in tissue culture and found to produce multiple shoots on a limited number of varieties. It is expected that new varieties and old cultivars will respond similarly with slight modifications to the plant tissue culture medium.

## 2. Ultimate goal(s) of this Program

Papaya – To develop virus resistant transgenic early bearing lines with high fruit quality on a compact plant and demonstrate that transgenic fruits are safe to grow. Cassava – Use molecular genetics to isolate and develop genetically enhanced plants through breeding with modified starch quality that can be used for industrial purposes. Pineapple – To develop a micropropagation system for the in vitro multiplication of pineapple that can be achieved with minimal technical equipment and applicable to the Caribbean region. Grape – To apply genetic engineering for the development of disease resistant table grapes that can be grown in tropical environments.

### V(E). Planned Program (Inputs)

#### 1. Estimated Number of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	1.0	0.0
2012	0.0	0.0	1.0	0.0
2013	0.0	0.0	1.0	0.0
2014	0.0	0.0	1.0	0.0
2015	0.0	0.0	1.0	0.0

### V(F). Planned Program (Activity)

#### 1. Activity for the Program

- Conduct research project
- Develop genetically enhanced plants
- Develop efficient micro-propagation systems
- Present data at conferences
- Develop fact sheets for the local population
- Publish results in scientific journals

#### 2. Type(s) of methods to be used to reach direct and indirect contacts

##### Extension

Direct Methods	Indirect Methods

#### 3. Description of targeted audience

The target audiences are the local crop farmers and back yard growers. These producers normally have less than two acres under production. The Virgin Islands has only three producers with total production acreage over

two acres.

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:0                      2012:0                      2013:0                      2014:0                      2015:0**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	0	0	0
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0

**V(H). State Defined Outputs**

**1. Output Target**

- Number of publications

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Number of local farmers growing micro-propagated sweet potato, cassava and hybrid papaya



**Outcome # 1**

**1. Outcome Target**

Number of local farmers growing micro-propagated sweet potato, cassava and hybrid papaya

**2. Outcome Type : Change in Action Outcome Measure**

<b>2011:2</b>	<b>2012:2</b>	<b>2013:3</b>	<b>2014:3</b>	<b>2015:3</b>
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**3. Associated Knowledge Area(s)**

- 201 - Plant Genome, Genetics, and Genetic Mechanisms
- 204 - Plant Product Quality and Utility (Preharvest)
- 206 - Basic Plant Biology

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Other (Fed certification of transgenics)

**Description**

Due to our location the USVI is subject to hurricanes which can hinder research projects. The local economy can also have a negative influence on state appropriations to the university. Federal certification for public release requires multiple years of field trials and documentation to obtain approval and approval is not guaranteed.

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- Retrospective (post program)
- Other (Informal discussions)

**Description**

Feedback will be obtained from discussions with local farmers either as part of informal meetings or formal meetings (Advisory Board, Workshops, Field Days, Ag Fair).

**2. Data Collection Methods**

- Whole population
- On-Site
- Observation

**Description**

{NO DATA ENTERED}

**V(A). Planned Program (Summary)****Program # 6****1. Name of the Planned Program**

Plant Germplasm Conservation and Enhancement

**2. Brief summary about Planned Program**

The use and maintenance of diverse germplasm are the key elements of successful plant breeding programs. The conservation and use of a comprehensive collection of genetically varied cultivated plants and their relatives are the biological foundation for the long term success of U.S. agricultural producers. Different selection and evaluation methods are used to develop cultivars within and among different tropical crop species, but elite germplasm is necessary in all instances to develop new superior cultivars. Evaluation, development and enhancement require long term commitments (20 to 40 years) to produce superior germplasm sources. Today the goal for project completion involves a 5 to 10 year time horizon. To ensure future genetic advances, a long term commitment is needed to increase genetic diversity of cultivated crops and to develop and enhance elite germplasm.

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** No

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
202	Plant Genetic Resources			80%	
205	Plant Management Systems			20%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

The Caribbean basin is a source of multiple tropical fruit and root crop species used in the local diet. Some of the established varieties still commonly grown by farmers are over 100 years old as found in cassava and pineapple. These old varieties need to be conserved for their genetic integrity. However, some of these varieties may not be the most productive or have the quality of some of the newer selected varieties. Import and quarantine restrictions limit the farmer's choice of plant material. The University of the Virgin Islands plays a key role in bringing in new varieties, evaluating them for their fruit quality and production potential and using them as breeding stock to improve existing material. In the USVI a preference is for larger, 1.2-kg fruit in papaya. However, most commercial export varieties developed in Hawaii produce 0.25 to 0.5 kg fruit. Breeding and selection is needed to incorporate the sweeter and firmer fruit characteristics into the larger fruited Caribbean varieties. Sorrel, *Hibiscus sabdariffa*, is a seasonal plant grown for its calyx used in making a nonalcohol drink. Sorrel is susceptible to high pH calcareous soils found on many farms and germplasm needs to be evaluated to find more high pH soil tolerant lines to extend the crop choices available to farmers and back yard growers.

**2. Scope of the Program**

- In-State Research

**V(D). Planned Program (Assumptions and Goals)****1. Assumptions made for the Program**

Early bearing papaya varieties have been developed and are being utilized by farmers. However, pests and diseases continue to plague the crop. Breeding and selection is needed to continue to make improvements to the crop. Sweet potato have been gaining interest on the island. Farmers are looking for a productive and high quality fruit producing plant. The established Caribbean varieties have viruses. Sorrel and sweet corn has potential for increased production with expanded the variety selection available to growers.

**2. Ultimate goal(s) of this Program**

- Papaya: Develop and enhance germplasm to broaden the genetic base for disease and pest resistance through breeding and selection. Improve the yield and fruit quality with the development of early bearing cultivars.
- Sweet potato: Identify plant varieties with improved fruit quality and high productivity in sustainable, integrated cropping systems.
- Cassava: Evaluate germplasm with modified characteristics to improve the production and quality of the starch.
- Orchids: Develop tissue culture protocols for the seed germination of the remaining two native species.

**V(E). Planned Program (Inputs)****1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	1.0	0.0
2012	0.0	0.0	1.0	0.0
2013	0.0	0.0	1.0	0.0
2014	0.0	0.0	1.0	0.0
2015	0.0	0.0	1.0	0.0

**V(F). Planned Program (Activity)****1. Activity for the Program**

- Conduct research project
- Sell papaya seeds to local framers
- Present data at conferences
- Develop fact sheets for local growers
- Publish results in scientific journals

**2. Type(s) of methods to be used to reach direct and indirect contacts****Extension**

Direct Methods	Indirect Methods

**3. Description of targeted audience**

The target audiences are the local crop farmers and back yard growers. These producers normally have less than two acres under production. The Virgin Islands has only three producers with total production acreage over two acres.

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:0                      2012:0                      2013:0                      2014:0                      2015:0**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	0	0	0
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0

**V(H). State Defined Outputs**

**1. Output Target**

- Number of publications

**2011:1                      2012:1                      2013:1                      2014:1                      2015:0**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Number of local farmers growing selected plant varieties

**Outcome # 1**

**1. Outcome Target**

Number of local farmers growing selected plant varieties

**2. Outcome Type : Change in Action Outcome Measure**

**2011:2**

**2012:2**

**2013:3**

**2014:3**

**2015:0**

**3. Associated Knowledge Area(s)**

- 202 - Plant Genetic Resources
- 205 - Plant Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes

**Description**

Due to our location the USVI is subject to hurricanes which can hinder research projects. The local economy can also have a negative influence on state appropriations to the university.

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- During (during program)

**Description**

Feedback will be obtained from farmers that grow and evaluate new varieties released under their growing environment (Workshops, Field Days, Ag Fair).

**2. Data Collection Methods**

- Sampling

**Description**

On farm interviews with farmers growing new varieties.

**V(A). Planned Program (Summary)****Program # 7****1. Name of the Planned Program**

Horticulture

**2. Brief summary about Planned Program**

Vegetable crops are grouped according to priority and economic importance. Grouping is based on market and consumer demands. Vegetable groups consist of: 1) high-demand crops (tomato, cucumber, okra, hot pepper, and eggplant); and 2) low demand crops (collard greens, beans, cantaloupes, watermelons, onions, squash, and beet). Cultivars for each vegetable crop will be evaluated for two or three seasons each year using sustainable vegetable production methods including organic fertilizers and mulches, and rotation with cover crops (lablab) as green manure. Sustainable production systems will be compared to conventional production systems. Cultivar selection will be based on disease resistance characteristics according to the prevailing disease incidence in the USVI.

**3. Program existence :** Mature (More than five years)

**4. Program duration :** Medium Term (One to five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** No

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
102	Soil, Plant, Water, Nutrient Relationships			30%	
202	Plant Genetic Resources			30%	
205	Plant Management Systems			30%	
216	Integrated Pest Management Systems			10%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

The horticulture industry in the U.S. Virgin Islands (USVI) is in the state of continuous decline attributed to a decreasing number of farmers over the years. Presently, 95% of the agriculture commodities consumed in the territory is imported. Crop production is constrained by poor soil and water characteristics, high incidence of pests and diseases, poor crop management practices including the use of old and low yielding crop cultivars, and high costs of imported inputs. Vegetables can be produced all year round and there is high market demand for them, but farmers fail to meet this demand due to inefficient cropping system and management method that restrict crop performance. High quality produce demands good market prices, which can be achieved only if farmers use improved crop management practices. This program focuses on the selection of pest and disease resistant cultivars integrated with crop rotation and cover crops to improve soil quality and fertility for year-round production of high quality fruits and vegetables. Development of sustainable production systems for vegetable crops is important to reduce production costs and increase profitability of USVI farmers, and to reduce the dependency of imported agricultural commodities.

**2. Scope of the Program**

- In-State Research

## V(D). Planned Program (Assumptions and Goals)

### 1. Assumptions made for the Program

Disease resistant varieties have been reported to perform successfully in reducing the incidence of a particular disease. These varieties, however, have been bred under intensive input management systems and their performance under low input conditions is unknown. Consequently, there is a need to identify and evaluate new vegetable cultivars for the best fit under low input sustainable production systems in the USVI. Many studies have reported the benefits of cover crops in reducing weeds, fixing nitrogen, recycling nutrients, and adding organic matter to the soil. In addition, cover crops and crop rotations offer potential in integrated pest management of vegetable crops that may reduce the use of expensive pesticides. The use of disease resistant varieties and sustainable management practices are expected to reduce disease incidence and production cost of vegetable crops in the USVI.

### 2. Ultimate goal(s) of this Program

This program will develop low-cost and profitable production systems for year-round vegetable production in the USVI. Varieties with reduced pesticide and fertilizer requirements will be readily adopted by farmers with limited resources. Increasing production of vegetable crops will impact positively in the local economy by reducing imports from the mainland and other Caribbean countries.

## V(E). Planned Program (Inputs)

### 1. Estimated Number of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	1.0	0.0
2012	0.0	0.0	1.0	0.0
2013	0.0	0.0	1.0	0.0
2014	0.0	0.0	1.0	0.0
2015	0.0	0.0	1.0	0.0

## V(F). Planned Program (Activity)

### 1. Activity for the Program

- Conduct research
- Present data at conferences
- Publish results in scientific journals

### 2. Type(s) of methods to be used to reach direct and indirect contacts

#### Extension

Direct Methods	Indirect Methods



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**3. Description of targeted audience**

The target audiences are the local crop farmers and back yard growers. These producers normally have less than two acres under production. The Virgin Islands has only three producers with total production acreage over two acres.

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

2011:0                      2012:0                      2013:0                      2014:0                      2015:0

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	0	0	0
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0

## V(H). State Defined Outputs

### 1. Output Target

- Research publications

**2011:1**

**2012:1**

**2013:1**

**2014:1**

**2015:0**

- Abstracts presented at conferences

**2011:1**

**2012:1**

**2013:1**

**2014:1**

**2015:0**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Selection of pest and disease resistant cultivars

**Outcome # 1**

**1. Outcome Target**

Selection of pest and disease resistant cultivars

**2. Outcome Type : Change in Action Outcome Measure**

**2011:10**

**2012:10**

**2013:10**

**2014:10**

**2015:10**

**3. Associated Knowledge Area(s)**

- 202 - Plant Genetic Resources

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes

**Description**

The occurring storms and hurricanes in the USVI can affect results of research projects. The local economy may have negative effect on state appropriations to the University.

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- Retrospective (post program)
- During (during program)

**Description**

Feedback from extension educators and farmers will be obtained during and after program through formal and informal meetings.

**2. Data Collection Methods**

- Whole population
- On-Site
- Observation

**Description**

{NO DATA ENTERED}

**V(A). Planned Program (Summary)****Program # 8****1. Name of the Planned Program**

Irrigation

**2. Brief summary about Planned Program**

Field experiments will be conducted in the US Virgin Islands (USVI) to improve micro-irrigation strategies and water use efficiency in horticultural crops. Soil moisture monitoring devices (capacitance based sensors) will be integrated with control systems to provide feedback for irrigation scheduling and optimization of water use. The strategies will be based on soil moisture levels of 10, and 30 kPa in comparison to fixed irrigation scheduling and rain-fed control for vegetables and fruit trees, respectively. In addition, horticultural crops will be grown in a shade-house under micro-irrigation to reduce water requirements. Water use under 30%, 50% and 70% shade will be measured to determine evapo-transpiration coefficients and water use efficiency.

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** No

**V(B). Program Knowledge Area(s)**

## 1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships			30%	
111	Conservation and Efficient Use of Water			30%	
132	Weather and Climate			10%	
205	Plant Management Systems			10%	
405	Drainage and Irrigation Systems and Facilities			20%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

Water is the most limiting constraint to agricultural production in the USVI. Existing ponds and dams are not sufficient to effectively store water for agricultural purposes. Underground water is used primarily for urban consumption together with desalinized seawater which makes it very expensive for the horticultural industry. Growers are aware of the benefits of micro-irrigation technology. However, water costs and availability as well as irrigation strategies have shown to be the limiting factor for crop production and hence for adoption. Knowledge about automatic control systems and water management strategies as well as water requirements (crop coefficients) will contribute to improve irrigation efficiency and water use efficiency. In addition, promoting production of shade loving crops will also increase water use efficiency and reduce water requirements for crop production in the USVI.

**2. Scope of the Program**

- In-State Research

- Multistate Research

**V(D). Planned Program (Assumptions and Goals)**

**1. Assumptions made for the Program**

Irrigation strategies based on soil water availability and plant requirement will improve irrigation efficiency. Soil moisture levels maintained slightly below field capacity and amount of water applied according to evapo-transpiration will reduce losses by percolation and run off. In the case of shade crops, less water will be needed to dissipate the reduced solar energy reaching the plant canopy. In addition, ground and air temperature as well as wind will decrease and relative humidity will increase under shade reducing evapo-transpiration. Excess of shade, however, may reduce photosynthesis affecting yield and crop quality.

**2. Ultimate goal(s) of this Program**

The ultimate goal of this program is adoption of irrigation strategies based on soil moisture and water requirements (evapo-transpiration) to increase irrigation efficiency in the USVI. A second long term goal is to increase production of shade crops to increase water use efficiency and, consequently, reduce water requirements and the dependency on expensive off farm irrigation water.

**V(E). Planned Program (Inputs)**

**1. Estimated Number of professional FTE/SYs to be budgeted for this Program**

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	1.0	0.0
2012	0.0	0.0	1.0	0.0
2013	0.0	0.0	1.0	0.0
2014	0.0	0.0	1.0	0.0
2015	0.0	0.0	1.0	0.0

**V(F). Planned Program (Activity)**

**1. Activity for the Program**

- Conduct research projects
- Present data at conferences
- Publish results in scientific journals

**2. Type(s) of methods to be used to reach direct and indirect contacts**

**Extension**

Direct Methods	Indirect Methods

**3. Description of targeted audience**

The target audiences are the local crop farmers and back yard growers. These producers normally have less than two acres under production. The Virgin Islands has only three producers with total production acreage over two acres.

**V(G). Planned Program (Outputs)**

**1. Standard output measures**

**Target for the number of persons(contacts) to be reached through direct and indirect contact methods**

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:0                      2012:0                      2013:0                      2014:0                      2015:0**

**3. Expected Peer Review Publications**

Year	Research Target	Extension Target	Total
2011	0	0	0
2012	0	0	0
2013	0	0	0
2014	0	0	0
2015	0	0	0

**V(H). State Defined Outputs**

**1. Output Target**

- Abstract presented at conference

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

- Research publications

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Number of farmers adopting irrigation strategies based on soil moisture
2	Knowledge of fertigation and chemigation use in vegetable crop production



**Outcome # 1**

**1. Outcome Target**

Number of farmers adopting irrigation strategies based on soil moisture

**2. Outcome Type : Change in Action Outcome Measure**

**2011:3                      2012:3                      2013:4                      2014:4                      2015:4**

**3. Associated Knowledge Area(s)**

- 102 - Soil, Plant, Water, Nutrient Relationships
- 111 - Conservation and Efficient Use of Water
- 132 - Weather and Climate
- 205 - Plant Management Systems
- 405 - Drainage and Irrigation Systems and Facilities

**4. Associated Institute Type(s)**

- 1862 Research

**Outcome # 2**

**1. Outcome Target**

Knowledge of fertigation and chemigation use in vegetable crop production

**2. Outcome Type : Change in Knowledge Outcome Measure**

**2011:4                      2012:4                      2013:4                      2014:4                      2015:4**

**3. Associated Knowledge Area(s)**

- 102 - Soil, Plant, Water, Nutrient Relationships
- 111 - Conservation and Efficient Use of Water
- 132 - Weather and Climate
- 205 - Plant Management Systems
- 405 - Drainage and Irrigation Systems and Facilities

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)**

**1. External Factors which may affect Outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes

**Description**

The occurring storms and hurricanes in the USVI can affect research projects and adoption of new technology. Costs of the technology may affect adoption also.

**V(K). Planned Program (Evaluation Studies and Data Collection)**

**1. Evaluation Studies Planned**

- Retrospective (post program)
- During (during program)

**Description**

Feedback from extension educators and farmers will be obtained during and after program through formal and informal meetings.

**2. Data Collection Methods**

- Whole population
- On-Site
- Observation

**Description**

{NO DATA ENTERED}

**V(A). Planned Program (Summary)****Program # 9****1. Name of the Planned Program**

Agronomy - Mixed Cover-Crop Livestock Systems

**2. Brief summary about Planned Program**

In developing countries, mixed crop-livestock systems are the most common form of livestock operation and they provide globally over 50% of the meat and over 90% of the milk. The addition of livestock into a smallholder farming system diversifies food and revenue producing capabilities through the production of dairy and meat products, which make the overall system more complex and sustainable. Cover crops may be able to play an integral part in the complex dynamics of mixed crop-livestock production systems and serve to meet organic crop agroecological needs. This project assess the potential of tropical leguminous and graminaceous annuals and perennials to serve a dual role as both a livestock forage source and a cover crop/green manure for soil improvement in tropical organic mixed crop-livestock agroecosystems. Rapid growth of the cover crops from optimum environmental conditions may allow the selected crops to produce abundant biomass throughout the growing season that can be used as a livestock forage and produce enough plant biomass that meet the needs of a CC/GM for subsequent crop production cycles. This research provides critical first steps in developing cover crop management strategies which will improve and maintain the requirements of a cover crop in cash crop production rotations and as a productive livestock forage resource without compromising the sustainability of each independent production system.

**3. Program existence :** Intermediate (One to five years)

**4. Program duration :** Long-Term (More than five years)

**5. Expending formula funds or state-matching funds :** Yes

**6. Expending other than formula funds or state-matching funds :** Yes

**V(B). Program Knowledge Area(s)****1. Program Knowledge Areas and Percentage**

<b>KA Code</b>	<b>Knowledge Area</b>	<b>%1862 Extension</b>	<b>%1890 Extension</b>	<b>%1862 Research</b>	<b>%1890 Research</b>
101	Appraisal of Soil Resources			10%	
204	Plant Product Quality and Utility (Preharvest)			30%	
205	Plant Management Systems			30%	
302	Nutrient Utilization in Animals			10%	
307	Animal Management Systems			20%	
	<b>Total</b>			100%	

**V(C). Planned Program (Situation and Scope)****1. Situation and priorities**

Small farm holders operating under limited external input farming conditions depend on the production of a diversity of farm products to be sold and consumed on the farm and in the extended family community. This includes agronomic, horticultural and livestock products that are produced in mixed crop-livestock systems. Cover crops can provide a crucial link between organic farming and livestock production. When planted during fallow periods between main crops, cover crops can improve soil physical, chemical, and biological properties and consequently lead to improved soil health and yield of principal crops. Livestock incorporation can provide valuable additional revenue to small holder farmers and can serve as a primary

source of organic fertilizer through added manure production. This will result in closed system nutrient cycling where the farm is recycling nutrients from cover crop to livestock to cash crop. Therefore, cover crops may be able to serve to build and improve soils for cash crop production, as well as provide forage in the form of principle grazing, stored hay, cut and carry forage or green chop for livestock production.

## 2. Scope of the Program

- In-State Research

### V(D). Planned Program (Assumptions and Goals)

#### 1. Assumptions made for the Program

In order to meet the requirements for a successful mixed cover crop-livestock system, agricultural plants must be selected that serve well as a cover crop and as livestock forage. Therefore it is necessary to identify crops that are able to withstand grazing pressure, contain high forage quality, produce high above-ground and below-ground biomass, can support multiple harvest dates, exhibit rapid re-growth, and provide competitiveness with weed populations. To be a beneficial cover crop, plants need to exhibit rapid germination and emergence, competitiveness, tolerance to adverse climatic and soil conditions, ease of suppression, fertility benefits, adequate biomass accumulation, and inexpensive establishment. Therefore, a crop that can serve in a dual role as a cover crop and a forage crop in mixed cover crop-livestock system must possess characteristics from each profile. Cover crops can serve a wide range of functions in conventional and organic agriculture. Different cover crops are selected to meet requirements for specific producer needs. Data shows that in organic crop production the overriding purpose of cover crop inclusion in a rotational cropping system is to protect topsoil, increase fertility through nutrient recycling, nitrogen fixation, and increasing organic matter, and to provide some level of pest control to reduce insect, weed, nematode, or pathogen incidence. Data also indicates that cover crop rotations can increase subsequent crop yields by maintaining or increasing soil fertility. It is crucial to identify, test, and select those tropical plants that hold the highest potential for providing as many of the attributes for a superior livestock forage and cover crop for low external input organic mixed cover crop-livestock systems.

#### 2. Ultimate goal(s) of this Program

- Evaluate tropical grasses and legumes for use as dual purpose crops to meet the requirements of a productive and beneficial cover crop and serve as valuable livestock forage. Crops to be evaluated will include sorghum sudan grass (*Sorghum bicolor* x *S bicolor*, var. mega green), sunn hemp (*Crotalaria juncea*, var. tropic sunn), and lab lab (*Lablab purpureus*, var. rongai). All selections have been previously tested by UVI-AES and have demonstrated excellent adaptation to the area and have proven independently to be excellent cover crops and/or forage crops, but have yet to be evaluated as a dual crop individually or in grass/legume combinations.
- Evaluate the re-growth competitiveness of sorghum sudan grass, sunn hemp, and lab lab in monoculture and in grass/legume combinations against tropical weeds under three different harvest intervals in organic mixed cover crop-livestock systems.
- Evaluate *Crotalaria juncea* (cv. Tropic Sun) as a viable hay source for small ruminant production in mixed cover crop-livestock systems.
- Determine cover crop and forage removal impact on soil fertility and nutrient composition.

### V(E). Planned Program (Inputs)

#### 1. Estimated Number of professional FTE/SYs to be budgeted for this Program

Year	Extension		Research	
	1862	1890	1862	1890
2011	0.0	0.0	2.0	0.0

Year	Extension		Research	
	1862	1890	1862	1890
2012	0.0	0.0	2.0	0.0
2013	0.0	0.0	2.0	0.0
2014	0.0	0.0	2.0	0.0
2015	0.0	0.0	2.0	0.0

### V(F). Planned Program (Activity)

#### 1. Activity for the Program

- Conduct research project
- Present data at conferences
- Publish results in scientific journals
- Conduct local and regional seminars

#### 2. Type(s) of methods to be used to reach direct and indirect contacts

##### Extension

Direct Methods	Indirect Methods

#### 3. Description of targeted audience

The target audience consists of local and regional farmers.

### V(G). Planned Program (Outputs)

#### 1. Standard output measures

Target for the number of persons(contacts) to be reached through direct and indirect contact methods

	Direct Contact Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Year	Target	Target	Target	Target
2011	0	0	0	0
2012	0	0	0	0
2013	0	0	0	0
2014	0	0	0	0
2015	0	0	0	0

**2. (Standard Research Target) Number of Patent Applications Submitted**

**2011:0                      2012:0                      2013:0                      2014:0                      2015:0**

**3. Expected Peer Review Publications**

<b>Year</b>	<b>Research Target</b>	<b>Extension Target</b>	<b>Total</b>
2011	1	0	1
2012	1	0	1
2013	1	0	1
2014	1	0	1
2015	1	0	0

**V(H). State Defined Outputs**

**1. Output Target**

- Abstracts presented at conferences

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

- Articles published in scientific journals

**2011:1                      2012:1                      2013:1                      2014:1                      2015:1**

**V(I). State Defined Outcome**

O. No.	Outcome Name
1	Outcomes will be measured by the number of local farmers that utilize cover crop technologies in mixed crop-livestock production systems and the number of farmers who use the tested cover crops for soil improvement and as livestock forage.

**Outcome # 1****1. Outcome Target**

Outcomes will be measured by the number of local farmers that utilize cover crop technologies in mixed crop-livestock production systems and the number of farmers who use the tested cover crops for soil improvement and as livestock forage.

**2. Outcome Type : Change in Action Outcome Measure****2011:2****2012:2****2013:2****2014:2****2015:2****3. Associated Knowledge Area(s)**

- 101 - Appraisal of Soil Resources
- 204 - Plant Product Quality and Utility (Preharvest)
- 205 - Plant Management Systems
- 302 - Nutrient Utilization in Animals
- 307 - Animal Management Systems

**4. Associated Institute Type(s)**

- 1862 Research

**V(J). Planned Program (External Factors)****1. External Factors which may affect Outcomes**

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes

**Description**

Due to our location the USVI is subject to hurricanes which can hinder research projects. In addition, St. Croix experiences a prolonged dry season which when coupled with limited water resources can provide for a highly variable and unpredictable growing season. The local economy can also have a negative influence on state appropriations to the university.

**V(K). Planned Program (Evaluation Studies and Data Collection)****1. Evaluation Studies Planned**

- Retrospective (post program)

**Description**

Feedback will be obtained from discussions with local farmers either as part of informal meetings or formal meetings (Advisory Board, Field Days, Ag Fair).

**2. Data Collection Methods**

- Other (Informal discussions)



**Description**

Information obtained through informal discussions with farmers.