HOOLEHUA PLANT MATERIALS CENTER

2007 TECHNICAL REPORT

Piligrass
Heteropogon contortus

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Hoolehua Plant Materials Center
2007

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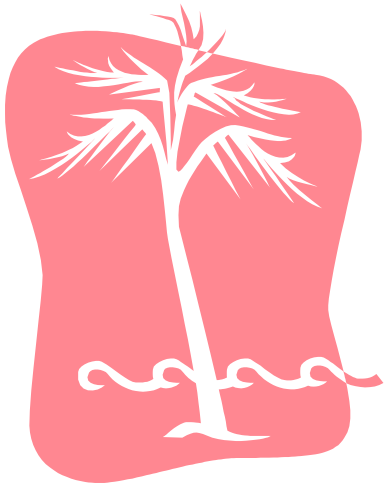

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HOOLEHUA PLANT MATERIALS CENTER
ANNUAL TECHNICAL REPORT 2007

INTRODUCTION

Mission
The mission of the Natural Resources Conservation Service (NRCS) Plant Materials Program is to develop, test and transfer state-of-the-art plant science technology to meet customer and resource needs. The Hoolehua Plant Materials Center's activities are consistent with the objectives of the current United States Department of Agriculture and NRCS Strategic Plan.

Location/History
The Hoolehua Plant Materials Center was originally established on the island of Maui in l957. The center was moved to an 80 acre site on the island of Molokai in 1973. Molokai, the fifth largest island in the Hawaiian chain, is 38 miles long and 11 miles wide (261 sq. miles). Now located in the Hoolehua plains area of Molokai, the Center is situated on the leeward or 'dry' side of the island at an elevation of 400 ft. The annual rainfall at the Center is approximately 21 inches per year with most of the rainfall occurs during the months of November through March.

PMC Physical Facilities
Buildings
The Center consists of six main facilities, a 30 ft. x 50 ft. office a 30 ft x l00 ft steel seed cleaning building, a 30 ft x 200 feet tile equipment storage building, a 22 ft x 40 ft shadehouse, and the NRCS Field Office and the Molokai/Lanai Soil and Water Conservation District Office.

Soils
The soil at the Hoolehua PMC consists of the Holomua series. This well-drained soils on the uplands of Molokai was developed in volcanic ash and material weathered from andesite rock. The surface layer is a dark reddish-brown silt loam about 9 inches deep. The upper part of the subsoil is dark reddish-brown silt loam, and the lower part of the subsoil is dark reddish-brown and dark-brown silty clay loam that has prismatic structure. The subsoil is 40 to 60 inches deep and the substratum is soft, weathered rock. Permeability is moderate. Runoff is slow and erosion hazard is slight. The mean annual soil temperature is 74 degrees Fahrenheit.

Irrigation

The Hoolehua PMC receives its gravity fed water from the Molokai Irrigation System (MIS). This water is a mixture of both well and surface water that originates approximately 10 miles from the Center on the mountainous slopes of Molokai. The Hoolehua PMC conveys its water to its test plots, increase blocks, and windbreaks through a network of underground water conveyance systems that utilizes both drip and sprinkler irrigation. Presently, there is over 25,000 feet of drip irrigation lines throughout the facility.

Hoolehua PMC Service Area

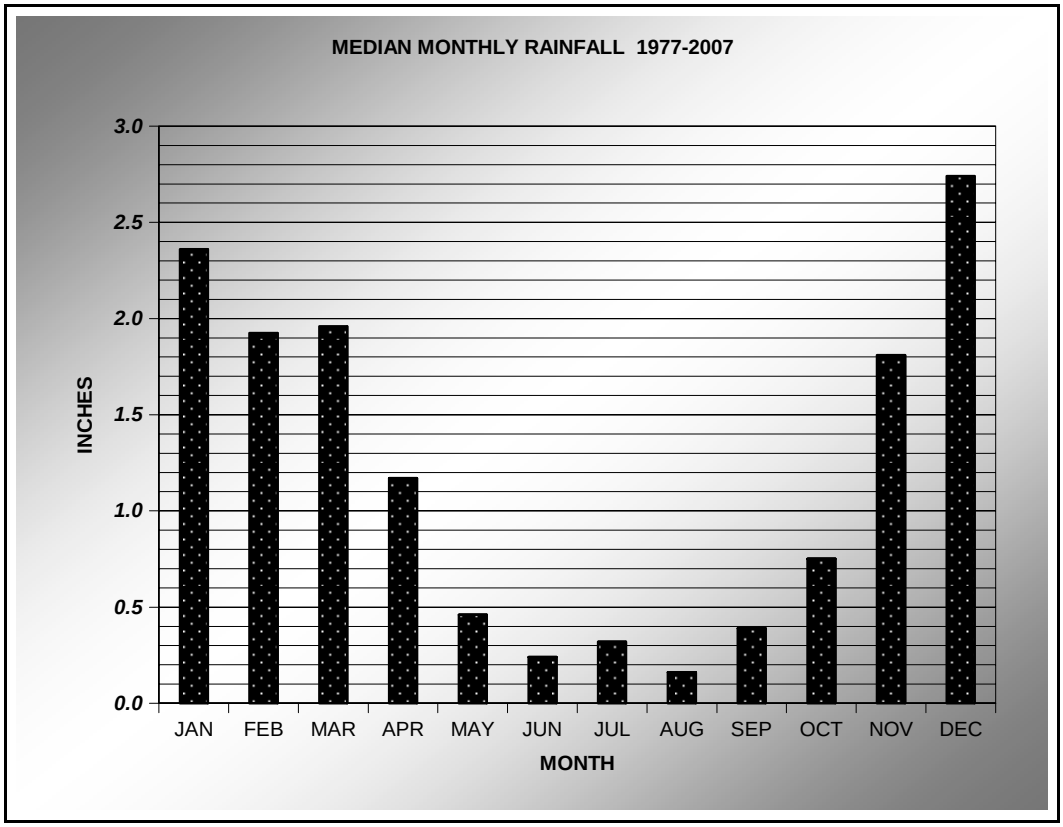
The center is responsible for servicing the needs of the State of Hawaii, the Territory of Guam, The Republic of Palau, The Republic of the Marshall Islands, the Territory of American Samoa, the Commonwealth of Northern Mariana Islands and the Federated States of Micronesia.

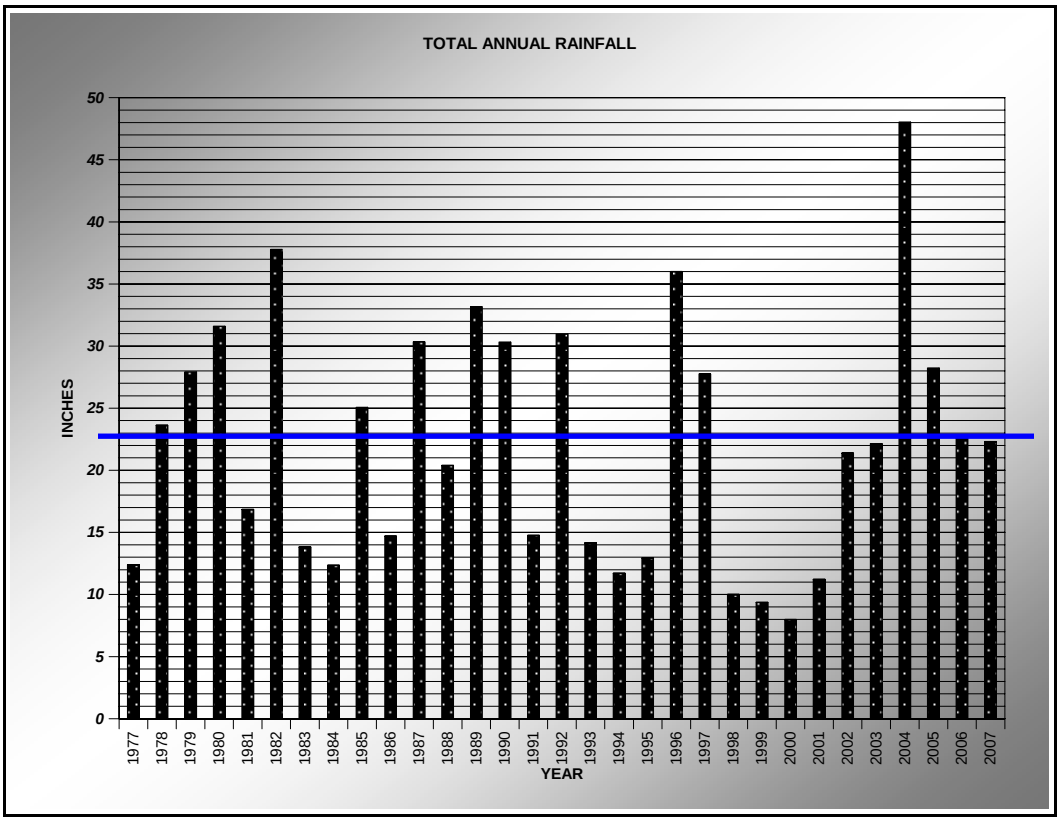
The islands owe their shape primarily to volcanic building and have been modified by erosion under strongly localized conditions. Elevations of the various islands vary from sea level to over 13,000 feet.

Soils are derived from volcanic lava, eruptive deposits of ash, tuff and cinders, and limestone and alluvial deposits from coral reefs. Age and a variety of parent material, plus extreme ranges in rainfall have resulted in a complexity of soils. Rainfall ranges from less than 10 inches to over 390 inches annually. The heaviest rains generally fall on the windward side of the mountains. The driest areas are semi-desert in character and vegetation is generally sparse. The difference in temperature between the coolest and warmest months of the year, at a given location, is usually not more than six to seven degrees. Tradewinds are fairly constant throughout the year with 15-25 miles per hour velocity being common. Land use is diversified and ranges from large acreages devoted to ranching, sugarcane, macadamia nuts, and pineapple to smaller acreages planted to truck crops, fruit and nut orchards, and subsistence farming. Some of the many different crops produced on these small farms include: banana, taro, bean, cucumber, watermelon, green pepper, tapioca, tomato, bitter melon, coconut, sweet potato, yam, papaya, onion, cabbage, radish, lettuce, cantaloupe, pumpkin, guava, sweet corn, betel nut, avocado, citrus, macadamia nut, coffee, breadfruit, and ornamental plants.

Agricultural operations range from highly mechanized agri-business plantations to hand-cultivated subsistence farms. Crop lands, regardless of the type of agricultural operation, range from relatively flat to very steep terrain. Primary conservation needs requiring plant materials include cover crops for orchards (especially macadamia nuts). Examples of use: protect sugarcane land between harvests, low-competing cover crops for inter-planting with sugarcane to protect the soil for the first six months, green manure crops for soil improvement and cover, windbreak plants, plants for stabilizing aqua-culture pond banks and shorelines, plants for permanent vegetative cover on waterways and other erosion prone areas, improved plants for range and pasture, plants for new practices such as vegetative row barriers (contour hedgerows), alley cropping, living mulch, and plants for filter strips.

HOOLEHUA PLANT MATERIALS CENTER RAINFALL DATA





PMC Current Priorities and Objectives

The Hawaii PMC is currently involved in addressing the following concerns:

- Source of Seed and Vegetative Materials for Plants Recommended in the Technical Guide Developing native plants to address resource concerns
- Living Mulch for Cultivated Crops
- Windbreaks for Crop Lands
- Cover Crops in Orchards
- Bioengineered Solutions for Stream/Slope Problems
- Plants for Agroforestry
- Cover/Green Manure Crops
- Plants for Vegetative Barriers
- Provide Plant Materials and Technical Assistance to the Kahoolawe Island Reserve Commission (KIRC)
- Plant Techniques to Control Invasive Species
- Improved Pasture and Range Grasses and Legumes

The Plant Materials Testing Process

To meet the needs and objectives of the Plant Materials Long Range Plan for Hawaii and the Pacific Basin, the Center performs the following procedures for its plant testing process:

1. Identification of problem. A particular problem is identified and is prioritized in the Long Range Plan.
2. Assembly. A collection of accessions having the potential for solving a problem or part of a problem is assembled from local and foreign collections, other Plant Materials Centers, Universities, plant breeders, and commercial seed companies.
3. Initial observation. Assembled planting materials are planted in rod row plantings and growth characteristics are noted and compared to each other and to the standards now in use. Accessions with better characteristics than the standard are then selected for further testing.
4. Initial increase. Promising accessions from the initial observation are increased in small plots to supply material for further testing.
5. Secondary testing. Further observations and comparisons to the standard are made using appropriate techniques. Information on establishment, management, and seed production is gathered. Plants that continue to exhibit better characteristics than the standard are selected for further testing.
6. Large scale increase. Large increase plantings are made of accessions selected from secondary testing to provide sufficient materials for final testing in field size plantings on farms of district cooperators.
7. Plants that have proven themselves in actual field plantings are named and released in cooperation with the University of Hawaii Institute of Tropical Agriculture and Human Resources, University of Guam, and other agencies. Seeds and plants are then made available for commercial production.

HAWAII PLANT MATERIALS CENTER RELEASES

Accession: *Crotalaria juncea*, cv. 'Tropic Sun'

Description: An erect branching annual legume that will grow to a height of 6 to 8 feet. Leaves are elliptical and flowers yellow. Sunn hemp is resistant to root-knot and reniform nematodes.

Use: Green manure and nematode control. Windbreak, alley cropping, and vegetative row barriers if re-seeded periodically as needed.

Culture: Established by broadcasting or drilling 40 to 60 pounds per acre. Seed must be inoculated. When grown for green manure, the crop should be plowed under before bloom stage, when nitrogen is high and decomposition rapid. This is important when maximum quantity of nitrate is desired immediately, as for truck crops. Normally, it should be plowed under within (60) days after planting.

Accession: *Erythrina variegata*, cv. 'Tropic Coral'

Description: A leguminous tree approximately (40) feet tall, very erect with numerous branches coming out of a single trunk. Growth habit resembles common panax, only on a larger scale. It is related to the wiliwili tree, but is not as well adapted to the dry lands as the 'Tropic Coral'. A fast-growing tree when adequate moisture is available.

Use: It has been used extensively as a windbreak, but may have uses as a vegetative row barrier and for alley cropping.

Culture: Established by rooted cuttings or by cuttings placed directly in the field. Supplemental irrigation should be provided in areas with less than 50 inches of rainfall.

Accession: *Paspalum hieronymii*, cv. 'Tropic Lalo'

Description: A low-growing stoloniferous grass. Its growth habit is similar to hilograss, but it forms a much tighter sod. When mowed, it becomes mat-like. Normal growth height is 4 to 10 inches. However at the PMC it has reached a height of 35 inches when grown under irrigation and not mowed for (6) months. It will tolerate heavy use such as equipment traffic.

Use: Ground cover in orchards, critical areas, filter strips to enhance water quality, heavy use areas, and grassed waterways.

Culture: Established by stolons and seed. The plant is a poor seed producer so propagation is mainly by vegetative means. Depending on growing conditions, it normally needs mowing once every 1 to 2 months. It can be mowed very close, less than one-half inch. It will grow in approximately 50 to 60 percent shade. Planting rates on 3 feet centers is equivalent to 40 bushels of stolons per acre.

Accession: *Paspalum vaginatum*, cv. 'Tropic Shore'

Description: A salt-tolerant perennial grass. Will grows to heights of 22 inches. It produces a thick mat of stolons at or just above the low-tide level which makes it excellent for stabilizing banks from wave action. It is adapted to coral sands of denser soils. Prawns will utilize the forage.

Use: Stabilizing banks on fish ponds, shoreline stabilization, re-vegetation of saline soils, and for lawns, pastures, and fairway where salt is a problem.

Culture: Established vegetatively. Seed is not available.

Accession: *Neonotonia wightii*, cv. 'Tropic Verde'

Description: A trailing, twining, herbaceous, perennial legume with slender, well branched stems. It grows to height of about 2½. Bright green leaves are trifoliate. There are approximately 58,000 seeds per pound.

Use: Recommended as a drought tolerant legume for range and pasture improvement and erosion control.

Culture: Established best by seed using standard seed drill or broadcasting in well prepared, weed free seedbed at a rate of 2 to 5 pounds per acre pure live seed (pls) for range, pasture, and hayland plantings. Increase rate to 40 pounds pls per acre for critical eroding areas. Plant seed ½ to 1 inch deep and lightly cover with harrow or roller.

Accession: *Dodonaea viscosa*, Kamiloloa Germplasm Aalii

Description: An indigenous native shrub or small tree. Normally grows to a height of three to over eleven feet. Leaves are elliptical, waxy, dark green or crinkled. The flowers are very small with female flowers developing into attractive paper lantern-like capsules that are dark maroon, red, pink and green in color. Extremely drought resistant and can grow from sea level to over 7,000 feet.

Use: Ecosystem restoration, stabilizing highly erodible sites, improving wildlife habitat, landscaping and windbreak. Released to address specific ecotype from the Maui Nui Group, which includes the islands of Maui, Lanai, Molokai and Kahoolawe

Culture: Established best by seed. For windbreak establishment plant seed ¼" to ½" deep and lightly cover with harrow or roller

Accession: *Heteropogon contortus*, Kahoolawe Germplasm Piligrass

Description: Piligrass is an erect, branching perennial that may form rather large bunches up to 5 feet tall under optimum conditions. Under natural conditions in Hawaii, it grows 1 to 3 feet tall. The long-awned seeds are sharp pointed forming tangled masses as they mature. When the seeds come in contact with moisture the hygroscopic awns and sharp barbed tips arch and twist, planting them into the soil. Piligrass has a world-wide distribution and is found in the warm tropical regions of both hemispheres.

Use: Primary recommendation for this grass would be vegetation to aid erosion control. Piligrass also has the potential for ecosystem restoration, re-vegetation of degraded habitats, and to increase diversity in riparian and other communities.
Culture: Piligrass seeds are able to germinate almost anywhere. If transplants are desired, it is recommended that piligrass be propagated in a shade house. Piligrass seeds have a dormancy period of about 6 months. After two months, seedlings should be exposed to direct sunlight and allowed to harden-off. They should be ready for transplanting to the field after 2 weeks of exposure to direct sunlight.

Accession: *Eragrostis variabilis*, Kahoolawe Germplasm Kawelu

Accession: *Chenopodium oahuense*, Kahoolawe Germplasm Aweoweo

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	HIPMC-P-9702-WL
Title	Wildlife Enhancement with Native Plants
National Project No.	Wildlife 1.1
Study Type	Initial Evaluation
Study Status	Active
Location	HIPMC
Study Leader	Glenn Sakamoto
Duration	1997 - 2006
Cooperators	

Land Use	Cropland		
Vegetative Practices	Primary	342	CRITICAL AREA PLANTING
	Secondary		
Resource Concern(s)	Resource	Consideration / Problem	
	Soil	Soil Erosion / wind	
		Soil Erosion / water	
Long Range Plan	Study falls under Part I, Section D of the HIPMC Multiyear Plan		

Objective:
To assemble and evaluate growth characteristics of native dry-land forest accessions for conservation use on severely eroded lands receiving less than 40 inches of precipitation annually.

Status of Knowledge:
Rapid establishment of permanent vegetative cover on critical areas such as stream-banks, roadsides, and steep hillsides is often difficult because of erosion, infertile soil, and unfavorable water-relations. Stream-bank protection is becoming increasingly important and plants that are easily propagated and established are needed. There is a need for plants that can survive under adverse conditions such as low fertility, fluctuating soil moisture, and minimum maintenance. They should be able to self-establish rapidly and have a strong root system. This study was initiated due to the growing concerns of re-establishing native dry-land forest trees for conservation use, especially in low elevation and low rainfall zones. Progressive land use change, the demise of native dry-land habitat and the ever increasing need for more plant growth information has prompt further investigation on native dry-land forest trees.

Materials and Methods:
Collections of native dry-land forest seeds will be assembled from five major island groups which included Molokai, Lanai, Kauai, Maui and Hawaii with the assistance of the NRCS field office personnel and volunteers. Assembly of native seeds will be difficult due to the variability in fruiting times of plant species. Fruiting times of native plants within the same species also vary from year to year and island to island. As seeds become available they will be propagated in a shade-house and moved to initial testing plots. Most of the seeds that will be propagated in the shade-house will be mechanically scarified by slightly nicking the seed with a knife to promote germination. Plants will be evaluated on growth height, vigor, disease/ insect tolerance and mortality. Irrigation will be 18hrs, once a week, using a 10gph shrub irrigator.

DISCUSSION:

The *Erythrina sandwicensis* assembly (accession# 9079696; 9079697; 9079698; 9079699; 9079700; 9079702; 9079703; 9079704; 9079705; 9079706) are collections from West Molokai at Okoli gulch. After four years of growth these accessions have an average height of 4.66m and average width of 5.27m. Once established these native trees are exceptionally fast growing and produce an abundance of thorny branches. Its sturdy trunk ranges from 20-40cm wide when measured 30cm above ground. *E. sandwicensis* continues to grow in height and produces a spreading canopy with a fair amount of foliage. To this date no flowering has been observed and also no major insect or disease problems have occurred. Powder mildew is noticeable during the rainy season but does not affect the overall vigor of the tree.

The thornless *E. sandwicensis*, accession #907920 was received as a rooted cutting from the island of Kauai. Its growth characteristic is similar to the West Molokai type and presently has an average height of 3.45m and width of 5.3m. The thornless, less offensive accession of *E. sandwicensis* make it an ideal candidate for urban areas as well as farmstead situations.

The *Sesbania tormentosa* assembly (accession #9079718 and #9079743) are collections from the upland district of Kawela on Molokai. Acc. #9079718 was planted from seed and Acc. #9079743 was propagated by cuttings. The *S. tormentosa* collected in Kawela is the upright-growth form, unlike the smaller shrub-type found at arid, coastal, lower elevation areas. Of the twelve plants planted, nine are still remaining. The average height is 4.65m the tallest being 6.57m. The average width is 6.43m. Once established, *S. tormentosa* is a very rapid growing leguminous tree, but lodges considerably by the wind. Both terminal trunk and branches are easily wind trained, but continues to grow well despite being exposed to strong trade winds. It produces an abundance of attractive flowers (summer months) that are salmon to orange-red in color. Disease problems have been noted in several of the test plots and several trees have exhibited die-back. The primary cause for the dieback has not been identified but preliminary observation suggests a fungal disease to the root system followed by secondary injury by a stem-boring

beetle. Seed production is abundant but is severely affected by a pod-boring insect that penetrates young seed pods to lay their eggs. The young larvae that emerge then devour the developing seed.

FY2005

Accessions have been evaluated for longevity and vigor. The Erythrina Gall Wasp has devastated the native Erythrina species of the entire state of Hawaii. There is no known way to suppress this pest. Erythrina accessions are under close observation as to its tolerance to this pest.

FY2006

The erythrina accessions have deteriorated significantly with some trees even dieing due to the infestation of the EGW. On the other hand, there are a number of other accessions that will be selected for further study. Milo will be evaluated for stream bank stabilization. Alahee and kauila will be evaluated for infield windbreak systems. Kului shows promise for critical planting. Koa and kou are large trees that could be useful for revegetation projects. Due to the size and age of the various accession, many of the trees will be retained for demonstration purposes.

List of Plant Accessions in Trial

	Species	common name	Accession#	number planted	date planted
1	Erythrina sandwicensis	wiliwili	9079696	1	3-Oct-1996
2	E. sandwicensis	wiliwili	9079697	1	3-Oct-1996
3	E. sandwicensis	wiliwili	9079698	1	3-Oct-1996
4	E. sandwicensis	wiliwili	9079699	1	3-Oct-1996
5	E. sandwicensis	wiliwili	9079700	1	3-Oct-1996
6	E. sandwicensis	wiliwili	9079701	2	3-Oct-1996
7	E. sandwicensis	wiliwili	9079702	1	3-Oct-1996
8	E. sandwicensis	wiliwili	9079703	1	3-Oct-1996
9	E. sandwicensis	wiliwili	9079704	1	3-Oct-1996
10	E. sandwicensis	wiliwili	9079705	1	3-Oct-1996
11	E. sandwicensis	wiliwili	9079706	1	3-Oct-1996
12	Sesbania tomentosa	ohai	9079718	11	3-Oct-1996
13	S. tomentosa	ohai	9079719	1	3-Oct-1996
14	Sophora chrysophylla	mamane	9079720	10	3-Oct-1996
15	S. chrysophylla	mamane	9079721	10	3-Oct-1996
16	Acacia koa	koa	9079686	9	27-Feb-1997
17	Caesalpinia kavaiensis	uhiuhi	9079707	4	27-Feb-1997
18	E. sandwicensis	wiliwili	9079687	2	27-Feb-1997
19	E. sandwicensis	wiliwili	9079688	1	27-Feb-1997
20	E. sandwicensis	wiliwili	9079689	1	27-Feb-1997
21	E. sandwicensis	wiliwili	9079690	1	27-Feb-1997
22	E. sandwicensis	wiliwili	9079691	1	27-Feb-1997
23	E. sandwicensis	wiliwili	9079692	1	27-Feb-1997
24	E. sandwicensis	wiliwili	9079693	1	27-Feb-1997
25	E. sandwicensis	wiliwili	9079694	1	27-Feb-1997
26	E. sandwicensis	wiliwili	9079695	1	27-Feb-1997
27	Metrosidoros polymorpha	ohia	9079708	10	27-Feb-1997
28	Thespesia populnea	milo	9079685	6	27-Feb-1997
29	Hibiscus brackenridgei	mao hau hele	9079709	11	30-Apr-1997
30	Hibiscus rockii		9079710	7	30-Apr-1997
31	Myroporum sandwicense	naio	9079712	2	13-Aug-1997
32	S. chrysophylla	mamane	9079713	10	28-Dec-1998
33	M. polymorpha	ohia	9079714	10	12-Nov-1999
34	Cordia subcordata	kou	9079684	6	27-Feb-2000
35	Renoldsia sandwicensis	ohe makai	9079715	1	13-Jun-2000
36	R. sandwicensis	ohe makai	9079716	11	13-Jun-2000
37	Alphitonia ponderosa	kauila	9079717	10	20-Jun-2000
38	Canthium ordoratum	alahee	9079721	3	20-Jun-2000
39	Nesoluma polynesicum	keahi	9079748	6	30-Aug-2001
40	Scaevola	naupaka	9079755	1	30-Aug-2001

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code HIPMC-T-9801-WI
Title Acacia koaia Windbreak Establishment

National Project No. Forestland 1.1
Study Type Initial
Study Status Active

Location HIPMC
Study Leader Glenn Sakamoto
Duration 1998-2006
Cooperators -Hawaii Soil Water Conservation Districts

Land Use Cropland
Vegetative Practices Primary 342 CRITICAL AREA PLANTING

Resource Concern(s)	Resource	Consideration / Problem
	Soil	Soil erosion / wind
	Air	Air Quality / air pollutants

Long Range Plan Study falls under Objective 2.1, Section C of the HIPMC Long Range Plan.

Objective
To evaluate Acacia koaia, a native hardwood tree, for windbreak potential. This includes propagation and cultural techniques for establishment.

Status of Knowledge

Experimental Design and Materials

Final Evaluations
Field plantings will be installed in each of the MLRAs found in Hawaii to test regional adaptation of materials tested at the PMC.

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	HIPMC-S-9902-CR
Title	Kahoolawe Island Native Plant (Piligrass) Restoration Initiative
National Project No.	Natural Areas 1.1
Study Type	Advanced Evaluation
Study Status	Active

Location	HIPMC
Study Leader	Glenn Sakamoto
Duration	1999 - 2006
Cooperators	Kahoolawe Island Reserve Commission (KIRC)

Land Use	Cropland		
Vegetative Practices	Primary	342	CRITICAL AREA PLANTING
	Secondary	550	RANGE PLANTING
Resource Concern(s)	Resource	Consideration / Problem	
	Soil	Soil Erosion / wind	
		Soil Erosion / water	
Long Range Plan	Study falls under Objective 2.2, Section A of the HIPMC Long Range Plan		

Objective:
To develop large-scale management techniques for *Heteropogon contortus*, this will include propagation, establishment, and harvesting. The technical data and plant materials produced will be provided to the K.I.R.C. to aid in the restoration of highly erodible sites on the island of Kahoolawe.

Status of Knowledge:
The maximum use of plants presently recommended is limited by the lack of reliable commercial seed sources. The problem is compounded by import regulations, the quarantine on millet seeds, and the quarantine on vegetative material of grasses. There is a need for readily available sources of native seed and vegetative material that are approved for conservation practices. Field plantings of native plants are needed in areas where agriculture is changing.

Native plants require special considerations to maintain their genetic integrity. It may be necessary to identify sources of natives on each island for propagating and planting on that island. Some native species that are already well-distributed throughout the island chain could be mass-produced by the PMC, in cooperation

with state and other federal agencies, for distribution to the public until supplies become commercially available.
Conservation efforts with the use of native plants have been an ongoing challenge for the island of Kahoolawe. Efforts in re-introducing natives to the island have been somewhat successful, but only on a very small magnitude. There is a need to develop a plant material source and technology in the large-scale production of native plant species. *Heteropogon contortus,* or more commonly known as piligrass, has the potential to fill this need. Primary recommendation for this grass would be vegetation to aid erosion control. Piligrass also has the potential for ecosystem restoration, re-vegetation of degraded habitats, and to increase diversity in riparian and other communities.

Piligrass is an erect, branching perennial that may form rather large bunches up to 5 feet tall under optimum conditions. Under natural conditions in Hawaii, it grows 1 to 3 feet tall. There is extensive variation within this species throughout its range. The stems are flattened, rather tough, smooth, and a pale bluish-green. Leaves are produced throughout the length of the stem and are flat or folded, 4-12 inches long, about 0.25 inches wide and rough to the touch. The flowering heads have narrow, crowded flower spikes up to 4 inches long. The spikelets overlap and each fertile one bears a conspicuous red-brown awn about 4 inches long, made crooked with two bends. The long-awned seeds are sharp pointed forming tangled masses as they mature. When the seeds come in contact with moisture the hygroscopic awns and sharp barbed tips arch and twist planting them into the soil. Piligrass has a world-wide distribution and is found in the warm tropical regions of both hemispheres.

Materials and Methods:
Because we are sending the plant materials produced by this trial directly to Kahoolawe, we want to use seed that is from the gene pool of the Maui Nui island group. *Heteropogon contortus*, Acc# 9079683, was collected from the island of Kahoolawe in the early 1990's. An increase plot of this seed will be established to provide seed material for our larger increases.

Propagation: Germination tests of the seed produced and stored will be performed on a regular basis to determine germination rates. Seeds will be stored by different methods to determine ideal storage conditions. Seedlings for field increase will be propagated in a shade-house environment.
Seeds for field increase will be germinated in 13 x 26 x 3 inch, 200 cell trays. Commercial sterile potting mix and perlite, 2:1 respectively will be used as the potting media. Seeds were sown ¼ inches deep and irrigated once daily in full sunlight. At 2 weeks of growth, a soluble fertilizer (10-20-10) will be applied at a rate of 1 tbs. per gallon, once a week for three weeks. At 5-6 weeks, a slow-release fertilizer (14.5-14.5-14.5) will be applied at a rate of 36 grams per tray.

Establishment: Fields will be installed between mature windbreak systems. Irrigation will be provided by an over-head sprinkler system at rate of 1 acre inch per week. Fertilizer amendments will be made according to soil tests. Chemical and manual weed control will be performed regularly.

Seedlings 3 months old will be transplanted with a single row mechanical transplanter in a well prepared, firm, weed free seedbed. Field9A will be planted in rows 40 inches apart and plants in each row spaced 2ft apart. Field10B will be planted in rows 36 inches apart and plants in each row spaced 2ft apart. Row spacing was determined by the tractor wheel-base. A pre-emergent herbicide (Dactyl W-75) will be applied at a rate of 16 lbs. per acre.

Harvesting: Various harvesting techniques will be tried to determine which will be ideal for *H. contortus*.

DISCUSSION:

Heteropogon contortus is a native perennial grass that does very well as a crop. At the Molokai PMC we are able to harvest our fields about every 3 months. After the last harvest, the field will grow for about 2 months. After 2 months the seed heads are just about 50% mature and beginning to 'tangle'. We would then cut the irrigation and let the field mature for another month or so, depending on when the field is at least 75% mature. At that point in time the field is ready to harvest. After the field is harvested, it is mowed down to a uniform 10-12 inches high. Grass clippings are left on the field to be utilized as mulch to aid control weeds and moisture retention. Supplemental fertilizers were added after every other harvest at a rate of 100 lbs. of nitrogen per acre, alternating between "Triple-16" and "Urea". Our data shows significantly higher yields during the months from June to September.

FY1999

Total seed harvested: 103.5 lbs.

Combine (M-17 Massey Fergusen):

There were three methods that we wanted to try using the combine to harvest the pili. One method was combining with no manipulation to the crop (green). Another method was to desiccate the field using a contact-herbicide (Finale), followed by the combine. The third method was to cut the field down with a rotary-mower, let it dry, and then picked up by the combine. All attempts to harvest *H. contortus* with the combine proved futile. Direct combining failed due to the high moisture content of the grass. For all situations, the combine failed to condition the seeds to an acceptable state due to the sharp pointed callus, long awns and tangling characteristics of the seed. The combine's concave, straw walkers, shakers, sieves, augers, everything became clogged preventing seeds from entering the hopper. Numerous attempts were made to try and minimize the clogging; adjusting fan speeds, removing screens, concave adjustment, installation of plates on the concave, and even constructing a catchment system that was pulled behind the combine to catch seeds being blown out. Fortunately, we were able to harvest some seed but only for a short duration before the combine would get clogged. It was obvious that using the combine was not the way to harvest *H. contortus* seed.

Grass Stripper (Flail-VAC by AgRenewel):
Failed attempts with the combine prompted the use of the Flail-VAC. The Flail-VAC is a rotary brush stripper that is attached to the front-end loader of a farm tractor and powered by an independent PTO-driven hydraulic system. The grass stripper enabled the harvesting of seeds without the use of desiccants and also provided the opportunity to repeatedly enter the field to collect remaining seeds as they matured. The amount of stems/foliage (unwanted material) collected along with the seed was minimal and could be separated during the cleaning phase. The Flail-VAC is able to harvest *H. contortus* seed sufficiently.

FY2000

Total seed harvested: 117lbs.

Baling:
Bales have had a lot of success being used for erosion control. It was only natural for the PMC to consider baling the *H. contortus*. At maturity the field is cut down with a VICON rotary-mower to a height of about 12-16 inches. The field is then allowed to dry for 2-3 days. The cut-grass is then flipped and raked into windrows with a BEFCO Side Delivery Rake for easier baling. These windrows are then allowed to dry for another day. After the final day of drying, the field is ready to be baled. Next fiscal year will be our first harvest for bales.

Seed Cleaning:
Numerous attempts were made at cleaning *H. contortus* seed to a usable state. Brush machines, hammermills, cement mixers, and threshers all failed at the task. The barbed callus and twisting nature of *H. contortus* awns made cleaning the seed very difficult. The hammermill did separate seeds and awns, but seed damage occurred regardless of blade adjustments. The small portable threshers worked best but did not break the awns small enough to pass through any seed clipper cleaners. The Almaco thresher is a portable, intermediate, thresher with an 8 HP gas engine, rasp bar type cylinder and grass concave. The overall dimensions are 112” x 72” x 54”. Seed that was harvested was run through the thresher twice using a 6mm grass sieve, concave was fully closed and cylinder speed set at slowest speed. We were able to condition the seed with the Almaco thresher so final seed cleaning could be done with The Seedburo100. The Seedburo100 seed and grain cleaner was used more as a seed scalper. Attempts to use the cleaner under “normal” seed cleaning conditions failed. The physical nature of *H. contortus* made separation of seed and awns virtually impossible with the machinery available. Seeds were not able to flow through hoppers, grain elevator or flow over screens. Fan speeds did not allow for appreciable separation of seeds and was not used. In the end a 1/16 round holed screen was used to separate as much awns as possible from the seed.

FY2001

Total seed-bales: 105 Total hay-bales: 495
An additional 1.4 acres has been planted in Field10A to increase production. The entire field was planted by hand with the help from volunteers (TREE). 1tbs. of 10-

30-10 fertilizer was applied for each plug. 10,584 plants were planted on 3/7/2001. Field was irrigated with a "Big Gun" waterwheel sprinkler. The "Big Gun" did not have enough reach to cover the entire field, so over-head impact sprinklers had to be installed. Two rows of pili had to be removed to make room for the new irrigation lines. Together with the insufficient irrigation and the direct application of fertilizer, there was a very high mortality rate for the seedlings. 5,605 seedlings had to be replanted by hand.

Fabricated Attachment ("PILI COMB" by David Duvauchelle):

Even though the Flail-VAC was 'doing' the job, we needed something a little more effective. Developed on the PMC, the "PILI COMB" is a simple fabrication of angle iron and re-bar. The angle iron provided the frame that re-bars lengths could be welded to, forming a large "comb" that could be attached to the bucket of the front-end loader. The tractor would then drive through the field with the height of "comb" set to the height of the seed heads. Only mature seed was removed and immature seed was left behind. At the end of the field the tractor would dump the seed that was collected into a truck and it would be ready for another pass. Virtually no unwanted material was collected along with the seed. Whatever immature seed that was left behind could be harvested later when they had matured. The "PILI COMB" proved to be the best way to harvest *H. contortus* for seed.

FY2002

Total hay-bales: 954 Total seed-bales: 11

February 2002, Field10A had its first harvest; 96 hay-bales.

Seed Bales:

It was discovered that the awn of the seed actually planted the seed into the soil. Not separating the seed from the awn could be beneficial to conservation work. With this in mind we tried baling the harvested seed. These seed- bales were a lot less bulky than the hay bales. For each harvest there was less material to work with as well. Because of the harsh conditions of pili seed-cleaning we will no longer be cleaning the seed. On the other hand, if the seed is desired for conservation work, we bale the seed harvested with the "PILI COMB".

FY2003

Total hay-bales: 2050

An additional 0.8 acres was been planted in Field6A to increase production for the Kahoolawe project.

FY2004

Total hay-bales: 1940 Total seed-bales: 12

FY2005
Total hay-bales: 2381

FY2006
Total hay-bales: 1927

The total number of bales produced is an indication that soil fertility has diminished. Soil samples were taken from each field and sent to the University of Hawaii for analysis. The results confirmed our suspicions that indeed nutrient levels were low and pH had dropped to unacceptable levels. With this information we can speculate that from a single planting one can expect about 4-5 years of good hay-bale production. After that time it is recommended that the field be conditioned to raise the pH level.

Due to the cut of all Congressional Earmark monies, this will be the last year that plant materials will be produced for the KIRC. It is anticipated that a reimbursable contract will be initiated to continue production. Until that time, no more bales will be produced. With production halted, this is an ideal time to turn the fields under for conditioning according to the soil tests.

Piligrass hay-bale Production

Fiscal Year 2001

Date	F-6A	Date	F-9A	Date	F-10A	Date	F-10B
		10/11/2000	119			10/11/2000	67
		1/16/2001	49			1/16/2001	32
		8/29/2001	140			8/29/2001	88
0		308		0		187	
			FY Total:	495			

Fiscal Year 2002

Date	F-6A	Date	F-9A	Date	F-10A	Date	F-10B
		11/19/2001	70	2/6/2002	96	11/19/2001	35
		3/25/2002	45	5/23/2002	175	4/11/2002	33
		6/25/2002	78	8/16/2002	205	6/25/2002	58
		9/16/2002	103			9/16/2002	56
0		296		476		182	
			FY Total:	954			

Fiscal Year 2003

Date	F-6A	Date	F-9A	Date	F-10A	Date	F-10B
		12/13/2002	72	11/6/2002	167	12/13/2002	43
		4/4/2003	146	2/24/2003	179	4/4/2003	76
		6/26/2003	185	6/5/2003	151	6/26/2003	93
7/14/2003	76	9/17/2003	303	8/28/2003	415	9/15/2003	144
76		706		912		356	
			FY Total:	2050			

Fiscal Year 2004

Date	F-6A	Date	F-9A	Date	F-10A	Date	F-10B
10/1/2003	219	12/22/2003	78	11/18/2003	300	12/22/2003	57
12/22/2003	129						
8/18/2004	344	7/28/2004	268	7/6/2004	421	7/28/2004	124
692		346		721		181	
			FY Total:	1940			

Fiscal Year 2005

Date	F-6A	Date	F-9A	Date	F-10A	Date	F-10B
11/12/2004	70	10/22/2004	128	10/6/2004	220	10/22/2004	66
3/22/2005	95	2/28/2005	98	1/28/2005	147	2/28/2005	56
6/16/2005	124	6/1/2005	171	5/16/2005	194	6/1/2005	107
9/7/2005	190	8/24/2005	214	8/8/2005	403	8/24/2005	98
479		611		964		327	
			FY Total:	2381			

Fiscal Year 2006

Date	F-6A	Date	F-9A	Date	F-10A	Date	F-10B
11/21/2005	86	11/8/2005	125	11/2/2005	123	11/2//2005	32
3/7/2006	66	2/17/2006	83	2/17/2006	162	2/17/2006	35
6/26/06	231	5/30/06	123	5/30/06	288	5/30/06	71
		9/5/06	200	9/5/06	207	9/5/06	95
383		531		780		233	
			FY Total:	1927			

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	HIPMC-S-9903-CR		
Title	Kahoolawe Island Native Plant (Aalii) Restoration Initiative		
National Project No.	Critical areas 1.1		
Study Type	Advanced Evaluation		
Study Status	Active		
Location	HIPMC		
Study Leader	Glenn Sakamoto		
Duration	1999 - 2006		
Cooperators	Kahoolawe Island Reserve Commission (KIRC)		
Land Use	Cropland		
Vegetative Practices	Primary	342	CRITICAL AREA PLANTING
	Secondary	550	RANGE PLANTING
Resource Concern(s)	Resource	Consideration / Problem	
	Soil	Soil erosion / wind	
		Soil Erosion / water	
	Air	Air Quality / air pollutants	
Long Range Plan	Study falls under Objective 2.2, Section A of the HIPMC Long Range Plan		

Objective:
To develop large-scale management techniques for *Dodonaea viscosa*, this will include propagation, establishment and harvesting. The technical data and plant materials produced will be provided to the KIRC to aid in the restoration of highly erodible sites on the island of Kahoolawe.

Status of Knowledge:
The maximum use of plants presently recommended is limited by the lack of reliable commercial seed sources. The problem is compounded by import regulations, the quarantine on millet seeds, and the quarantine on vegetative material of grasses. There is a need for readily available sources of native seed and vegetative material that are approved for conservation practices. Field plantings of native plants are needed in areas where agriculture is changing.

Native plants require special considerations to maintain their genetic integrity. It may be necessary to identify sources of natives on each island for propagating and planting on that island. Some native species that are already well-distributed throughout the island chain could be mass-produced by the PMC, in cooperation

with state and other federal agencies, for distribution to the public until supplies become commercially available.

Conservation efforts with the use of native plants have been an ongoing challenge for the island of Kahoolawe. Efforts in re-introducing natives to the island have been somewhat successful, but only on a very small magnitude. There is a need to develop a plant material source and technology in the large-scale production of native plant species. *D. viscosa,* or more commonly known as aalii, has the potential to fill this need. The fibrous spreading root system, rapid growth, and spreading canopy make it an effective soil stabilizer which is particularly useful in controlling gully and coastal dune erosion. It is drought-tolerant and has the ability to withstand wildfires. *D. viscosa* shrubs are somewhat shade tolerant and suitable for riparian and restoration projects. They are also very wind hardy and useful as an in-field windbreak system.

Dodonaea viscosa is a shrub or sometimes a small tree ranging in height from 6-25 feet. Its long and slender leaves have margins that are usually wavy or crinkled. The flowers are fairly small and the female flowers develop into papery capsules that may be red, pink, green, yellow, or tan. Seeds are roundish, black and very small; about 1/16" wide. There are about 84,200 seeds per pound. ʻAʻaliʻi is found throughout the tropical regions of the world. Until recently, *D. viscosa* is considered indigenous to all of the main Hawaiian islands except Kahoʻolawe. However, it has since been observed on Kahoʻolawe, possibly as a result of the removal of the feral goats. *D. viscosa* is adapted to a wide range of habitats, from sea-level to nearly 8,000 feet and tolerating annual rainfall of 12-98 inches.

Materials and Methods:
June of 1998 Kamiloloa Germplasm Aalii seeds will be propagated in the shade-house. Seeds will be scarified and immersed in hot tap water for 24 hours. They will then be removed, toweled dried and immediately planted to 11" x 17" x 2" seedling flats. Planting media consisted of sterile potting mix and perlite at a ratio of 2:1 respectively. Seeds will be sown ¼ inches deep and irrigated once daily under 50% shade. At four weeks or when true leaves emerge; a slow release fertilizer (14.5-14.5-14.5) will be applied at eight-week intervals. At 12 weeks, seedlings will be transplanted to 1" x 7" dibble tubes. Seedlings will be planted at 24-32 weeks. Spacing between transplants will be 6ft. in Field7 and 10ft. in Field11. Supplemental fertilizer (16-16-16) will be incorporated into the soil prior to planting at a rate of one pound per linear foot. The irrigation will be a drip-system using ¾ inch poly tube and 2 gph emitters, applied at a rate of 4hrs/day once per week for the first 3 months and increased to 8hrs/day once per week from 4-12 months. At 12 months of growth irrigation will be supplied at a rate of 18hrs/day once per week.

DISCUSSION:

FY1999

Disease problems were minimal with powdery mildew being the main disease during the second through fourth month of seedling growth. Weekly spraying of a commercial fungicide (Garden Dust) was necessary to prevent dieback. High humidity during the rainy season and being under 50% shade may have attributed to the increase of the disease. Seedlings were hardened off in direct sun at four months of growth. In December 1998 through March of 1999 the *D. viscosa* increase fields were established. A total of 2000 linear feet was planted in Fields7 and Field11 with 6-8 month old seedlings.

FY2000

In March and April an additional 1.2 acres were transplanted with 818 seedlings for an additional four thousand linear feet. Rows were spaced 15 feet apart with 5 feet spacing within rows. Supplemental fertilizer (10-30-10) was incorporated prior to planting at a rate of 300 lbs. of phosphorus per acre. Black plastic woven mulch was used to reduce weed maintenance and increase moisture retention. In the summer of 2000 the initial increase rows were manually harvested by hand and seeds were cleaned. Methods on how to mechanically harvest is still undetermined. Cleaning was accomplished by use of a brush machine, LA-H from Westrup. The seed was conditioned using the paddles and No. 7 size wire mantle (screen). Final cleaning was done with the conventional seed clipper. A modest yield of approximately four pounds of seeds was harvested.

Current seed yields are below projections and are anticipated to increase as plants mature. One of the concerns of seed production is the plant's individual characteristic as being dioecious and monoecious. The ratio in which this occurs in a given population is still uncertain and provides a challenge in producing high yielding seed fields. Under ideal conditions *D. viscosa* is a fast growing plant that can attain an average height of 5.6 feet in one year.

FY2000-2005

In 2005, plants were pruned back to an average of 7 feet in height and 5 feet wide to aid in harvesting. The seeds were getting hard to reach and the aisles were starting to close up. Before the pruning, yields continued to be very low. 2001 produced 6.5 lbs. 2002 produced 14 lbs. 2003 produced 3.3 lbs. 2004 produced 6.5 lbs. In 2005 the yield was 7.4 lbs.

FY2006

The field was pruned in late 2005. Only the side branches were cut because we do not have the right equipment to handle the pruning of the tops. Although D. viscosa does well if it is pruned, it is important to note that only the new growth should be cut. If the woody branches are cut, for some reason, D. viscose has a difficult time recovering. Pruning should be done regularly to avoid trimming the larger branches. Weed maintenance is down to a minimum with the removal of irrigation. Dodonaea viscosa is very drought tolerant, and there have been many recommendations to cut the water to increase seed production. The harvesting was still done by hand with

the help of three Americorps volunteers. Although it took about 4 weeks, working 2-3 hours in the mornings, this year's harvest was the largest with 22.4 pounds of cleaned seed.

Due to the cut of all Congressional Earmark monies, this will be the last year that plant materials will be produced for the KIRC. It is anticipated that a reimbursable contract will be initiated to continue production. Because this field has such low maintenance requirements, we will continue to harvest the seed. Dodonaea viscosa is highly sought after as a conservation plant, but there is no mechanical means to harvest the seed on a large scale. During the following fiscal year, we will try to develop a mechanical harvester to reduce the amount of labor required to harvest the seed of Dodonaea viscosa. We also will experiment with this plants ability to recover from extreme pruning.

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	HIPMC-T-0001-CR
Title	Native Plant Hay-Bales for Use on Highly Erodible Sites
National Project No.	Critical Area 1.1
Study Type	Advanced Evaluation
Study Status	Active
Location	HIPMC
Study Leader	Glenn Sakamoto
Duration	2000 - 2009
Cooperators	Kahoolawe Island Reserve Commission (KIRC)
Land Use	Cropland
Vegetative Practices	Primary

Resource Concern(s)	Resource	Consideration / Problem
	Soil	Soil Erosion / wind
		Soil Erosion / water

Long Range Plan Study falls under Objective 2.2, Section A of the HIPMC Long Range Plan

Objective:
To investigate the potential use of, *Heteropogon contortus* hay-bales to aid the re-vegetation work on the island of Kahoolawe.

Status of Knowledge
The maximum use of plants presently recommended is limited by the lack of reliable commercial seed sources. The problem is compounded by import regulations, the quarantine on millet seeds, and the quarantine on vegetative material of grasses. There is a need for readily available sources of native seed and vegetative material that are approved for conservation practices. Field plantings of native plants are needed in areas where agriculture is changing.

Native plants require special considerations to maintain their genetic integrity. It may be necessary to identify sources of natives on each island for propagating and planting on that island. Some native species that are already well-distributed throughout the island chain could be mass-produced by the PMC, in cooperation with state and other federal agencies, for distribution to the public until supplies become commercially available.

Conservation efforts with the use of native plants have been an ongoing challenge for the island of Kahoolawe. Efforts in re-introducing natives to the island have been somewhat successful, but only on a very small magnitude. There is a need to develop a plant material source and technology in the large-scale production of native plant species. *Heteropogon contortus,* or more commonly known as piligrass, has the potential to fill this need. Primary recommendation for this grass would be vegetation to aid erosion control. Piligrass also has the potential for ecosystem restoration, re-vegetation of degraded habitats, and to increase diversity in riparian and other communities.

Piligrass is an erect, branching perennial that may form rather large bunches up to 5 feet tall under optimum conditions. Under natural conditions in Hawaii, it grows 1 to 3 feet tall. There is extensive variation within this species throughout its range. The stems are flattened, rather tough, smooth, and a pale bluish-green. Leaves are produced throughout the length of the stem and are flat or folded, 4-12 inches long, about 0.25 inches wide and rough to the touch. The flowering heads have narrow, crowded flower spikes up to 4 inches long. The spikelets overlap and each fertile one bears a conspicuous red-brown awn about 4 inches long, made crooked with two bends. The long-awned seeds are sharp pointed forming tangled masses as they mature. When the seeds come in contact with moisture the hygroscopic awns and sharp barbed tips arch and twist planting them into the soil. Piligrass has a world-wide distribution and is found in the warm tropical regions of both hemispheres.

Though the utilization of hay bales for conservation is relatively new to Hawaii and its use on Kaho'olawe, the practice has long been used and documented on the mainland for many years. Information of the construction, placement and design of hay bales has been available to the public. In recent years hay bales on the mainland are used to reintroduce native rangeland and pasture grasses to areas where they once persisted. This approach capitalizes on the concept of baling mature stands of grasses which are producing seed and the use livestock to ingest and transport the ingested seed bales to areas that need to be populated with a specific species of forage. The use of piligrass bales on Kaho'olawe utilizes the same concept but without livestock.

The use of hay bales for controlling erosion on Kaho'olawe is unique in that it is not only being utilized on an island where decades of overgrazing persisted, leaving a desolate barren landscape but is also being used on an island that was once littered with unexploded military ordinance. Though most of the island has been swept or cleared of these ordinances, there is no guarantee that some ordinances remain. Ideally, it no ordinances were ever used on Kaho'olawe, implementing conventional conservation practices, (with or without hay bales) would be a much easier task. The use of machinery such as disk, tillers, and drills to prepare seedbeds is currently inadvisable. Also, much of the areas that need treatment are steep, gullied and rocky, and as such not recommended for tractor machinery work. The use of bales though tedious, time consuming and expensive is safer and environmentally friendly to the overall mission of KIRC.

Materials and Methods

The KIRC staff is challenged with the re-vegetation effort of the Island of Kahoolawe. Piligrass seed bales are one of the main products being provided to KIRC to accomplish this task. During the baling process, mature piligrass seed is incorporated into the bales. The piligrass seed bales are then transported by helicopter to various disturbed sites on the island of Kahoolawe to be used for testing, modifying and evaluating different ways to effectively control the erosion on Kahoolawe. These piligrass seed bales are serving as a seed source for piligrass, physical barriers to trap sediment, protection for newly planted plants, seedbeds for native plants, mulching for plants, and diversions to divert water from roadways or other highly erodible areas. The use of piligrass seed bales will control soil erosion, increase soil moisture retention, and provide a micro-environment for native plants to take hold.

One of the methods used is to construct sediment traps in gullies and wash-outs. These sediment traps not only catch soil that is carried by runoff and wind, but they also provide a place for seeds to germinate and take hold where there was none before. Another method used to trap sediment is to construct berms. Because of the nature in which the piligrass is compressed during the baling process, the bales can be peeled apart into various sized “flakes”. The KIRC staff has taken advantage of this characteristic fabricated “bundles” with piligrass flakes encased in commercially manufactured erosion control matting in an attempt to conserve materials. These bundles are placed cross-slope of highly erodible sites to form piligrass berms. After the sediment traps and berms are set in place and have successfully “trapped” wind and water eroded soil, piligrass seed is then spread in these areas of trapped soil. It is in these types of areas, where the soil has collected, that seeds are able to settle, germinate, root and take hold.

Piligrass seed bales have also been used to construct “planter boxes” to help establish native plants. Bales for this method are arranged to form a square. Within this square potting mix, that has accumulated from previous planting projects, is recycled and mixed with soil to produce a planting media for native plants. They are irrigated regularly to produce healthy native plants that are able to produce seed. These planter boxes serve as seed banks and are placed in areas where sediment traps and berms are constructed.

Still another valuable use for piligrass bales is the construction of water diversion structures. These structures are strategically placed along access roads and small waterways to divert water off road shoulders and exited to a safe outlet.

DISCUSSION:

Since its introduction to the island of Kaho'olawe in 2000, piligrass bales have taken many shapes and name changes. Planter boxes, shingles, flakes, Kipukas, C sections, X's and bundles are just a few of the names being used to identify specific uses of pili. The use of pili all have one common denominator in that they alter the micro-environment and provide an environment conducive for plant growth and sediment retention. The use and placement of these bales should not be considered a permanent fix to the problems of erosion, but should be looked upon as a temporary structure to aid in a series of steps towards a permanent erosion control system. Piligrass bales will deteriorate in time and unless a suitable control measure is taken to replace or stabilize these pili bales, erosion will continue and the use of bales would have been in vain.

The most significant benefit that was observed with bales was its use as a mulching practice; a physical barrier to protect plants and the diversion of excess water from roadway shoulders. This practice utilizes the bales most effectively and possibly be longer lasting as a conservation application. The most dramatic response observed with the use of hay bales for controlling erosion, but not necessarily the most effective, were sediment containment structures such as berms and check dams. Theses structures had an immediate and dramatic impact in the trapping of sediment, but may not be an effective long term conservation practice.

Mulching

(As observed on October 2005 at the north east Lua Makika crater rim and the old Moiwi access road)

Mulching by separating flakes or sections from bales and placing them on the hardpan areas is working. At one site visited, it was observed that by placing these flakes across the slope on gently sloping areas (less than 2 percent) enabled wind blown sediment and soil runoff to accumulate within and up slope of these flakes. This accumulation of soil provided a suitable environment for seeds within the pili bales to germinate and grow along these flakes. These flakes were approximately 2-3 inches thick and laid side by side in a single row. According to Paul Higashino, Native Plant Restoration Coordinator flakes were installed in February 2005. Piligrass were approximately 14 inches tall and growing well. Growing piligrass formed a vegetative barrier along the edges of these flakes and trapped sediment. Though the treatment area visited was small (less than10 feet long), the effects were positive and effective in controlling erosion. The use of this method also enabled the KIRC staff to maximize the use of the bales. Mr. Higashino estimates that for each bale used in this method, he could cover approximately 15 to 20 linear feet of mulch. In contrast, using entire bales that have not been separated would utilize 24 bales. It was interesting to note that the flakes did not blow away with the wind. This was either due to the placement of the flakes in a slight depression or the direction of the prevailing trade winds was not able to blow them away.

Placing these flakes along the contour of a slope and finding a method for tacking the flakes to the ground to prevent them from blowing away, in the open hardpan

areas, would be most beneficial. This method is simple and requires minimal amount of resources.

Another method similar to the flake approach uses the same concept but requires more resources to construct and install. A fibrous erosion-control-matting made primarily of coconut fiber is used to wrap the piligrass in long bundles. These fiber mats rolls can be purchased commercially and come in various widths and lengths. The fiber mat used on Kaho'olawe were approximately 4 feet in width and were cut to various lengths, depending on the area where it was being installed. To construct these bundles, fiber mat sheets were rolled out on the ground and piligrass flakes were placed along the desired length of the sheet. The flakes (2-3" thick) were then rolled up in the fiber mat, tied at 2 to 3 feet intervals and transported to the desired site. Once at the site the bundles were placed across the slope or across shallow washouts and staked down with wooden pegs to minimize movement and undermining of the bundles. The bundles were most effective in gently sloping areas (2 to 3 percent). The use of this type of mulching practice will require further observation to determine its limitations on its applicability in Kahoolawe hardpan areas.

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	HIPMC-T-0201-CR
Title	Kahoolawe Island Native Plant (Emoloa) Restoration Initiative
National Project No.	Natural Areas 1.1
Study Type	Advanced Evaluation
Study Status	Active

Location	HIPMC
Study Leader	Glenn Sakamoto
Duration	2001 - 2009
Cooperators	Kahoolawe Island Reserve Commission (KIRC)

Land Use	Cropland		
Vegetative Practices	Primary	342	CRITICAL AREA PLANTING
	Secondary	550	RANGE PLANTING
Resource Concern(s)	Resource	Consideration / Problem	
	Soil	Soil Erosion / wind	
		Soil Erosion / water	
Long Range Plan	Study falls under Objective 2.2, Section A of the HIPMC Long Range Plan		

Objective:
To develop large-scale management techniques for *Eragrostis variabilis*, this will include propagation, establishment, and harvesting. The technical data and plant materials produced will be provided to the KIRC (Kahoolawe Island Reserve Commission) to aid in the restoration of highly erodible sites on the island of Kahoolawe.

Status of Knowledge:
The maximum use of plants presently recommended is limited by the lack of reliable commercial seed sources. The problem is compounded by import regulations, the quarantine on millet seeds, and the quarantine on vegetative material of grasses. There is a need for readily available sources of native seed and vegetative material that are approved for conservation practices. Field plantings of native plants are needed in areas where agriculture is changing.

Native plants require special considerations to maintain their genetic integrity. It may be necessary to identify sources of natives on each island for propagating and planting on that island. Some native species that are already well-distributed throughout the island chain could be mass-produced by the PMC, in cooperation

with state and other federal agencies, for distribution to the public until supplies become commercially available.

Conservation efforts with the use of native plants have been an ongoing challenge for the island of Kahoolawe. Efforts in re-introducing natives to the island have been somewhat successful, but only on a very small magnitude. There is a need to develop a plant material source and technology in the large-scale production of native plant species. *Eragrostis variabilis,* or more commonly known as kawelu or emoloa, has the potential to fill this need. Conservation uses for kawelu include ecosystem restoration, erosion control, and enhancing diversity in riparian and other communities.

Kawelu, a love grass, is endemic to the Hawaiian island chain. It is found on the Pearl and Hermes atolls, Kure, Midway, Lisianski, Laysan, Nihoa, and all of the main Hawaiian Islands. It occurs on sand dunes, grasslands, open sites in dry forest, and exposed slopes and ridges or cliffs at elevations ranging from sea level to 3,500 feet.

E. variabilis is a somewhat variable, tufted perennial grass. Under natural conditions in Hawaii, it usually grows 1-3 feet tall by approximately 2 feet wide. The stems are erect and smooth. There is considerable variation in length of leaves and flowering panicles. The leaf blades are flat at the base and rolled inward at the upper part. Leaves are 0.50-0.60 inch wide and up to 32 inches long. The flowering head or panicles are narrow and range from 8-16 inches long. They are either somewhat open or dense and spike-like, with branches strongly upright to spreading. The oval, dark reddish brown seeds are 0.03-0.06 inch long, with minute groove and there are about 3.136 million per pound. There are about 3.136 million seeds in a pound.

Materials and Methods:

Because we are sending the plant materials produced by this trial directly to Kahoolawe, we want to use seed that is from the gene pool of the Maui Nui island group. *E. variabilis*, Acc# 9079729, was collected by Stefanie Aschmann, Soil Conservationist for the U.S. Navy in 1990 on the island of Kahoolawe. It is uncertain if this accession was collected from a naturally occurring stand or from native plant testing sites instituted by the Navy and the Native Hawaiian Plant Society in mid 1980's. An increase plot of this accession will be established in F-2 to provide seed material for a larger increase.

Propagation: Seedlings for field increase will be propagated in a shade-house environment. Seeds will be germinated in 13 x 26 x 3 inch, 200 cell trays. Commercial sterile potting mix and perlite, 2:1 respectively will be used as the potting media. Seeds will be sown ¼ inches deep and irrigated once daily in full sunlight. At 2 weeks of growth, a soluble fertilizer (10-20-10) will be applied at a rate of 1 tbs. per gallon, once a week for three weeks. At 5-6 weeks, a slow-release fertilizer (14.5-14.5-14.5) will be applied at a rate of 36 grams per tray.

Establishment: Fields will be installed between mature windbreak systems. Irrigation will be provided by an over-head sprinkler system at rate of 1 acre inch per week. Fertilizer amendments will be made according to soil tests. Chemical and manual weed control will be performed regularly.
Seedlings 3 months old will be transplanted with a single row mechanical transplanter in a well prepared, firm, weed free seedbed. Rows will be planted 36 inches apart and plants in each row will be spaced 2ft apart. Row spacing was determined by our tractor wheel-base. Irrigation will be provided by an overhead sprinkler system delivering 1 inch per week.

Harvesting: Various harvesting techniques will be tried to determine which will be ideal for *E. variabilis*.

Post-Harvest: Various seed cleaning techniques will be tried using conventional seed cleaning equipment. The seed will be stored for a short period, in an enclosed air-conditioned room, until it can be transported to Kahoolawe by helicopter.

DISCUSSION:

Eragrostis variabilis is a perennial grass with a relatively short-lived life span and a weak root system. At the Molokai PMC, *E. variabilis* flowers emerge once a year from the middle of November to January. It can be harvested from late February to March when the seed heads are ~75% mature. After the harvest with the combine, fertilizer is dropped, the irrigation is turned back on and the ratooned crop is ready for the next season. Usually, we can get two harvests from one planting, and after the second harvest yields tend to go down. On average, *E. variabilis* produces about 100 lbs. of seed per acre. The field is then allowed to go fallow for several months. A cover crop of *Crotalaria juncea* can then planted to condition the soil. *E. variabilis* seeds are usually started in February to March. By May to June the seedlings are ready to be transplanted into the field. We have been investigating the direct seeding of *E. variabilis*; unfortunately we have had very little success due to seedlings dampening off and the lack of an herbicide that is able to control grasses in an *E. variabilis* crop. What follows is our yearly account of activities related to *E. variabilis*.

FY2000

In July, our initial seed increase plot was planted in Field 2 (F-2) by hand. Four double-rows were planted with about 200 plants in each row. In each double-row, the plants were staggered in a 1 foot by 1 foot configuration with 3 foot spacing between double rows. Two months after planting a pre-emergent herbicide was applied at a rate of 1oz. to 1 quart of water to test the tolerance level of *E. variabilis'* to the herbicide. After a month, there were no signs of damage to the plants and there was exceptional weed control. By November 22, the first heads had emerged with an average plant height of 28 inches.

After the harvest of F-2 we will cut the plot to a height of 6-8 inches to see if *E. variabilis* will be able to be ratooned. With the seed harvested from F-2, we plan to plant an increase field in Field 6 (F-6, 0.8 acre). We anticipate the field to be 0.8 acres, about 90ft by 400ft.

FY2001

In February, to insure as much seed as possible from the plot, F-2 was harvested by hand. *E. variabilis* has a very small, but flowable seed. We used a seed scalper to do the seed cleaning. Total cleaned seed was 8.85 lbs. After the seed was harvested we tried to use the rotary mower to cut the grass. This did not work because *E. variabilis* is very fibrous when green. We instead had better success using a standard mower attached to the farm tractor. On February 27, 100 lbs. of 10-30-10 fertilizer was applied to the ratooned crop in F-2. By May, the plot showed promise of re-growing.

March 21, we started 50 trays (200 cells each) of *E. variabilis* in the shade house for our increase in F-6. By June the seedlings were ready to plant. We prepared F-6A by incorporating into the soil 500 lbs. of 10-30-10 fertilizer. Three irrigation lines 420 feet long were installed 50 feet apart. Before we planted the field, the soil was spike-toothed to achieve a uniform seed bed. On June 14, we planted 29 rows of *E. variabilis* seedlings. Each row contained about 200 plants. Manual weed control was performed on a regular because weeds were a big problem. We plan to work with Dr. Defrank of the University of Hawaii to ascertain any potential chemicals that would be suitable to use on *Eragrostis variabilis*. We will also attempt to harvest F-2 and F-6 with our Massey-Ferguson combine. This will require the desiccation of the field with a contact herbicide before harvest.

Increase fields planned for next year include Field 15A (F-15A, 1.0 acre) and Field 16A (F-16A, 1.0 acre). Both fields will be approximately 1 acre in size and will have the same irrigation and plot layout as F-6A. Both fields have already plowed.

FY2002

By early January F-2 and F-6 were at least 75% mature. Finale was applied to desiccate F-2 on January 17 and to F-6 January 31 at a rate of 6 quarts per acre. F-2 was harvested with the combine on February 1 and F-6 was harvested on February 7, also with the combine. F-2 produced 2.6 lbs. of seed and F-6 produce 225lbs. of seed.

After F-6 was harvested, its vigor appeared to be very low due to the harvesting process. Anticipating that the field would ‘die’ we decided to remove it. The majority of the vegetative material was removed from the field with a front-end loader and the remaining residue was burned in the field. F-2 on the other hand will be kept to observe it ability to recover from the desiccant.

By April we were ready to increase F-15A and F-16A. The irrigation system was installed. Both fields were then disked and 700 lbs. of 16-16-16 fertilizer was applied and incorporated it into the soil with a tiller. The weeds were flushed and then sprayed with Round-Up. In June, the fields were leveled to a firm seed bed with a rake attachment.

On June 26, we planted 34 rows of *E. variabilis* in F-15A with the mechanical transplanter followed by an application of a preemergent herbicide 1 week after planting. On July 9, we planted 33 rows of *E. variabilis* in F-16A with the mechanical transplanter followed by an application of a preemergent herbicide 1 week after planting. I month after each of the plantings a second application of the preemergent herbicide was applied.
In October, a rust (fungus) was observed in both fields. Samples were sent to the University of Hawaii for analysis. In November a fungicide was applied to both fields at a rate of 1 lb. per 50 gallons of water to reduce the effects of the rust.

Next year we plan to replant F-15A and ratoon F-16A to compare the yields and determine if there may be differences. We also plan to increase Field 15B (F-15B, 1.0 acre) which has already been prepped and the irrigation system installed. Also, Dr. DeFrank will perform a screening trial in Field 12B (F-12B) for preemergent herbicides for native grasses including *E. variabilis*. Fields planned for increase in 2004 include Field 14A (F-14A, 1.0 acre), Field 14B (F-14B, 1.0 acre), and Field 16B (F-16B, 1.0 acre). These fields have already been plowed.

FY2003

In February, F-2 was harvested for the last time. The crop had regrown, but it had a significantly lower yield from the year before. F-2 was sprayed with RoundUp and the vegetative material was allowed to decompose in the field. It is safe to say that E. variabilis yield start to diminish after the second harvest.

Also in February, Dr. DeFrank's chemical trial was installed onto F-12B and by July, he had finished evaluating it. Details of this trial can be viewed at the Hoolehua PMC website. After this trial we decided to replant the crop to increase overall seed production and to also test a different irrigation system using drip tape.

In July, 500 lbs. of 10-20-20 fertilizer was applied and incorporated into the soil of F-12B. A total of seven irrigation lines were installed by burying the drip tapes below the surface of the soil. On July 22, 14 rows of E. variabilis were planted, 2 rows per drip tape, using the mechanical transplanter. An application of preemergent herbicide was applied 2 days after planting.

F-15A and F-16A had matured in February. Both fields were desiccated and allowed to dry down. On February 26 we began harvesting F-15A and the combine got clogged up. We were able to remove the stuck material and continue with the harvesting. F-15A produced 100 lbs. of seed. On March 3 we harvested F-16A and

the combine had clogged up again. We speculate that this could have been due to the wrong combine setting. F-16A produced 100 lbs. of seed.

We knew that E. variabilis could tolerate being ratooned, therefore, we wanted to compare yields from a “second harvest” ratooned crop and a “first harvest” crop planted from seedlings. F-15A will be designated as the crop to be replanted and F-16a will be the crop to be ratooned.

In F-16A, we ran the baler through the field in order to remove the vegetative material to expose the soil. The preemergent herbicide works better if it has direct contact with the soil. On May 30, the preemergent was applied.

In F-15A, we also ran the baler through the field, but set lower to the ground than F-16A, to remove as much of the vegetative material as possible. The field was then prepped to be planted. A fertilizer application of 850 lbs. of 16-16-16 wad incorporated into the soil and the irrigation system installed. On July 8, we planted 31 rows with the mechanical transplanter followed by the first application of preemergent. A second application of preemergent herbicide was applied 41 days after planting.

F-15B had been prep for planting the year before. This field is primarily for seed increase. In June, fertilizer was incorporated into the soil. In July, 32 rows were planted with the mechanical transplanter. Two applications were applied, one after planting and another application 1 month after that.

We plan to increase F-14A and Field 14B next year. Both fields have already been plowed and seedlings have been started in the shadehouse. Fertilizer will be incorporated into the soil before planting. We also plan to use a green manure crop of Crotalaria juncea in F-16B. We want to compare yields of this fields and a field using commercial fertilizers. Crotalaria seed will be planted in December at a rate of 60 pounds of pure live seed per acre. We expect F-16B to have the higher yield.

FY2004

By early February all of the emoloa fields were ready to harvest. Finale was applied to each field and within two weeks they had all been desiccated and ready to harvest. The combine was use to harvest the seed. F-12A produced 10 pounds of seed. We suspect the low yield to be related to the drip irrigation system. Next year, we will harvest this field for seed bales as per request by the KIRK. This will be the last emoloa crop for F-12A. F-15B produced 80 pounds of seed. This amount is closer to the average harvest.

We were interested in comparing the harvest yields from a “second harvest” ratooned crop and a “first harvest” crop planted from seedlings. F-15A was the crop that replanted and F-16A was the crop that was ratooned. F-15A produced 60 pounds of seed while F-16A produced 125 pounds of seed. This was a very

dramatic difference between the two fields and it was apparent that the second harvest will produce a larger harvest yield.

The KIRC wanted us to bale the emoloa field to compare the bales to piligrass bales. F-15A produced 41 bales, F-15B produced 53 bales, and F-16A produced 139 bales. F-16A produced more bale due to the fact that we wanted to remove as much material from the field as possible since we were going to prep the field to be replanted. F-15A and F-15B will be ratooned crops.

In February F-14A and F-14B were prepped and ready to be planted. The seedlings were started in March in the in the shadehouse and would be ready to transplant in early June. In an attempt to reduce labor time in production we direct-seeded emoloa into F-14A. We used a Nivex direct-seed planter to plant 34 rows using 1.4 pounds of seed. Within a week the seeds began to germinate nicely. Captan (fungicide) was applied to help protect the plants from damping off, which they tend to do in the shadehouse. Also, Dr. Defrank recommended that we apply Buctril, a broadleaf preemergent herbicide, at a rate of 1 quart per acre. Buctril was applied 19 days after planting. Urea was also applied through the overhead irrigation system at a rate of 200 pounds per acre. On March 19, plants were showing signs of damping off and although we had controlled the broadleaf weeds, there were a lot of grassy weeds that were beginning to become a problem. We used a tractor pulled cultivator to try and knock down the grassy weeds. This worked fine between the rows, but there were grassy weeds growing within the emoloa clumps that could only be removed by hand. By March 30, much of the field had damped off and the grassy weeds were a huge problem, so we tilled the field under. I was obvious that we needed to do more research if we wanted to direct-seed the emoloa. We need to find a better fungicide to stop the damping off of new seedlings and we also need an herbicide that allows us to control grassy weeds in a grass crop. In June we installed 30 rows in F-14A and 23 rows in F-14B. F-14B was smaller because we did not anticipate that our attempt to direct-seed F-14A to fail. These fields will be primarily for seed increase for the Kahoolawe project.

On February 17, we cut down the Crotalaria green manure crop in F-16B and allowed it to decompose. On March 30, we tilled the dried up crotalaria material into the soil. In May, we planted 30 rows in F-16B. We want to compare yields of this field and a field using commercial fertilizers. We planted 32 rows in F-16A for this comparison.

This year we have seven emoloa fields. They will all be for seed increase with the exception of F-12A, which will be harvested for seed bales. Next year, we plan to decrease production to 4 fields. The objective is to have 2 newly planted fields, 2 ratooned fields, and 2 fallow fields in rotation. The fallow fields will be planted with a green manure crop at the end of the year so it can be planted with emoloa the following year. We will also try to transplant the emoloa seedlings in March as compared to May or June. We speculate that a ratooned crop has a more established root system there by producing a larger yield. By planting the seedlings earlier, they have more time to develop a healthy root system.

FY2005

On February 11, all *Eragrostis* fields were sprayed with 'Finale' for desiccation. F-12B produced 96 seeded bales. For some reason, F-14A and F-14B did not dry out as much as we anticipated. Instead of reapplying chemical, we decided to harvest the field as is. On March 1, we harvested the fields and apparently, the combine had no problem with the green vegetation in 14A and 14B. F-14A produced 93 pounds of seed, F-14B also produced 93 pounds of seed, F-15A produce 96 pounds of seed, F-15B produced 187 pounds of seed, F-16A produced 90 pounds of seed, and F-16B produced 127 lbs of seed. F-16B had a significantly higher yield as compared to F-16A. Our numbers indicate that a green manure crop will increase *Eragrostis variabilis'* seed crop yields more than commercial fertilizers. More research is needed to confirm these results.

For next year's crop F14A, F14B, F16A, and F16B will be ratooned, and the fields will be harvested without using a desiccant. F15A and F15B will be allowed to go fallow until November at which time a green manure crop of 'Tropic Sun' will be planted and then incorporated into the soil. We will replant F-15A and F-15B in FY2006.

FY2006

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	HIPMC-T-0202-CR
Title	Kahoolawe Island Native Plant (Aweoweo) Restoration Initiative
National Project No.	Natural Areas 1.1
Study Type	Advanced Evaluation
Study Status	Active

Location	HIPMC
Study Leader	Glenn Sakamoto
Duration	2001 - 2009
Cooperators	Kahoolawe Island Reserve Commission (KIRC)

Land Use	Cropland		
Vegetative Practices	Primary	342	CRITICAL AREA PLANTING
	Secondary	550	RANGE PLANTING
Resource Concern(s)	Resource	Consideration / Problem	
	Soil	Soil Erosion / wind	
		Soil Erosion / water	
Long Range Plan	Study falls under Objective 2.2, Section A of the HIPMC Long Range Plan		

Objective:
The objective is to develop large-scale management techniques for *Chenopodium oahuense*, which will include propagation, establishment, and harvesting. The technical data and plant materials produced will be provided to the KIRC to aid in the restoration of highly erodible sites on the island of Kahoolawe.

Status of Knowledge:
The maximum use of plants presently recommended is limited by the lack of reliable commercial seed sources. The problem is compounded by import regulations, the quarantine on millet seeds, and the quarantine on vegetative material of grasses. There is a need for readily available sources of native seed and vegetative material that are approved for conservation practices. Field plantings of native plants are needed in areas where agriculture is changing.

Native plants require special considerations to maintain their genetic integrity. It may be necessary to identify sources of natives on each island for propagating and planting on that island. Some native species that are already well-distributed throughout the island chain could be mass-produced by the PMC, in cooperation

with state and other federal agencies, for distribution to the public until supplies become commercially available.

Conservation efforts with the use of native plants have been an ongoing challenge for the island of Kahoolawe. Efforts in re-introducing natives to the island have been somewhat successful, but only on a very small magnitude. There is a need to develop a plant material source and technology in the large-scale production of native plant species. *Chenopodium oahuense,* or more commonly known as aweoweo, has the potential to fill this need. The potential uses for aweoweo include ecosystem restoration, erosion control, and enhancing diversity in riparian and other communities.

A weakly scented shrub, the aweoweo can reach 5-20m in height. Its leaves are 3-lobed and somewhat fleshy. Leaves are also pubescent with the bottom half more pubescent and a lighter green as well. Flowers are small on leafless panicles producing seeds that are dark-brown and about 0.8mm in diameter. *C. oahuense* is endemic to the Hawaiian Islands. It can be found on the northwestern Hawaiian islands of Lisianski, Laysan, French Frigate Shoals, Necker, and Nihoa. It is also found throughout the main Hawaiian Islands, but, according to the Manual of the Flowering Plants of Hawaii (1999), ‘aweoweo has not been observed to be occurring naturally on the island of Kaho’olawe. *C. oahuense* is adapted to dry habitats of coastal and dry forests and can also be found in subalpine shrublands as well, ranging in elevation from 0 – 2,520 meters.

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	HIPMC-T-0602-WI		
Title	Panax (*Polyscias guilfoylei)*: Growth-Rate Effects from Nitrogen Supplements		
National Project No.	Cropland 1.1		
Study Type	Advanced Evaluations		
Study Status	Active		
Location	HIPMC		
Study Leader	David Duvauchelle		
Duration	March 2006 through March 2011		
Cooperators	-Alton Arakaki, University of Hawaii, Cooperative Extension		
Land Use	Cropland		
Vegetative Practices	Primary	650	WINDBREAK/SHELTERBELT ESTABLISHMENT
	Secondary	380	WINDBREAK/SHELTERBELT RENOVATION
		422	HEDGEROW PLANTING
		311	ALLEY CROPPING
Resource Concern(s)	Resource	Consideration / Problem	
	Soil	Soil Erosion / wind	
		Soil Erosion / water	
	Air	Air Quality / air pollutants	
Long Range Plan	Study falls under Part 3 of the HIPMC LRP		

Objective:
The objective is to produce a growth rate in panax that is comparable to that of *Erythrina variegata* or 'Tropic Coral'. Various nitrogen treatments will be applied to two accessions of *Polyscias guilfoylei* in an attempt to stimulate a faster growth rate and also to determine if there are growth rate differences between the two.

Status of Knowledge:
Many areas of cropland are subject to frequent strong winds. Velocities of 10 to 25 miles per hour or more may be expected much of the time. Permanent and semi-permanent windbreaks are needed on much of this land. Fire may destroy certain tree species that do not have the capacity of renewal. There is a need for rapid-growing annual or perennial plants for windbreaks. These plants could be used as primary windbreaks and for crops requiring additional windbreaks in fields already planted to windbreak trees. They should have the capability of renewal after fire. They should produce a minimum of root competition, be relatively pest-free, esthetically pleasing, and have a low maintenance requirement. Additionally, there is a need for windbreaks for farmsteads and feedlots to serve as screens on

highway medians and other areas. *Polyscias guilfoylei* may be a suitable choice for a windbreak. It is a slender tree that can attain heights in excess 20 feet. As good of a windbreak as panax is, 'Tropic Coral' has been the choice of many of the local farmers because of its taller growth and faster growth rate. Recently, the Erythrina Gall Wasp (EGW) has devastated Hawaii's 'Tropic Coral' windbreak systems. *Polyscias guilfoylei* could be a potential substitute for Hawaii's local farmers.

Polyscias guilfoylei is a columnar shrub with erect branches up to 24ft tall; leaves mostly 5.9-19.7" long, 1-pinnate, leaflets opposite, blades variable, but commonly broadly ovate or elliptic and coarsely dentate or lacerate, commonly variegated with white or pale yellow margins, or sometimes all dark green; leaflets mostly 1.9-3.9" long; inflorescence a compound panicle. The origin of panax is unknown, but it is widely cultivated in the paleotropics and in some parts of the neotropics.

Experimental Design Randomized Complete Block Design, RCB

BLOCK P

Treatment 1	Title: Acc# 9079789 (P1) Description: no nitrogen (control)
Treatment 2	Title: Acc# 9079789 (P2) Description: 25 lbs. of nitrogen per acre
Treatment 3	Title: Acc# 9079789 (P3) Description: 50 lbs. of nitrogen per acre
Treatment 4	Title: Acc# 9079789 (P4) Description: 100 lbs. of nitrogen per acre

BLOCK B

Treatment 1	Title: Acc# 9079807 (B1) Description: no nitrogen (control)
Treatment 2	Title: Acc# 9079807 (B2) Description: 25 lbs. of nitrogen per acre
Treatment 3	Title: Acc# 9079807 (B3) Description: 50 lbs. of nitrogen per acre
Treatment 4	Title: Acc# 9079807 (B4) Description: 100 lbs. of nitrogen per acre

Materials and Methods:

Both accessions were collected on the island of Molokai. The non-variegated sample (acc# 9079789) a variety from the Hoolehua PMC. It had been collected from a residence from the Kalae area. The variegated sample (acc# 9079807) is a variety that was collected from the Bauman's residence in the Kamililoa area. Each accession was planted in separate rows / blocks to simulate a windbreak in actual windy situations. The accessions were kept separate because this trial was planted to also serve as increase plots for further study. Although the accessions were kept separate, each replicated treatment within both accession blocks were arranged in random order. This trial was replicated (4) times.

Before the cuttings were planted, a base fertilizer (10-20-20) application of 50 pounds of nitrogen per acre was incorporated into the soil of both rows. The

planting was irrigated with t-tape once a week at 8 hour intervals. The cuttings were cut to (18) inches in length and planted (6) inches deep with 2 foot spacing between each cutting. Each treatment consisted of (9) 'trial' cuttings separated by (3) 'buffer' cuttings. Ammonium Sulfate (21-0-0) was selected to be the source of nitrogen. The fertilizer treatments were split into (4) application and applied at (3) month intervals. The first treatment application was applied 3 months after planting to insure there was enough root development for nutrient uptake. The first evaluation of the trial was 90 days after the first treatment application.
Trial start date: March 7, 2006.

FIELD ACTIVITY NOTES

3/7/06	Planted trial
3/8/06	Sprayed Goal: 1oz/gal - 9 gallons……KD
4/8/06	Observation: buds emerging…….....KD
4/26/06	Sprayed Fuselade: 2oz/gal – 6 gallons……..NB
5/9/06	Replanted dead cuttings…….....NB, JB
5/9/06	Manual weed-control – broadleaves…….JB, JD
6/7/06	Manual weed-control……..KD, JD
6/8/06	**FIRST NITROGEN TREATMENT……KD, JD**
7/21/06	Manual weed control……..NB
7/24/06	Observation: variegated accession losing leaves……RJ
8/7/06	Chemical weed control - Sprayed Finale: 3oz/gal South side of both accessions; North side of variegated Accession……NB
9/11/06	Manual weed control……..... NB, JB, JD
9/12/06	Dropped Ronstar G 200lb/ac - 3.8lbs/accession…….. JB, JD
9/12/06	Chemical weed control - Sprayed Finale: 2oz/gal …….. NB
9/13/06	**SECOND NITROGEN TREATMENT FIRST EVALUATION……KD, NB, JB**
10/19/06	Sprayed Finale: 2oz/gal……JB, JD
11/28/06	Manual weed control……..NB,JB,KD,KC
11/30/06	Sprayed Finale: 2oz/gal – 4 gallons……NB
12/6/06	**THIRD NITROGEN TREATMENT SECOND EVALUATION…….. KD,JD,KC**
12/21/06	Manual weed control……..KD, KC
12/21/06	Dropped Ronstar G - 7lbs. east / 7lbs. west……..KD,JD,KC
1/24/07	Manual weed control…….. NB,KC
1/24/07	Chemical weed control - Sprayed Finale: 2oz/gal……NB,KC
3/5/07	Chemical weed control - Sprayed Finale: 2oz/gal……... NB
3/20/07	Manual weed control…….. KD,JB,KC
3/21/07	**FOURTH NITROGEN TREATMENT THIRD EVALAUTION……KD,Pat,Jim**
5/30/07	**FOURTH EVALAUTION……KD,JB,KC**
4/21/08	**FIFTH EVALAUTIONS……..KD,KD**

DISCUSSION

Observation: 190 DAP

The panax cuttings started to show signs of growth at around 3-4 weeks after planting. Compared to 'Tropic Coral this is relatively slow. There was a noticeable boost in vigor for all plants after the first fertilizer treatment.

During the week of July 17, the plants of the variegated accession had lost its new growth leaves and shoots. Chickens and other birds, and locus were observed in the vicinity and could be the cause of the leaf damage. Although some organism may have eaten the new leaves, something else has hindered the plants ability to recover. The cause could be from an herbicide application to control weeds. Because the damage was only to the variegated accession, the data collected will not be totally accurate. We will continue to apply the fertilizer treatments with hopes that the plants will recover.

The non-variegated accession progressed fine with no or very little damage. A number of leaves had shown some sort of 'spotting' effect. The cause is unknown, but was monitored closely for any detrimental effects. There wass some leaf damage due to leaf eating insects, but had affected plant vigor. The measurements indicated no significant difference between the fertilizer treatments of the non-variegated accession.

Observations: 274 DAP

The variegated accession had suffered severely from chemical drift, although it is uncertain what chemical had affected the plants. Initially the planting was not affected all at once. The east end of the line had been affected first and, gradually over a 2 week period, the entire line was affected. The cause is still unknown, but the plants were slowly recovering in the same manner in which they were affected. Many of the plants were recovering normally and sending out new shoots from the top of the plant. On the other hand, there were also many plants that seemed to be stunted and formed galls where there should have been new shoots. If new shoots had emerged they were generally from beneath the soil.

The non-variegated accession continued to progress with little damage to any plants. The leaf 'spotting' was more apparent among more plants, but still had no affect on plant vigor. Some sort of organism continues to eat the new leaves of both accessions, though the affect of the damage is having little effect on plant vigor. Another locus was found and we suspect that this could be the leaf-eating culprit. Ants are beginning to farm aphids on some plants, but currently they are not causing any problems. Some lady bugs are present and we hope the two insects will balance out. The second measurements have shown that there is no significant difference between the different fertilizer treatments.

Observations: 379 DAP
According to the data collected, there still appears to be no significant differences between the different fertilizer treatments. Apparently, a secondary factor is affecting the growth rate of the trial. Plants at both ends of the rows are shorter and gradually become taller toward the center. We are speculating that this could be due to the fact that a 'Tropic Coral' windbreak was planted in the same spot before the trial may have left some residual amounts of nitrogen. It has been 1 year since the panax cuttings were planted in the ground and they have already reached an average height of 84 cm or 7ft with some trees reaching above 8ft. This is quite close 'Tropic Coral's' 1 year growth of 10ft. Although we are not seeing any significant difference between the fertilizer treatments, the facts remains that the addition of nitrogen has increased the growth-rate of panax.

Observations: 449DAP
Despite the growth-rate increase that we are pleased to see, there are some negative results. More trees have continued to break off due to high winds. These trees appear to have fallen at random and not related to the treatments, but the majority of them are the taller trees toward the center of the row. After 15 months since the panax cuttings were planted in the ground and they had reached an average height of 247cm or about 8ft with some trees reaching above 9ft. This is very close 'Tropic Coral's' 1 year growth of 10ft.

Observations: 776 DAP
One year after the last evaluation, measurements were randomly taken from the two different accession lines. It was agreed that only random measurements be taken since during the application of fertilizer treatments the data had indicated that there were no significant differences between the various treatments. Visual observations of the trial only confirm that the trees are very uniform in height with differences that are hardly noticeable by the naked eye. Both accessions are now over 2 years old and appear to be in good health with good vigor.

There are some important differences between the two accessions at 2 years of age that should be noted. According to the data, the non-variegated accession is, on average, 1.37 feet taller than the variegated accession. From the very start of this trial, the non-variegated accession had remained the taller of the two. Also, there have been a number of trees that have fallen due to the occasional high winds. Overall, the non-variegated accession had lost more trees to high winds. It should be mentioned that the variegated accession is in a position that would probably provide more wind protection. The new panax trial is designed to eliminate this situation. Additionally, the "main" stem widths were measured and averaged, though it was not a factor that was previously evaluated. After 2 years of growth, on average, the 'main" stem width of the non-variegated accession was 1– 1 ½ inches wide and the variegated accession was ½-1 inch wide. The number of "main" stems produced also differed with the variegated accession producing more.

Polyscias guifoylei (Panax) - Growth Effects of Nitrogen Treatments

DATA SUMMARY

DATE: 12-Sep-06 DAP: 190

Non-Variegated -- Accession #9079789				
REP	TREATMENT	HT-AVG	WD-AVG	VI-AVG
I	NonVAR1	80.56	61.11	3.33
II	NonVAR1	100.00	80.56	1.56
III	NonVAR1	87.86	70.00	2.14
IV	NonVAR1	66.00	56.67	3.83
I	NonVAR2	75.63	64.38	3.38
II	NonVAR2	85.56	70.00	2.33
III	NonVAR2	81.25	69.38	2.50
IV	NonVAR2	83.13	65.63	2.50
I	NonVAR3	77.78	63.33	3.00
II	NonVAR3	83.13	71.25	2.13
III	NonVAR3	93.13	76.88	2.50
IV	NonVAR3	68.33	47.50	3.83
I	NonVAR4	81.43	68.57	2.71
II	NonVAR4	91.67	69.17	2.17
III	NonVAR4	83.13	65.63	2.38
IV	NonVAR4	60.00	51.25	4.75

Variegated -- Accession #9079807				
REP	TREATMENT	HT-AVG	WD-AVG	VI-AVG
I	VAR1	47.78	37.22	7.00
II	VAR1	40.56	23.33	7.00
III	VAR1	59.44	33.89	6.22
IV	VAR1	67.22	45.56	5.33
I	VAR2	37.78	29.44	7.00
II	VAR2	40.56	30.00	7.00
III	VAR2	62.22	36.11	6.00
IV	VAR2	64.38	38.13	4.25
I	VAR3	44.44	35.00	7.00
II	VAR3	46.67	31.67	7.00
III	VAR3	50.00	34.44	6.67
IV	VAR3	68.33	47.22	3.44
I	VAR4	43.33	35.56	7.00
II	VAR4	47.22	28.13	7.00
III	VAR4	62.78	36.11	6.33
IV	VAR4	59.44	36.11	4.89

Treatments	HT - height (cm)
1 - no nitrogen	WD - width (cm)
2 - 100lb/A	VI - vigor (scale)
3 - 200lb/A	1 - excellent
4 - 400lb/A	5 - average
	9 - poor

Polyscias guifoylei (Panax) - Growth Effects of Nitrogen Treatments

DATA SUMMARY

DATE: 6-Dec-06 DAP: 274

Non-Variegated -- Accession #9079789				
REP	TREATMENT	HT-AVG	WD-AVG	VI-AVG
I	NonVAR1	135.56	106.67	3.11
II	NonVAR1	168.89	144.44	2.00
III	NonVAR1	152.14	130.00	2.00
IV	NonVAR1	110.83	90.00	3.17
I	NonVAR2	133.13	111.88	2.88
II	NonVAR2	150.00	131.11	2.22
III	NonVAR2	141.88	122.50	2.13
IV	NonVAR2	143.13	120.63	2.00
I	NonVAR3	137.22	110.56	2.22
II	NonVAR3	145.00	128.13	2.00
III	NonVAR3	160.00	141.88	2.00
IV	NonVAR3	120.00	96.67	2.67
I	NonVAR4	140.71	119.29	2.71
II	NonVAR4	158.33	140.00	2.17
III	NonVAR4	148.13	123.13	2.00
IV	NonVAR4	103.75	81.25	3.25

Variegated -- Accession #9079807				
REP	TREATMENT	HT-AVG	WD-AVG	VI-AVG
I	VAR1	55.00	21.67	5.67
II	VAR1	51.67	24.44	6.22
III	VAR1	84.44	43.33	3.89
IV	VAR1	98.89	51.11	3.89
I	VAR2	35.00	26.11	6.11
II	VAR2	43.33	20.56	6.56
III	VAR2	93.89	61.11	2.56
IV	VAR2	98.13	50.00	3.75
I	VAR3	50.56	26.67	6.00
II	VAR3	56.67	31.11	5.89
III	VAR3	67.22	42.78	4.00
IV	VAR3	114.44	90.00	2.00
I	VAR4	43.33	32.78	6.22
II	VAR4	53.33	27.78	6.00
III	VAR4	81.67	46.11	3.44
IV	VAR4	86.67	44.44	4.67

Treatments	HT - height (cm)
1 - no nitrogen	WD - width (cm)
2 - 100lb/A	VI - vigor (scale)
3 - 200lb/A	1 - excellent
4 - 400lb/A	5 - average
	9 - poor

Polyscias guifoylei (Panax) - Growth Effects of Nitrogen Treatments

DATA SUMMARY

DATE: 12-Mar-07 DAP: 379

Non-Variegated -- Accession #9079789				
REP	TREATMENT	HT-AVG	WD-AVG	VI-AVG
I	NonVAR1	201.67	114.44	3.67
II	NonVAR1	243.89	150.00	2.11
III	NonVAR1	220.71	127.14	3.29
IV	NonVAR1	187.50	100.00	3.50
I	NonVAR2	200.00	125.63	3.13
II	NonVAR2	226.11	138.33	2.33
III	NonVAR2	216.25	125.63	2.38
IV	NonVAR2	221.25	127.50	2.38
I	NonVAR3	215.56	125.56	2.22
II	NonVAR3	226.25	126.88	2.25
III	NonVAR3	225.00	133.13	2.63
IV	NonVAR3	193.33	96.67	3.67
I	NonVAR4	215.00	117.86	3.86
II	NonVAR4	230.00	134.17	2.50
III	NonVAR4	221.25	131.88	2.75
IV	NonVAR4	173.75	88.75	3.75

Variegated -- Accession #9079807				
REP	TREATMENT	HT-AVG	WD-AVG	VI-AVG
I	VAR1	82.22	51.67	5.67
II	VAR1	81.11	47.22	6.22
III	VAR1	134.44	80.00	3.89
IV	VAR1	157.78	103.89	3.89
I	VAR2	43.89	37.78	6.11
II	VAR2	52.22	32.78	6.56
III	VAR2	158.33	108.33	2.56
IV	VAR2	150.00	107.86	3.75
I	VAR3	72.78	52.78	6.00
II	VAR3	84.22	57.22	5.89
III	VAR3	117.22	79.44	4.00
IV	VAR3	180.56	127.78	2.00
I	VAR4	66.11	47.22	6.22
II	VAR4	88.89	55.00	6.00
III	VAR4	135.00	96.11	3.44
IV	VAR4	141.11	91.67	4.67

Treatments	HT - height (cm)
1 - no nitrogen	WD - width (cm)
2 - 100lb/A	VI - vigor (scale)
3 - 200lb/A	1 - excellent
4 - 400lb/A	5 - average
	9 - poor

Polyscias guifoylei (Panax) - Growth Effects of Nitrogen Treatments

DATA SUMMARY

DATE: 29-May-07 DAP: 449

Non-Variegated -- Accession #9079789				
REP	TREATMENT	HT-AVG	WD-AVG	VI-AVG
I	NonVAR1	247.00	125.00	3.25
II	NonVAR1	274.38	170.00	2.00
III	NonVAR1	256.67	148.33	2.33
IV	NonVAR1	220.83	114.17	3.50
I	NonVAR2	227.50	146.67	3.00
II	NonVAR2	255.00	152.00	2.20
III	NonVAR2	249.29	153.57	2.29
IV	NonVAR2	255.00	138.13	2.38
I	NonVAR3	245.00	135.00	2.33
II	NonVAR3	260.63	145.00	2.25
III	NonVAR3	255.00	190.00	2.00
IV	NonVAR3	225.00	120.00	3.67
I	NonVAR4	244.17	135.00	3.50
II	NonVAR4	271.25	151.25	2.25
III	NonVAR4	256.43	145.00	2.43
IV	NonVAR4	213.75	105.00	3.75

Variegated -- Accession #9079807				
REP	TREATMENT	HT-AVG	WD-AVG	VI-AVG
I	VAR1	124.38	75.00	5.63
II	VAR1	115.00	68.33	6.22
III	VAR1	191.67	112.78	3.89
IV	VAR1	208.13	133.13	3.89
I	VAR2	76.11	61.67	6.11
II	VAR2	82.22	56.67	6.56
III	VAR2	203.33	137.78	2.56
IV	VAR2	190.63	129.38	3.75
I	VAR3	98.89	72.78	6.00
II	VAR3	115.00	78.89	5.89
III	VAR3	160.00	103.33	4.00
IV	VAR3	227.78	146.67	2.00
I	VAR4	93.33	65.00	6.22
II	VAR4	120.56	75.56	6.00
III	VAR4	173.89	125.00	3.44
IV	VAR4	170.56	115.56	4.67

Treatments	HT - height (cm)
1 - no nitrogen	WD - width (cm)
2 - 100lb/A	VI - vigor (scale)
3 - 200lb/A	1 - excellent
4 - 400lb/A	5 - average
	9 - poor

Polyscias guifoylei (Panax) - Tested Release

EVALUATION Sheet

DATE: April 21, 2008

DAP: 776

Variegated -HEIGHT

	CENTIMETERS	FEET
1	228	7.48
2	219	7.19
3	165	5.41
4	247	8.10
5	275	9.02
6	232	7.61
7	270	8.86
8	265	8.69
9	341	11.19
10	342	11.22
11	328	10.76
12	332	10.89
13	362	11.88
AVERAGE	**277.38**	**9.10**

Non-Variegated - HEIGHT

	CENTIMETERS	FEET
1	306	10.04
2	288	9.45
3	329	10.79
4	298	9.78
5	241	7.91
6	341	11.19
7	353	11.58
8	365	11.98
9	272	8.92
10	348	11.42
11	349	11.45
12	316	10.37
13	343	11.25
AVERAGE	**319.15**	**10.47**

SUMMARY

The objective of this trial was to evaluate the effects that various nitrogen supplements will have on two accessions of panax. Unfortunately, we discovered a design flaw in the trial. With the two accessions being planted completely separate from each other, we cannot be certain that the effects that occurred were due to accession or location differences. The trial had set up as two 'separate' Randomized Complete Blocks. We should have designed it as a Split Plot Design with Randomized Complete Blocks. This would have been a more reliable way to determine differences between accessions. Since we can still gain valuable information from this trial, the evaluations will continue with the understanding that the data that is collected will need to be confirmed with different trial design.

The data collected support the fact that there are no significant differences between the different fertilizer treatments of this particular trial. A secondary factor that is affecting the growth rate of the trees seems to be the only plausible explanation. It has been observed that plants at both ends of the rows are shorter and gradually become taller toward the center. This could be due to some residual amounts of nitrogen left by the 'Tropic Coral' windbreak that had been growing in the same spot before the trial. Another explanation is that a base fertilizer application was applied to the entire trial; therefore, we are not seeing the low end of the growth-rate spectrum. Although we are not seeing any significant differences between the fertilizer treatments, the facts remains that the addition of nitrogen has increased the growth-rate of panax significantly.

Despite the growth-rate increase that we are pleased to see, there are some negative results. Recently, the trail had been exposed to exceptionally high winds and individual plants had broken off at the lower potions of the trees. These trees appear to have fallen at random and not related to the treatments, but the majority of them are the taller trees toward the center of the row. This could be related to the increased growth-rate, but we cannot be certain.

We will continue to monitor this trial to determine the age at which panax is able to reach its maximum height of 20-25ft. We plan conduct another new trial to confirm our findings here and to eliminate some factors that might have contributed to growth differences.

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	HIPMC-P-0603-CR		
Title	*Sporobolus virginicus*: Selection for Tested Release		
National Project No.	Critical Area 1.1		
Study Type	Advance Evaluation		
Study Status	Active		
Location	HIPMC		
Study Leader	David Duvauchelle		
Duration	2006 - 2008		
Land Use	Cropland		
Vegetative Practices	Primary	342	CRITICAL AREA PLANTING
	Secondary	327	CONSERVATION COVER
		350	RANGE PLANTING
Resource Concern(s)	Resource	Consideration / Problem	
	Soil	Soil Erosion / wind	
		Soil Erosion / water	
Long Range Plan	Study falls under Objective 2.1, Section E of the HIPMC Long Range Plan		

Objective:

To determine if there are any significant differences between five accessions of S*porobolus virginicus,* which were collected from various locations in the Hawaiian Islands. A 'Tested Release' will be selected based on propagation, vigor, and rate of growth.

Status of Knowledge:

The maximum use of plants presently recommended is limited by the lack of reliable commercial seed sources. The problem is compounded by import regulations, the quarantine on millet seeds, and the quarantine on vegetative material of grasses. There is a need for readily available sources of native seed and vegetative material that are approved for conservation practices. Field plantings of native plants are needed in areas where agriculture is changing.

Native plants require special considerations to maintain their genetic integrity. It may be necessary to identify sources of natives on each island for propagating and planting on that island. Some native species that are already well-distributed throughout the island chain could be mass-produced by the PMC, in cooperation with state and other federal agencies, for distribution to the public until supplies become commercially available.

Conservation efforts with the use of native plants have been an ongoing challenge for state of Hawaii. There is a need to develop a plant material source and technology in the large-scale production of native plant species. *Sporobolus virginicus,* or more commonly known as akiaki, has the potential to fill this need. Conservation uses for akiaki include ecosystem restoration, erosion control, and enhancing diversity in riparian and other communities.

Sporobolus virginicus is a low-growing vigorous perennial grass that spreads by rhizomes. The height ranges from 4 to 8 inches tall. Roots can grow down to 18" deep. Leaves are 1-4" long and 0.04-0.12" wide with distinctly two-ranked and salt crystals common on leaves and stems. The leaf sheath is overlapping and hairy at the throat. Its inflorescence is dense and spike-like. The panicle, 3" long, is shorter than other Sporobolus species.

S. virginicus is commonly found in coastal dune habitats and it does best if sea water level fluctuates from 2 inches above soil surface to 6 inches below. It also does well in a variety of different soils from clays to sands. Being a plant that is adapted to low rainfall and high salinity, *S. virginicus* is fairly wide spread throughout the tropical regions and is native to the Pacific Islands Region as well as the continental United States. It also occurs in Africa, western seaboard of India, Sri Lanka, and Australia.

Experimental Design: Randomized Complete Block Design

Treatment 1	Sporobolus virginicus: HA-4840
Treatment 2	Sporobolus virginicus: HA-4846
Treatment 3	Sporobolus virginicus: HA-4861
Treatment 4	Sporobolus virginicus: HA-4894
Treatment 5	Sporobolus virginicus: HA-5802

Materials and Methods:

Sprig samples were collected from five different locations in Hawaii and from four different islands. HA-4840 is from Moomomi, Molokai, HA-4846 is from Papohaku, Molokai, HA-4861 is from Kaena, Oahu, HA-4894 is from Wailuku, Maui, and HA-5802 is from Rocky Road Beach, Kahoolawe. These samples were planted at the Hoolehua PMC as increase blocks. In July 2006, sprigs will be taken from these blocks and planted into dibble tubes to be started in a shade-house. When ready, the propagules will be planted, by hand, into replicated plots 9ft long x 9ft wide with 16 plants per plot. Plants will be planted in a block form, 4 x 4 plants, with plants spaced 1 foot apart. The trial will be replicated 4 times. 6-foot wide mulch paper will border the plots to help weed control. Irrigation will be provided by micro sprinklers set on a timer to put down 1inch of water per week.

S. virginicus does produce viable seed, but in very minute quantities. Because of this characteristic, sprigs will be the primary way to propagate it. In the past we had trouble propagating S. virginicus by sprigs. With the understanding that S. virginicus is a rhizomatous type of grass, care was taken to select the most promising of rhizomes. One cutting of rhizome was planted in each dibble tube. Our success rate was a discouraging 20-30 percent. For this trial a different method to propagate *S. virginicus*, suggested by Craig Smith, the Agronomist of the PIA West, will be

tested. Instead of one sprig for each dibble tube, 5-6 sprigs of rhizomes and stems will be planted in each dibble tube. The planting will be replicated 6 times for each accession. There is some concern on the health of the plots from which the sprigs will taken from, so at the end of the trial, this propagation technique will be tested again using sprigs from the trial plots. This is under the assumption that the trial plots will be more vigorous than our increase plots.

By using a point frequency grid, each plot will be evaluated for density or percent cover. Length, width and heights of the plots will also be measured to determine rate of spread. After 8 months the plots will be clipped to evaluate forage yields. The plots will be cut two more times after that, at 60-70 days between cuttings. In addition to forage yields, after each cutting, point frequency measurements will also be made to determine rhizome cover.

AKIAKI TRIAL FIELD ACTIVITY

8/01/06	Started propagules for trial……..	NB, Americorps
1/15/07	Observations: There has been a significant difference in take between accessions. At the end of the trial, we will perform another propagation trial to confirm our findings……..	KD
1/17/07	**Planted trial…….**	**KD,NB, JB,KC**
2/7/07	Manual weed control……	NB,KC
3/1/07	Manual weed control……	NB,KC,KD
3/20/07	Manual weed control……	KD,JB,KC
3/21/07	Point Frequency data taken……	KD,Pat,Jim
4/11/07	Manual weed control……	NB,JB,KC
5/2/07	Manual weed control……	KD,JB,KC
5/29/07	Manual weed control……	JB,KC
5/29/07	**Point Frequency data taken……**	**KD,JB,KC**
8/14/07	**Point Frequency data taken……**	**KD, KC**
9/5/07	Manual weed control……	KD, KC
9/20/07	**1st Forage Yield Samples taken and dried……**	**KD, KC**
9/27/07	All vegetative material cut to 1”……..	KD, GS, KC
9/28/07	1st Forage Yield samples weighed……	KD, KC

DISCUSSION

Evaluation – 63 DAP (days after planting)

All of the plots are growing reasonably well with the exception of the entire fourth replication. Because of its position closest to an ironwood windbreak, the fourth replication is receiving less sunlight and, overall, appears to be less vigorous than the other replications. It is obvious that Sporobolus virginicus has a low shade tolerance. Presently there are no signs of disease or insect damage.

By just visual observation of the accessions, three different forms can be distinguished. The Moomomi accession has a growth form the stays relatively low to the ground. The Kaena and the Kahoolawe accessions are very similar to each other with a seashore paspalum "look" to them with the Kaena accession being the more vigorous of the two. The Papohaku and Maui accessions are also very similar to each other. These two have bluish-green colored leaves that are noticeably wider than the other accessions. These are only early observations and will be supported or contradicted with the following evaluations.

Although the data collected is only initial evaluations, we are seeing some trends. The data indicates that the Moomomi accession has the highest point frequency hits with the Kaena and Wailuku accessions following relatively close behind. The data also shows that the Kahoolawe accession is starting to spread relatively quicker compared to the other accessions. Again, the Kaena and Wailuku accessions follow relatively close behind in rate of spread. Further evaluation will confirm our findings.

Sporobolus virginicus (aki aki) - TESTED RELEASE

DATA SUMMARY

DATE: March 23, 2007

REP	ACC	LENGTH	WIDTH	HEIGHT	PTFRQ
1	MOOMOMI	145	135	20	51
2	MOOMOMI	150	145	25	66
3	MOOMOMI	140	135	20	33
4	MOOMOMI	150	130	20	35
1	KAHOOLAWE	155	145	30	37
2	KAHOOLAWE	165	155	35	36
3	KAHOOLAWE	150	155	35	27
4	KAHOOLAWE	130	110	35	18
1	WAILUKU	155	140	25	45
2	WAILUKU	145	155	35	44
3	WAILUKU	145	130	25	36
4	WAILUKU	140	130	25	16
1	PAPOHAKU	135	140	30	32
2	PAPOHAKU	150	150	30	19
3	PAPOHAKU	130	130	25	26
4	PAPOHAKU	130	110	30	17
1	KAENA	160	150	30	41
2	KAENA	165	155	35	44
3	KAENA	150	125	30	33
4	KAENA	125	120	35	23

Evaluation – 132 DAP (5/29/07)

The plots continue to grow very well. After 132 DAP, all plots in REP I and REP II have almost filled in. REP III and REP IV are also progressing, but continue to lag behind in growth. We are speculating that it could not only be due to the shade factor, but also lack of irrigation. During windy periods, it was observed that the irrigation coverage for REP IV was reduced compared to the others. The physical differences are becoming more distinct. The low growing Moomomi accession has stood out as the fastest to cover ground. The Wailuku accession is very vigorous, and although it is not spreading as fast as the Moomomi accession, it does seem to produce more rhizomes than the other accessions. The accession from Kahoolawe is proving to be a likely candidate as a high forage producer because of its tall growth. We will confirm this at a later date by taking forage yield samples.

The data supports our observations that the Moomomi accession is spreading the fastest and has the highest point frequency hits. The data also indicates that Kahoolawe accession is the second fastest to spread. The Kaena and the Kahoolawe accessions have relatively similar rates of spread, but it is the Kaena accession that has point frequency hits that are significantly similar to that of the Moomomi accession.

DATA SUMMARY - 132DAP

REP	ACC	LENGTH	WIDTH	HEIGHT	PTFRQ
1	MOOMOMI	210	230	30	98
2	MOOMOMI	250	235	30	99
3	MOOMOMI	230	200	20	64
4	MOOMOMI	195	170	20	81
1	KAHOOLAWE	220	195	55	87
2	KAHOOLAWE	225	225	40	86
3	KAHOOLAWE	220	190	30	73
4	KAHOOLAWE	190	175	45	60
1	WAILUKU	250	220	45	98
2	WAILUKU	195	240	30	75
3	WAILUKU	205	180	30	61
4	WAILUKU	160	155	30	30
1	PAPOHAKU	170	170	45	66
2	PAPOHAKU	195	180	40	54
3	PAPOHAKU	130	145	35	50
4	PAPOHAKU	135	130	25	41
1	KAENA	230	215	40	97
2	KAENA	225	205	35	87
3	KAENA	210	185	35	93
4	KAENA	155	160	35	60

SUMMARY

The Kaena and Kahoolawe accessions both produce long runners. Some rhizomes are produced, but the majority of the growth is in the form of runners that have a low tendency to 'tack' down or produce roots. The difference between the two is only slight, with the Kaena accession being the more vigorous of the two.

The Wailuku and Papohaku accessions have a strong tendency to produce rhizomes with some new growth stems that tend to bury back into the soil. These two accessions do produce a nice uniform stand, however the rate of growth and amount of point frequency hits are relatively low. Differences are also only slight with the Wailuku accession being the more vigorous of the two.

The Moomomi accession also has a very strong tendency to spread by rhizomes. By visual observations, it produces the most rhizome growth of all the accessions, therefore making it an excellent candidate for soil stabilization. Also, its leaves and stems are thinnest of all the accessions which could make it more palatable as feed.

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	HIPMC-P-0701-WI		
Title	*Polyscias guilfoylei* (panax) - Tested Release		
National Project No.	Cropland 1.1		
Study Type	Advanced Evaluations		
Study Status	Active		
Location	HIPMC		
Study Leader	David Duvauchelle		
Duration	March 2006 through March 2011		
Cooperators	-Alton Arakaki, University of Hawaii, Cooperative Extension -Hawaii Soil Water Conservation District		
Land Use	Cropland		
Vegetative Practices	Primary	650	WINDBREAK/SHELTERBELT ESTABLISHMENT
	Secondary	380	WINDBREAK/SHELTERBELT RENOVATION
		311	ALLEY CROPPING
Resource Concern(s)	Resource	Consideration / Problem	
	Soil	Soil Erosion / wind	
		Soil Erosion / water	
	Air	Air Quality / air pollutants	
Long Range Plan	Study falls under NRCS Objective 2.1 Part C of the HIPMC Long Range Plan.		

Objective:
The objective is to produce a growth rate in panax that is comparable to that of *Erythrina variegata* or 'Tropic Coral', which has a growth rate of about 10 feet per year. Various nitrogen treatments will be applied to *Polyscias guilfoylei* in an attempt to stimulate a faster growth rate. Also, we want to determine if there is significant difference in the effect of nitrogen between two different accessions of panax. This trial will be an attempt to increase the accuracy of a previous panax trial which had a few factors that could not be controlled or explained.

Status of Knowledge:
Many areas of cropland are subject to frequent strong winds. Velocities of 10 to 25 miles per hour or more may be expected much of the time. Permanent and semi-permanent windbreaks are needed on much of this land. Fire may destroy certain tree species that do not have the capacity of renewal. There is a need for rapid-growing annual or perennial plants for windbreaks. These plants could be used as primary windbreaks and for crops requiring additional windbreaks in fields already planted to windbreak trees. They should have the capability of renewal after fire.

They should produce a minimum of root competition, be relatively pest-free, esthetically pleasing, and have a low maintenance requirement. Additionally, there is a need for windbreaks for farmsteads and feedlots to serve as screens on highway medians and other areas.

Polyscias guilfoylei is a good choice for a windbreak. It is a columnar shrub with erect branches up to 24ft tall. The panax at the Molokai PMC has measured closer 30ft tall. The leaves are mostly 5.9-19.7" long, 1-pinnate, leaflets opposite, blades variable, but commonly broadly ovate or elliptic and coarsely dentate or lacerate, commonly variegated with white or pale yellow margins, or sometimes all dark green; leaflets are mostly 1.9-3.9" long; inflorescence a compound panicle. The origin of panax is unknown, but it is widely cultivated in the paleotropics and in some parts of the neotropics.

As good of a windbreak as panax could be, 'Tropic Coral' has been the choice of many of the local farmers because of its taller growth of about 40ft and faster growth rate. Recently, the Erythrina Gall Wasp (EGW) has devastated Hawaii's 'Tropic Coral' windbreak systems. *Polyscias guilfoylei* could be a potential substitute for Hawaii's local farmers.

Experimental Design: SPLIT PLOT Design

Treatment 1	Title: Acc# 9079789 Non-variegated (1N) Description: no nitrogen (control)
Treatment 2	Title: Acc# 9079789 Non-variegated (2N) Description: 25 lbs. of nitrogen per acre
Treatment 3	Title: Acc# 9079789 Non-variegated (3N) Description: 50 lbs. of nitrogen per acre
Treatment 4	Title: Acc# 9079789 Non-variegated (4N) Description: 100 lbs. of nitrogen per acre
Treatment 5	Title: Acc# 9079807 Variegated (1V) Description: no nitrogen (control)
Treatment 6	Title: Acc# 9079807 Variegated (2V) Description: 25 lbs. of nitrogen per acre
Treatment 7	Title: Acc# 9079807 Variegated (3V) Description: 50 lbs. of nitrogen per acre
Treatment 8	Title: Acc# 9079807 Variegated (4V) Description: 100 lbs. of nitrogen per acre

Materials and Methods:
Before planting, a soil sample of the trial area was submitted to the University of Hawaii at Manoa to evaluate nutrient deficiencies. All recommended amendments were added with the exception of nitrogen. The nitrogen source for the treatments is from Ammonium Sulfate (21-0-0). Each nitrogen treatment will be applied at 90-DAY intervals for a total of 4 applications. Plant height, length and width will be measured. Plant vigor will also be evaluated at the same 90-DAY intervals. The plots will be aligned in a single row as a windbreak to simulate actual wind situations. The trial is drip-irrigated once a week at 24 hours intervals. Weeds will be controlled with a pre-emergent herbicide as well as by hand.

Both accessions being tested were collected on the island of Molokai. The non-variegated accession (acc# 9079789) is from the Hoolehua PMC and the variegated accession (acc# 9079807) is from the Bauman's residence in the Kamililoa area. Vegetative cuttings were used since panax rarely produces viable seeds. Cuttings were cut to 36" long and be planted 12" deep with 2ft spacing between each cutting. The trial is replicated 4 times. Each replication consists of four plots representing 4 different treatments. Each plot consists of 12 plants; 2 'buffer' plants on each end of 8 'trial' plants. These 8 'trial' plants are 4 plants of the variegated accession and 4 plants of the non-variegated accession. The order in which these accession were planted, be it 4 variegated plants first and 4 non-variegate plants second or visa-versa, was completely randomized. The order of the different treatments was also randomized.

The initial evaluation will be made and the first nitrogen treatment will be applied on October 23, 2007 (90 days after planting) to insure that there is enough root development for sufficient nutrient uptake.

PANAX-2 TRIAL FIELD ACTIVITY

7/17/07……..Received results for soil tests……GS
7/23/07……..Dropped 350 pounds gypsum incorporated into soil
with tiller…… KD
7/24/07……..Installed irrigation system and made cuttings;
irrigated overnight…….. KD, JB, KM,MN
7/25/07……..Planted cuttings – ground hard, difficult to plant…….. KD, JB, KM,MN
8/13/07……..**Observation:** new shoots emerging (19 DAP)……. KD
8/16/07……..Manual weed control; also dropped Ronstar – 7lbs…. KC
8/31/07……..Manual weed control……..KD, KC

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

Study ID Code	HIPMC-T-0702-IN		
Title	Piligrass: Mulching Rates with Seeded Hay-Bales		
National Project No.	Critical Area 1.1		
Study Type	Advanced Evaluations		
Study Status	Active		
Location	Hoolehua PMC		
Study Leader	David Duvauchelle		
Duration	August 2007 through September 2008		
Land Use	Wildlife Habitat		
Vegetative Practices	Primary	650	WINDBREAK/SHELTERBELT ESTABLISHMENT

Resource Concern(s)	Resource	Consideration / Problem
	Soil	Soil Erosion / wind
		Soil Erosion / water

Long Range Plan Study falls NRCS Objective 2.3 Part A of the HIPMC LRP

Objective:
Heteropogon contortus (piligrass) seeded-hay mulch thickness has a direct effect on *H. contortus* seedling growth. The objective for this trial was to evaluate the effects of various mulch rates on emerging piligrass seedlings.

Status of Knowledge:
Undesirable plants have invaded grazing lands. They consume needed moisture, and are generally not as well suited for controlling erosion as other more desirable species. These invasive species lower the productivity of the land. High seeding rates of may provide a dense cover of desirable native species that will be competitive and not allow the undesirable species to return. Experimentation with high seeding rates of native and other desirable plants to provide cover when invasive species are replaced is needed. *Heteropogon contortus,* or more commonly known as piligrass, has the potential to fill this need. Primary recommendation for this grass would be vegetation to aid erosion control. Piligrass also has the potential for ecosystem restoration, re-vegetation of degraded habitats, and to increase diversity in riparian and other communities.

Piligrass is an erect, branching perennial that may form rather large bunches up to 5 feet tall under optimum conditions. Under natural conditions in Hawaii, it grows 1 to 3 feet tall. There is extensive variation within this species throughout its range. The stems are flattened, rather tough, smooth, and a pale bluish-green. Leaves are produced throughout the length of the stem and are flat or folded, 4-12 inches long, about 0.25 inches wide and rough to the touch. The flowering heads have narrow,

crowded flower spikes up to 4 inches long. The spikelets overlap and each fertile one bears a conspicuous red-brown awn about 4 inches long, made crooked with two bends. The long-awned seeds are sharp pointed forming tangled masses as they mature. When the seeds come in contact with moisture the hygroscopic awns and sharp barbed tips arch and twist planting them into the soil. Piligrass has a world-wide distribution and is found in the warm tropical regions of both hemispheres.

Experimental Design Randomized Complete Block Design, RCB

Treatment 1 Title: T1 - ¼ ton per acre of hay
Description: 0.71 lbs. per plot

Treatment 2 Title: T2 - ½ ton per acre of hay
Description: 1.42 lbs. per plot

Treatment 3 Title: T3 - ¾ ton per acre of hay
Description: 2.14 lbs. per plot

Treatment 4 Title: T4 - 1 ton per acre of hay
Description: 2.85 lbs. per plot

Treatment 5 Title: T5 - 2 ton per acre of hay
Description: 5.69 lbs. per plot

Treatment 6 Title: T6 - 3 ton per acre of hay
Description: 8.54 lbs. per plot

Materials and Methods:
The *Heteropogon contortus* used (ACC# 9079683) is a Source Identified strain from the island of Kahoolawe that has been cultivated at the Hoolehua Plant Materials Center. The *H. contortus* hay-bales produced at the Hoolehua PMC are about 35 pounds and contain, on average, about 1/2 pounds of bulk seed. *H. contortus* seed has a dormancy period of at least 6 months. The bales that were used were harvested on October 11, 2007. The plots were started on May 12, 2008. Tests have shown the germination rate of *H. contortus* seed peaks at about 45-50%. A germination test of the seed contained in the bales that were utilized for this evaluation was done and it had shown the seed to have a germination rate of about 12%. With these numbers, the seeding rate of the various mulch rates to be evaluated can be calculated.

35 lbs.	= 1.00 bales	= 0.50 lb. bulk seed	= **0.06 lb pure live seed**
¼ ton hay/A	= 14.25 bales/A	= 7.125 lb. bulk seed	= **0.86 lb. pls/A**
½ T hay/A	= 28.50 bales/A	= 14.25 lb. bulk seed	= **1.72 lb. pls/A**
¾ T hay/A	= 42.75 bales/A	= 21.38 lb. bulk seed	= **2.58 lb. pls/A**
1 T hay/A	= 57.00 bales/A	= 28.50 lb. bulk seed	= **3.44 lb. pls/A**
2 T hay/A	= 114.00 bales/A	= 57.0 lb. bulk seed	= **6.88 lb. pls/A**
3 T hay/A	= 228.00 bales/A	= 114.0 lb. bulk seed	= **13.76 lb. pls/A**

PLANT MATERIALS SPECIALIST REPORT

R.J. Joy, Plant Materials Specialist

This report includes a summary of promising species in Field Plantings. Information gained from Field Plantings is incorporated into the Field Office Technical Guides to make them more useful to our Field Office personnel. New cultivars or varieties that are released through our Plant Materials Program depend on the data collected from Field Plantings to support and document their release. The Field Planting is the final phase of testing in the plant materials systematic testing process. It is where a new plant is tested on a farm or other site under actual use conditions.

The excellent cooperation between Plant Materials and Field Office personnel in the Pacific Basin Area has enabled us to maintain a viable Plant Materials Program. We look forward to the continued high interest in plant materials by our field people who are so important to the success of the program.

SUMMARY OF PROMISING SPECIES

Arachis glabrata & *Arachis pintoi* (forage peanut): Forage or perennial peanuts are native to Brazil and make a dense cover, although they are slow to establish and spread. They may be grazed but are probably more useful as a low maintenance, permanent cover for erosion control and beautification. *Arachis pintoi* cultivars (Amarillo, Forrajero, Golden Glory) are susceptible to chlorosis caused by spider mites. Amarillo and Forrajero are commercially available as seed. *Arachis glabrata* cultivars are propagated by rhizomes. *Arachis pintoi* is performing well as a conservation cover in papaya on Kauai.

Avena strigosa (black oat): A new cultivar of black oat named Soilsaver was recently released by Auburn University and is in commercial seed production in Georgia. In our trials, black oat has looked similar to common oat. Its advantages include root-knot nematode resistance and allelopathy. Soilsaver is a selection from the Brazilian cultivar IAPAR 61-Ibipora, which is being grown on many acres in Brazil as a cover crop.

Azadirachta indica (neem): The neem tree contains several useful active ingredients. Among the most useful is a natural pesticide called azadirachtin. It is mainly extracted from the small fruits but it is also contained in the leaves. There are natural pesticides on the commercial market that contain azadirachtin. We are testing neem as a windbreak tree. It grows approximately 60 feet tall and has a moderate growth rate. Its branches are somewhat brittle so it should be used as the inside tree in a multiple row windbreak. It shows some damage from salt spray in a Field Planting

near the ocean on Kauai. It has a tendency to produce sprouts from the roots and these must be removed when it is used as a windbreak adjacent to cropland.

Brachiaria decumbens (signalgrass): Signalgrass is resistant to the yellow sugar cane aphid, which can significantly reduce yields of other forage grasses such as kikuyu. It is growing well where fertility is adequate such as on the limestone soils on Guam and Tinian. It is showing some intolerance to low fertility soils in a field planting in Hakalau, near Hilo, where it requires fertilizer to compete with the relatively unpalatable Hilo or t-grass (*Paspalum conjugatum*).

Canthium ordoratum (alahe'e, lla't): This indigenous tree has a moderate growth rate and grows to approximately 15 feet. It is native to the Hawaiian and Mariana islands. The botanical variety *tinianense* is endemic to the Marianas. *Canthium* is an attractive tree with glossy, green leaves and clusters of small, fragrant, white blossoms. It is wind tolerant.

Chloris gayana (Rhodesgrass): Rhodesgrass is naturally adapted to areas that receive between 25 and 40 inches of rainfall annually. It has long been a popular grass for grazing in these areas. Although it may not persist in higher rainfall areas, it appears to have application as living mulch in vegetable production where it could be re-seeded periodically. Invasiveness would not be a problem. Seeds are available commercially. The cultivar Nemkat has root-knot nematode resistance and Katambora is resistant to reniform nematodes.

Crotalaria juncea (sunn hemp): Sunn hemp grows well throughout the Pacific Islands Area. The cultivar Tropic Sun is an excellent cover/green manure crop and is resistant to root-knot and reniform nematodes. It is becoming popular in California and the South. The restrictions on the use of methyl bromide have increased its popularity because of its ability to control nematodes. Growers in southern Florida are, apparently, only moderately successful in producing Tropic Sun seed on a commercial scale. The commercial production of seed is progressing on Oahu and seed should be available from seed suppliers sometime in 2007.

Dodonaea viscosa ('a'ali'i, lampuaye): A widely adapted indigenous shrub that is native to Hawaii and naturalized in the Northern Marianas. It is a good windbreak, hedge, and screen plant and has use in landscaping and restoration work. It is performing well on Kaho'olawe. Its morphological features are variable or polymorphic. It grows to a height of approximately 10 to 20 feet, depending on the amount of moisture it receives, and has a moderate growth rate. Its attractive seed capsules make colorful leis. We have released a source identified selection collected on Molokai referred to as Kamiloloa Germplasm 'A'ali'i.

Eragrostis variabilis ('emoloa, kawelu, lovegrass): Kawelu is a perennial bunchgrass that is endemic to Hawaii. It is an attractive grass that is found on all the main islands and the Northwestern Hawaiian Islands as well. A selection, collected on Kaho'olawe, was formally released as Kaho'olawe Germplasm Kawelu Source Identified Class of Natural Germplasm. The native Hawaiians sometimes used kawelu as an alternative to piligrass for thatching their houses and other buildings. It

occurs on coastal dunes and grasslands, open sites in dry forests, and on exposed cliffs up to approximately 3,600 feet and 80 inches of annual rainfall. It shows promise for erosion control, restoration, and beautification. Because it is endemic to the Hawaiian Islands, it should be planted only there. It may be somewhat short lived. Field Plantings on Kaho'olawe are moderately successful so far.

Gliricidia sepium (gliricidia, quick stick, madre de cacao, rechesengel): Gliricidia is a leguminous tree about 30 feet tall. It is easily propagated by cuttings or seeds. A windbreak planting on the island of Hawaii is performing well.

Heteropogon contortus (piligrass, tanglehead): Pili is indigenous to Hawaii and is widely distributed in the tropics and subtropics. The native Hawaiians used it to thatch their houses in dry areas. It is a drought tolerant bunch grass that is currently being used for erosion control and restoration on the island of Kaho'olawe. This selection of pili was collected on Kaho'olawe and has been formally released as Kaho'olawe Germplasm Piligrass Source Identified Class of Natural Germplasm. In a stream bank stabilization Field Planting at Kanaha stream on Oahu, this accession of pili appears to be somewhat shade tolerant. On Kaho'olawe, it is the main grass planted in restoration plantings. It is doing a good job of erosion control where it was seeded and as intact hay bales.

Ischaemum digitatum (baronsgrass): Baronsgrass is a creeping perennial with a somewhat open growth habit. Ranchers in the Hilo area like it for grazing. It is tolerant of high rainfall and low soil fertility. *Ischeamum* grows well in Palau and Pohnpei.

Musa sp. (dwarf Brazilian banana): The cultivar Santa Catarina Prata is a delicious dessert banana that has enough wind tolerance to be used as a windbreak. It was brought to Hawaii from Brazil by Dr. Leng Chia of the University of Hawaii (UH). We began testing it as a windbreak because of requests from farmers in the Pacific Islands Area, West, for multipurpose windbreaks. It has performed well wherever it has been planted in the Pacific Islands Area. The bananas are well accepted in the commercial market.

Paspalum hieronymii (paspalum): Cultivar Tropic Lalo is performing well throughout the Pacific Islands Area. It is a perennial, creeping grass that forms a dense cover when mowed, is tolerant of traffic, and is low maintenance. It is becoming popular as a conservation cover in the southern United States.

Paspalum vaginatum (seashore paspalum): The cultivar Tropic Shore is planted to a constructed wetland in Wahiawa on Oahu. Heliconia was also planted, primarily as an income generating crop. The Tropic Shore, which is very tolerant of salt water, is doing well while the heliconia is not growing well. The constructed wetland was designed to filter waste water that has a high concentration of salts.

Pennnisetum purpureum (Napiergrass, elephantgrass): There are various accessions of Napiergrass; common, hybrid, and hybrids of Napier and pearl millet. The hybrids are sterile which means that there is little concern that they will become

invasive. ‘Mott’ is a hybrid Napier cultivar that was released by the University of Florida. It is very leafy and is performing well as a forage plant in the Pacific Islands Area. A PMC developed hybrid (HA-5690) is a cross between bannagrass, a tall Napier, and a male sterile pearl millet. This is a tall plant that has promise for windbreak, vegetative barrier, and forage. It performed well on a slope planting using the live fascine technique. A Napier x pearl millet hybrid (PMN Hybrid) was developed by the Hawaii Agriculture Research Center (formerly Hawaiian Sugar Planters’ Association) for the USDA-ARS Georgia Coastal Plain Experiment Station. It was developed for forage and has thinner stems than other Napiers.

Sporobolus virginicus (‘aki’aki, seashore rushgrass): An indigenous, creeping, perennial grass that spreads by rhizomes. It is native to sandy, usually coastal sites in tropical and subtropical areas worldwide. It is usually found just above the high-tide mark. It will grow up to 1,000 feet in elevation but the soil must be fairly loose for the rhizomes to spread. It is drought tolerant and very salt tolerant. There is a vigorous stand of ‘aki’aki on the beach near Garapan, Saipan. The most promising accession in Hawaii (HA-4846) was collected from Papohaku Beach on the west end of Molokai.

Stenotaphrum secundatum (St. Augustinegrass): The accession HA-4963 has performed well as a cover crop at the UH Poamoho and Kainaliu Experiment Stations. It competes well with weeds, has good drought tolerance, and is very shade tolerant. A dwarf selection, HA-5231, is performing well as a conservation cover in orchards. The chinch bug has been reported to damage St. Augustine lawns on Kauai. We haven’t observed damage in our Field Plantings, but it is something we must look for in our evaluations.

Vetiveria zizanioides (vetivergrass): The ‘Sunshine’ selection is sterile. It is performing well as vegetative barriers for erosion control on Guam, Saipan, American Samoa, Maui, Hawaii, Kauai, and Oahu. On the island of Hawaii, it is stabilizing waterway outlets. Vetivergrass is native to India. It is a tall bunch grass with a strong root system that contains an essential oil used in making perfume. The World Bank has promoted the use of vetiver for erosion control in developing countries.