# HOOLEHUA PLANT MATERIALS CENTER

# 2006 TECHNICAL REPORT

Piligrass
*Heteropogon contortus*

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# Hoolehua Plant Materials Center
# 2006

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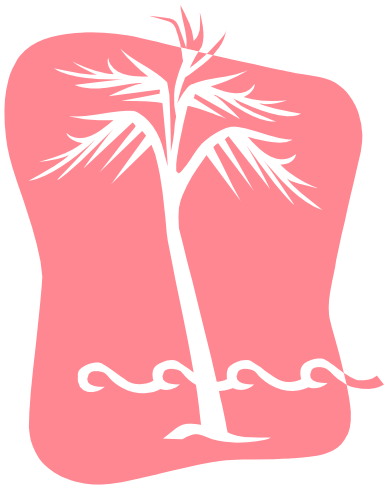

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# HOOLEHUA PLANT MATERIALS CENTER
## ANNUAL TECHNICAL REPORT 2006

# 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

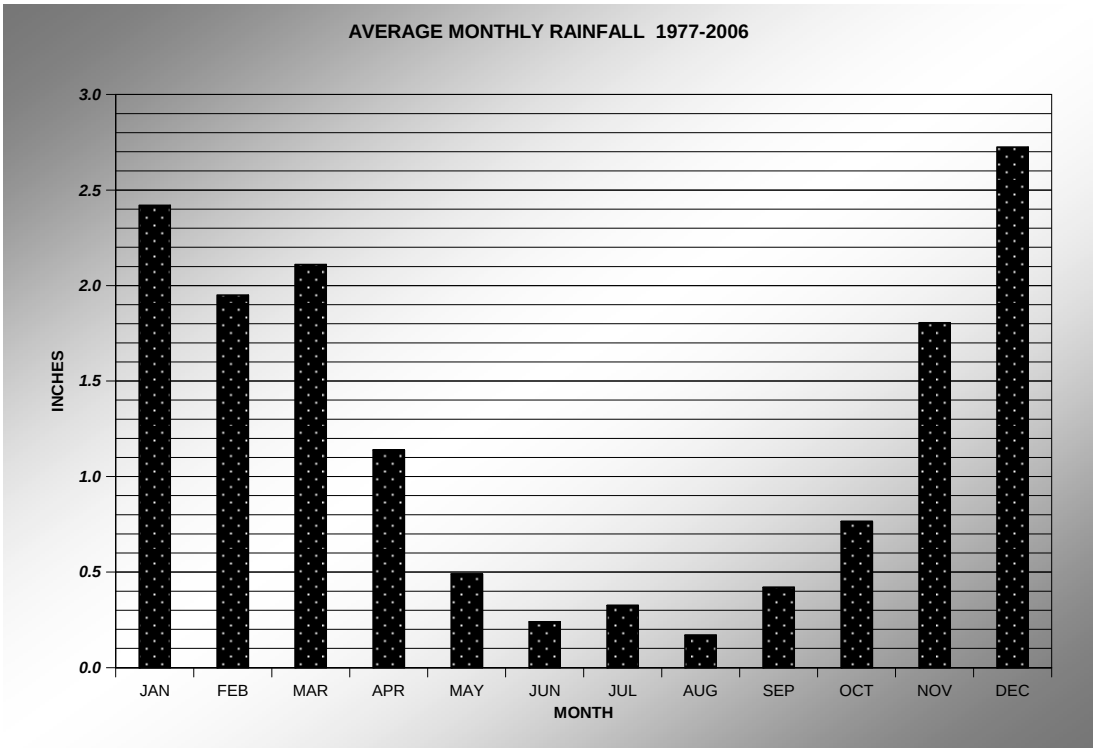
The center is responsible for servicing the needs of the State of Hawaii, the Territory of Guam, The Republic of Palau, The Republic of the Marshall Islands, the Territory of American Samoa, the Commonwealth of Northern Mariana Islands and the Federated States of Micronesia.

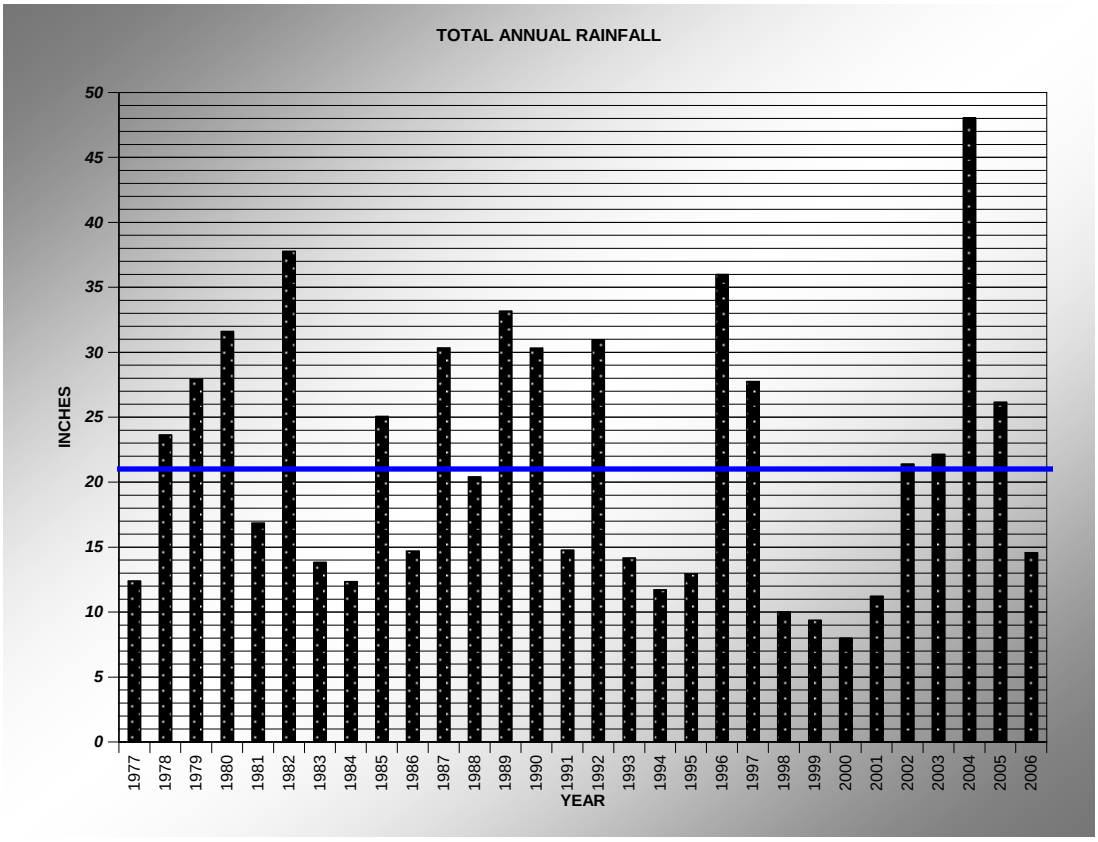
The islands owe their shape primarily to volcanic building and have been modified by erosion under strongly localized conditions. Elevations of the various islands vary from sea level to over 13,000 feet.

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

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

| | |
|---|---|
| **Study ID Code** | HIPMC-P-8801-CP |
| **Title** | Grass and Legume Groundcover Trial |
| **National Project No**. | Cropland 1.1 |
| **Study Type** | Initial Evaluation |
| **Study Status** | Active |
| **Location** | HIPMC |
| **Study Leader** | Glenn Sakamoto |
| **Duration** | 1988 - 2007 |
| **Cooperators** | |
| **Land Use** | Cropland |
| **Vegetative Practices** | Primary 340 COVER CROP |
| | Secondary |
| **Resource Concern(s)** | Resource / Consideration / Problem |
| | Soil / Soil Erosion / water |
| | Soil / Soil Erosion / wind |
| **Long Range Plan** | Study falls under Objective 2.1, Section D of the HIPMC Long Range Plan |

**Objective:**

To assemble and evaluate potential grasses and legumes for use in orchard conditions.

**Status of Knowledge**

A large percentage of the tree crops in Hawaii are on sloping land. Suitable, permanent cover crops are needed to prevent soil loss. Rank growing, weedy species naturally establish themselves in many areas and their control is expensive. There is a need for plants that are easy to establish and manage. Many orchards are faced with the problem of diminishing permanent ground covers as orchard canopy increases. The reduced sunlight within the orchards floor cannot sustain an adequate permanent ground cover to help control soil loss. Potential ground covers must be shade tolerant and not interfere with harvesting operations. Cover crops that can survive in areas with annual rainfall as low as 30 inches and are suited for controlled-grazing in orchards and wood lots are desirable.

**Materials and Methods**

In 1988, an initial evaluation planting of 64 accessions of various legumes, and grasses was conducted. SCS field office personnel assisted in the assembly of many of the accessions. The following table depicts the various accessions and their origin.

INITIAL EVALUATION FOR COVER CROPS FOR ORCHARDS

| | | | |
|---|---|---|---|
| 1. | Anthyllis vulneraria | HA-3311 | FEP -1 |
| 2. | Arachis pintoi | HA-4762 | cv. Amarillo - Australia |
| 3. | Axonopus affinis | HA-4736 | Meyers Lake, Molokai |
| 4. | Axonopus compressus | HA-4689 | Lava Tree State Park, HI |
| 5. | A. compressus | HA-4702 | Hilo Fed.bldg. |
| 6. | A. compressus | HA-4705 | Cliff Rainbow Hotel, Ponape |
| 7. | A. compressus | HA-4711 | Beumont Exp. Sta. Hilo |
| 8. | A. compressus | HA-4712 | Hilo |
| 9. | A. compressus | HA-4714 | Hono. Dept.of Ag. lawn |
| 10. | A. compressus | HA-4733 | Coco Palms Hotel, Kauai |
| 11. | A. compressus | HA-4735 | Ala Moana Park, Oahu |
| 12. | A. compressus | HA-4737 | S. Skipper, Hilo |
| 13. | A. compressus | HA-4739 | Guam, PACBAS Office |
| 14. | A. compressus | HA-4740 | Nekken Exp. Sta. |
| 15. | A. compressus | HA-4741 | Nikko Hotel & Museum grnds. |
| 16. | A. compressus | HA-4756 | Peleliu |
| 17. | A. compressus | HA-4757 | Yap Dept.of Ag. nusery |
| 18. | A. compressus | HA-4758 | M. Lockays Grove, Yap |
| 19. | A. compressus | HA-4759 | Palau Marineculture lab |
| 20. | A. compressus | HA-4760 | Palau EPA office |
| 21. | A. compressus | HA-4772 | Kokee Nat. Park,HI 3300'eleva. |
| 22. | A. compressus | HA-4782 | Uraguay - NPMC & S.Rgnl.PI Sta |
| 23. | A. compressus | HA-4783 | Uraguay - NPMC & S.Rgnl.PI Sta |
| 24. | A. compressus | HA-4784 | Brazil " " " " " |
| 25. | A. compressus | HA-4785 | Swaziland " " " " " |
| 26. | A. compressus | HA-4786 | Uraguay " " " " " |
| 27. | A. compressus | HA-4787 | India - NPMC and S.Rgnl.PI Sta. |
| 28. | A. compressus | HA-4806 | Royal Lahaina Resort, Maui, HI |
| 29. | A. compressus | HA-4810 | Coconut Island, HIlo HI |
| 30. | A. compressus | HA-4811 | HTBG, HI (mowed) |
| 31. | A. compressus | HA-4812 | HTBG, HI (unmowed) |
| 32. | Canavalia maritima | HA-4821 | Maui along beach hwy. |
| 33. | Centrosema pubescens | HA-4703 | Ponape Ag.Station |
| 34. | Desmodium heterophyllum | HA-4335 | Sheldon Whitney, UH |
| 35. | D. heterophyllum | HA-4572 | Hilo Ext. Ser off. |
| 36. | D. heterophyllum | HA-4704 | Ponape Ag Station |
| 37. | D. heterophyllum | HA-4738 | Mac Farms HI |
| 38. | D. heterophyllum | HA-4809 | IRFL-3293 - Dr.Kretschmer |
| 39. | D. heterophyllum | HA-4816 | HI Cacao |
| 40. | D. heterophyllum | HA-4824 | Maui |

| | | | |
|---|---|---|---|
| 41. | Desmodium ovalifolium | HA-4761 | Yin-Tao Chen, Palau |
| 42. | Desmodium sp. | HA-4732 | Palau Airport |
| 43. | D. triflorum | HA-4706 | Ponape Ag. Sta. |
| 44. | D. hirtum | HA-4770 | Knox City PMC |
| | (replant w/ D. ovalifolium | HA-4879 | 12/19/90 |
| 45. | Dichondria sp. | HA-4825 | Maui |
| 46. | Glycine javanica | HA-2970 | NPMC - orig. S. Africa |
| 47. | G. javanica | HA-2971 | NPMC - Rep of the Congo |
| 48. | G. javanica | HA-2972 | NPMC - Rep of the Congo |
| 49. | G. javanica | HA-2974 | NPMC - orig. Brazil |
| 50. | G. javanica | HA-2975 | NPMC - Orig. Africa |
| 51. | Glycine falcata | HA-3093 | NPMC - Miss PMC repro - Aust. |
| 52. | J. sandwicensis | HA-4815 | M'loa hwy. Mahana stretch MKK. |
| 53. | Lab Lab purpureus | HA-2957 | NPMC-Repro S.Reg.PI Orig.Kenya |
| 54. | Lotononis bainessii | HA-3004 | NPMC - orig. Ivory Coast |
| 55. | Sporobulus virginicus | HA-4852 | Anaeho'omalu beach,HI |
| 56. | Stylosanthes gracilis | HA-3177 | NPMC - Brazil |
| 57. | S. gracilis | HA-3176 | NPMC - Brazil |
| 58. | Stylosanthes guyanensis | HA-3181 | NPMC - Brazil |
| 59. | Trifolium pratense | HA-4776 | New Zealand Grasslands Pawera |
| 60. | Vicia ludoviciana | HA-3196 | |
| 61. | Vigna marina | HA-3386 | Kailua Beach by Palmer |
| 62. | Vigna sp. | HA-3384 | Artesian St. by Palmer |

## DISCUSSION:

Accessions were screened for overall plant performance. Four accessions were selected and moved to increased plots for advanced testing. They are as follows:

| | | |
|---|---|---|
| *Axonopus compressus* | - 9037940 - | Puna, HI. by R. Joy |
| *Axonopus compressus* | - 9037941 - | Rep. of Belau, R. Joy |
| *Desmodium heterophyllum* | - 9037945 - | Pohnpei, Fed. of Mic., R. Joy |
| *Desmodium triflorum* | - 9037946 - | Pohnpei, Fed. of Mic., R. Joy |

The *Axonopus compressus* accessions proved to be excellent candidates for orchard situations, unfortunately, they have rated relatively high on the H.E.A.R. list and its release has been delayed or somewhat postponed. They are currently being maintained in foundation blocks and field plantings are being evaluated at various MLRA sites.

Further study will be conducted on the two Desmodium accessions.

SPECIES: *Axonopus compressus*
DESCRIPTION: A stoloniferous perennial grass. It has a creeping, mat-forming growth habit. Stolons are strongly branched, rooting at each node. Leaf blade is lanceolate, flat, 1 to 6 inches long, 1/8 to 5/8 inch wide, broad at the base with a somewhat blunt apex, often fringed with hairs. Flowering culms are erect, 5 to 15 inches high. Usually two inflorescences develop successively, the second and succeeding inflorescences remaining hidden inside the sheath but ultimately projecting beyond the sheath and becoming long-exerted.
USE: For ground cover in shady conditions, primarily orchard ground cover and more specifically for macadamia nut orchards. It will grow in full sun and should have application for filter strips, erosion-prone areas. It makes a very acceptable turf.

SPECIES: *Desmodium heterophyllum*
DESCRIPTION: A perennial, prostrate, strongly stoloniferous legume. Roots freely at the nodes and is non-twining. Growth height varies with accession, but the maximum height is about 12 to 18 inches. It grows well in association with grasses and is somewhat shade tolerant. Seed pods do not adhere to clothing.
USE: Orchard cover crop in association with desirable grasses. Living mulch, filter strips, critical area planting, and pasture.

SPECIES: *Desmodium triflorum* (L.) DC.
DESCRIPTION: A prostrate, non-twining, creeping perennial legume. Stems are slender and branching into a thick mat. It is stoloniferous in growth and roots freely at nodes. Growth height ranges from 10 inches to a maximum height of 23 inches. It grows well in association with grasses and is somewhat shade tolerant.
USE: Orchard cover crop in association with desirable grasses. Living mulch, filter strips, critical area planting, and pastures.

The following *Axonopus compressus* accessions were removed

HA-4702, HA-4705, HA-4711, HA-4712, HA-4714, HA-4733, HA-4735, HA-4736, HA-4737, HA-4739, HA-4740, HA-4741, HA-4756, HA-4757, HA-4758, HA-4759, HA-4760, HA-4789, HA-4806, HA-4810, HA-4811, HA-4812, HA-4784, HA-4785, HA-4786

Other plots that were removed included five accessions of *Glycine javinica* (HA-2970, HA-2974, HA-2972, HA-2971, and HA-2975) and two accessions of *Desmodium spp*. (HA-4738, HA-4732). All other remaining accessions were kept for observation. They were biannually evaluated for vigor and longevity. Each year plots were cut back to 3'x10' blocks to determine tolerance and growth rate.

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

| | | | |
|---|---|---|---|
| **Study ID Code** | HIPMC-P-8901-OT | | |
| **Title** | Native Plant Trial | | |
| **National Project No**. | Natural Areas 1.1 | | |
| **Study Type** | Initial Evaluation | | |
| **Study Status** | Active | | |
| **Location** | HIPMC | | |
| **Study Leader** | Glenn Sakamoto | | |
| **Duration** | 1989 - 2008 | | |
| **Cooperators** | | | |
| **Land Use** | Cropland | | |
| **Vegetative Practices** | Primary | 342 | CRITICAL AREA PLANTING |
| | Secondary | 327 | CONSERVATION COVER |
| | | 350 | RANGE PLANTING |
| | | 612 | TREE/SHRUB ESTABLISHMENT |
| **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 2.1, Section E of the HIPMC Long Range Plan | | |

**Objective:**

To assemble and evaluate adaptable species of native plants for use on highly eroded lands which receive less than 30 inches of precipitation per year. Select promising species for further investigation.

**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. 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. Hawaii has approximately 85,000 acres of arid regions that receive less than 30 inches of annual rainfall, and adaptable native ground cover would greatly improve the lands quality for its agricultural needs, sustaining native plant species, and would be beneficial for controlling soil and wind erosion. Interest in native plants has been increasing in recent years in both

commercial and private sectors of the State. The demand for native species for both ornamental and conservation use has prompted the further investigation by the Hawaii Plant Materials Center.

**Materials and Methods:**

Plot Plan:

Plants within plots will be planted 1 foot apart. Plots will be 10 feet long by 3 feet wide and each plot will be 15 feet apart. Each row will have 16 plots and the rows will be spaced 20 feet apart.

Management:

A clean firm seedbed will be prepared by disking and tilling. Fertilizer application will be administered according to fertility tests. Mechanical weed control by tilling, undercutting and hand hoeing will be performed regularly. Contact chemical herbicide will be used only as directed by supervisor. A drip irrigation system will be installed and water will be applied according to tensiometers or by moisture feel testing.

Assembly:

Seeds or vegetative materials will be obtained from various SCS Field Offices throughout the State. Below is a list of selected species and their origin.

With the exception of *Gossypium sandwicense* all accessions assembled were planted to field plots using vegetative cuttings. *G. sandwicense* was planted by seed and later transplanted to test plots.

| | | | |
|---|---|---|---|
| 1. | Jacquemontia sandwicensis | HA-4829 | Kahoolawe 1000' elev. |
| 2. | J. sandwicensis | HA-4830 | Kahoolawe E. eroded slope 1000' |
| 3. | J. sandwicensis | HA-4831 | M'loa hwy at PMC water intake |
| 4. | Sesuvium sp. | HA-4832 | Akulikuli, Kahoolawe 1000'elev |
| 5. | Lipocaeta integrifolia | HA-4837 | Moomomi beach area MKK. |
| 6. | J. sandwicensis | HA-4838 | Moomomi beach dunes MKK. |
| 7. | Boerhavia diffusa | HA-4841 | Moomomi beach dunes MKK |
| 8. | J. Sandwicensis | HA-4839 | Moomomi rd. |
| 9. | Sporobulus virginicus | HA-4894 | 0.5 mi past Wailuku wst.trtmt.plt |
| 10. | J. sandwicensis | HA-4893 | K'Kai pier, MKK |
| 11. | Sporobolus virginicus | HA-4840 | Moomomi beach dune |
| 12. | Sesbania molokaiensis | HA-4844 | Moomomi beach rd. |
| 13. | Sida fallax | HA-4895 | Moomomi beach sand dunes,MKK |
| 14. | Sporobulus virginicus | HA-4846 | Papohaku beach MKK |
| 15. | Jacquemontia sp. | HA-4845 | Maui by Neal Fujiwara |
| 16. | J. sandwicensis | HA-4853 | Lapakahi State Park, Kohala |
| 17. | J. sandwicensis | HA-4854 | Sandy Beach, Oahu |
| 18. | J. sandwicensis | HA-4855 | Makapuu Beach Park, Oahu |
| 19. | J. sandwicensis | HA-4859 | Kahului,Maui behind McDonalds |
| 20. | J. sandwicensis | HA-4860 | Keana Pt., Oahu |
| 21. | Sporobulis virginicus | HA-4861 | Mokuleia Keana Pt. HI |
| 22. | J. sandwicensis | HA-4862 | Kuaohala public hunting area |
| 23. | J. sandwicensis | HA-4864 | .25 mi. S. of papohaku beach MKK |
| 24. | S. virginicus | HA-4852 | Kapalaoa Beach by C. Harada |

| | | | |
|---|---|---|---|
| 25. | Sida fallax | HA-4933 | 4-5 diff. plants Mkk R. Joy |
| 26. | J. sandwicensis | HA-4815 | Mahana, Molokai |
| 27. | Gossypium sandwicense | HA-4847 | Ma'o |
| 28. | Euphorbia degeneri | HA-4842 | Moomomi, R.Joy, G.Sakamoto |
| 29. | Heliotropium anomalum | HA-4843 | Moomomi, Molokai |

## DISCUSSION:

All accessions were kept for observation. They were biannually evaluated for vigor and longevity. Each year plots were cut back to 3'x10' blocks to determine tolerance and growth rate. Of the 29 accessions planted, 2 accessions did not grow; they include the *Euphorbia degeneri* and *Sesbania molokaiensis*.

*Sporobulus virgincus* has been included in the Hawaii SCS Technical Guide for conservation use. It has been selected for advance testing as a 'Tested Release'. It is very drought tolerant. Tests have also shown that it has high tolerances for various commonly used herbicides.

Other accessions selected for future advanced testing include *Sida fallax*, *Waltheria indica*, and *Vitex rotundifolia*, J*acquemontia sandwicensis, Lipochaeta integrifolia.* These plants have the potential of being cultivated on large scales and are suited to low rainfall zones.

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

| | | | |
|---|---|---|---|
| **Study ID Code** | HIPMC-P-8903-CP | | |
| **Title** | Contour Hedgerow / Alley Cropping Trial | | |
| **National Project No**. | Cropland 1.1 | | |
| **Study Type** | Initial Evaluation | | |
| **Study Status** | Active | | |
| **Location** | HIPMC | | |
| **Study Leader** | Glenn Sakamoto | | |
| **Duration** | 1989 - 2006 | | |
| **Cooperators** | | | |
| **Land Use** | Cropland | | |
| **Vegetative Practices** | Primary | 422 | HEDGEROW PLANTING |
| | Secondary | 330 | CONTOUR FARMING |
| | | 601 | VEGETATIVE BARRIER |
| **Resource Concern(s)** | Resource | Consideration / Problem | |
| | Soil | Soil erosion / water | |
| | | Soil Erosion / wind | |
| **Long Range Plan** | Study falls under Objective 2.1, Section F of the HIPMC Long Range Plan | | |

**Objective:**
To assemble and evaluate leguminous and non-leguminous plant accessions for use in cropping systems where conventional conservation practices are limited or unavailable due to topography, resources or environmental concerns.

**Status of Knowledge:**
Many of the farmlands in Hawaii & the Pacific Basin are situated on steep hillsides. NRCS Field personnel are seeking alternative conservation practices to help local farmers control their erosion problems. Contour hedgerow enables farmers to plant leguminous plants or grasses strategically on the contour, thereby providing vegetative barriers to trap & filter sediments. This practice allows farmers to install conservation practices where machinery is unable to do so.

**Materials and Methods:**
In September 1989, selected accessions were planted to field plots. Accessions will be evaluated on overall performance, growth rate, vigor, disease and insect resistance for one year. After one year of growth, all accessions with potential to be vegetative barriers will be coppiced to a 3 feet height with continued coppicing performed on a quarterly basis. Gross vegetative yields from coppiced plots will being tabulated and re-growth characteristics noted. Realistically, coppicing with this type of practice would not be done so frequently. It is assumed coppicing would be

done as needed by the cooperator. The intent of frequent coppicing is to screen out those accessions that can withstand extreme circumstances. Advanced testing will be conducted on those accessions which can withstand the conditions and will persist for longer period.

| | | | |
|---|---|---|---|
| 1. | *Sesbania aegyptica* | HA-4649 | NPMC T-53226 |
| 2. | *S. sesban* | HA-4753 | NFTA (873) "Kakamega", Kenya |
| 3. | *S. sesban* | HA-4754 | NFTA (874) "Wamba", Kenya |
| 4. | *S. sesban* | HA-4755 | NFTA (875) "Manchururiati", Kenya |
| 5. | *S. sesban* | HA-4749 | NFTA (812) "Waimanalo campsite" |
| 6. | *S. sesban* | HA-4726 | D. Evans UH - CSIRO CPI 28114, Venzu |
| 7. | *Sesbania grandiflora* | HA-4746 | NFTA (N899) |
| 8. | *S. grandiflora* | HA-4751 | NFTA (835) "Ellison Hort Ltd.", Aus. |
| 9. | *S. grandiflora* | HA-4752 | NFTA (872) "Kitui", Kenya |
| 10. | *S. cannabina* | HA-4721 | D. Evans UH - CSIRO CPI 78174 |
| 11. | *S. cannabina* | HA-4725 | D. Evans UH - CSIRO CQ1445, Aus. |
| 12. | *S. cannabina* | HA-4727 | D. Evans UH - Taiwan. |
| 13. | *S. cannabina* | HA-4728 | D. Evans UH - CSIRO CQ1424, Aus. |
| 14. | *S. cannabina* | HA-4730 | D. Evans UH - Waimea Aboretum |
| 15. | *Sesbania exasperata* | HA-4722 | D. Evans UH - CSIROCPI 63925 surinam |
| 16. | *Sesbania pachycarpa* | HA-4723 | D. Evans UH, Sengal |
| 17. | *Desmanthus virgatus* | HA-4767 | (TQ94) fr. B. Smith via B. Cook Aus. |
| 18. | *D. virgatus* | HA-4765 | (3CPL8351) B. Smith - B. Cook, Aus. |
| 19. | *D. virgatus* | HA-4763 | (CPL79653) B. Smith - b. Cook, Aus. |
| 20. | *D. virgatus* | HA-4764 | (TQ90) B. Smith - B. Cook, Australia |
| 21. | *Gliricidia sepium* | HA-4745 | NFTA (N898) |
| 22. | *G. sepium* | HA-4747 | NFTA (220) , Costa Rica |
| 23. | *Cajanus cajan* | HA-4598 | (NP (WR) –15) - R. Yost UH |
| 24. | *C. cajan* | HA-4596 | (Gwalior-3) - R. Yost UH |
| 25. | *C. cajan* | HA-4595 | (ICP7065) - Yost UH |
| 26. | *C. cajan* | HA-4594 | (Bahar - R. Yost UH |
| 27. | *C. cajan* | HA-4593 | (ICP9051) - R. Yost UH28 |
| 28. | *C. cajan* | HA-4592 | (HY-3c) - R. Yost UH |
| 29. | *C. cajan* | HA-4591 | (ICP11299) - R. Yost UH |
| 30. | *S. grandiflora* | HA-4650 | NPMC –19- |
| 31. | *Sesbania emerus* | HA-4729 | D. Evans UH, Peru |
| 32. | *Sesbania macrantha* | HA-4724 | D. Evans UH, Rwanda |
| 33. | *D. virgatus* | HA-4768 | (CPL78382) B. Smith - B. Cook, Aus. |
| 34. | *D. virgatus* | HA-4766 | (CPL40071) B. Smith - B. Cook, Aus. |
| 35. | *C. calothyrsus* | HA-4748 | NFTA (495), Costa rica |
| 36. | *C. calothyrsus* | HA-4743 | NFTA (N896) Java, Indonesia |
| 37. | *Flemingia macrophylla* | HA-4750 | NFTA (833) Hawaii |
| 38. | *Vetiveria zizanioides* | HA-4778 | NPMC - S. PI Sta. (India) |
| 39. | *V. zizanioides* | HA-4779 | NPMC - S. PI Sta. (India) |
| 40. | *V. zizanioides* | HA-4780 | NPMC - S. PI Sta. (India) |
| 41. | *V. zizanioides* | HA-4781 | NPMC - S. PI Sta. (India) |
| 42. | *Cymbopogon citratus* | HA-4960 | G. Sakamoto - Hilo |
| 43. | *Entolasia imbricata* | HA-3511 | NPMC (Kenya) |

## DISCUSSION:

After approximately (18) months of coppicing, it has been observed that the regrowth of many of the accessions and the over all performance of plant vigor, disease resistance has been deteriorating. The accessions listed below have withstood extensive coppicing and have performed well, plants within the stand are beginning to die or show signs of stress. They had no mortality during the first year of coppicing and exhibited good vegetative re-growth. After the first year, the accessions began to express signs of stress, death, and poor re-growth. It was determined that the reduced vigor and death of these accessions was primarily caused by the frequent coppicing of the stand. These accessions were also affected by insect and disease problems possibly due to stress put on by the frequent coppicing.

| | | |
|---|---|---|
| 1. | *Sesbania aegyptica* | HA-4649 |
| 2. | *Sesbania sesban* | HA-4753 |
| 3. | *Sesbania grandiflora* | HA-4746 |
| 4. | *S. grandiflora* | HA-4751 |
| 5. | *S. grandiflora* | HA-4752 |
| 6. | *S. grandiflora* | HA-4650 |
| 7. | *Gliricidia sepium* | HA-4745 |
| 8. | *G. sepium* | HA-4747 |
| 9. | *Flemingia macrophylla* | HA-4750 |
| 10. | *Vetiveria zizanioides* | HA-4778 |
| 11. | *V. zizanioides* | HA-4779 |
| 12. | *V. zizanioides* | HA-4780 |
| 13. | *V. zizanioides* | HA-4781 |
| 14. | *Cymbopogon citratus* | HA-4960 |

### FY2005

Since 1989 only 6 of the original accessions remain under evaluation. The six remaining accessions include *Sesbania grandiflora*, HA-4751, HA-4752; *Gliricidia sepium*, HA-4745, HA-4747; *Flemingia macrophylla*, HA-4750; and *Calliandra calothysus*, HA-4748, HA-4743.

*Vetiveria zizanioides*, HA-4778, HA-4779, HA-4780, and HA-4781 preformed exceptionally well during its evaluation, forming a dense, fast growing, tight and robust bunch grass type characteristics. However, in the summer and fall of 1990 during its first cycle of flowering and seeding germination tests concluded a high percentage of viable seed. Because of the high germination rates and the possibility that these accessions could become an invasive pest, a decision was made to eradicate and destroy all three accessions.

In 1996, an accession of *V. zizanioides* HA-5754, PI–9054943, was received from Craig Elevitch, Holualoa, HI. This *V. zizanioides*, under the cultivar name 'Sunshine' was originally obtained from the USDA-ARS Plant Introduction Station, Griffin, Georgia. Vegetative slips of this accession were propagated at the PMC and

performed exceptionally well. During the first cycle of flowering and seeding, seed samples were sent and tested at the Hawaii Department of Agriculture for seed viability. Results indicated that 'Sunshine' possessed no viable seed. 'Sunshine' *V. zizanioides* is currently being increased at the Center and is gaining popularity as vegetative barrier in the Pacific Island Area.

*Sesbania grandiflora*, HA-4751 and HA-4752, continues to persist though not as vigorous as in previous years. Four accessions of sesbania sp. were originally planted to this trial. S. grandiflora, HA- 4746, and HA- 4650 did not tolerate the coppicing and gradually showed signs of dieback and eventually died. *S. grandiflora*, HA-4751 and HA-4752, are experiencing similar dieback characteristics as HA-4746 and HA-4650. *S. grandiflora*, though a fast growing tree does not initiate and abundance of new growth and lateral branching from its terminal shoot.

*Gliricidia sepium* selections continue to express good vigor and growth. *G. sepium*, HA-4745 and HA-4747 are the original two accessions planted to this trial in 1989. *G. sepium*, HA-5806 was received in 1998 from Craig Elevitch and planted to this trial as rooted cuttings. All *G. sepium* trees are performing exceptionally well. There are no major insect or disease problems. *G. sepium*, HA-4745 and HA-4747 responded very well to coppicing and produced and abundance of regrowth. *G. sepium*, HA-5806 received no coppicing but exhibit the same growth characteristic as HA-4745 and HA-4747. *G. sepium* selections are moderately fast growers and obtain a average height of 480 cm. in about 24 months. They are also easily propagated by cuttings and need no special treatment for rooting. *G. sepium*, at the Hoolehua PMC, flowers annually during the months of February through April. Seeds are numerous and do not seem to volunteer.

*Calliandra calothysus*, HA-4748, HA-4743 continue to grow very well at the PMC. It has tolerated coppicing and produced an abundance of branching and foliage. Branches are somewhat brittle but do not seem to break in the wind. It has a somewhat spreading type canopy with fine textured foliage. *C. calothysus* flowers annually during the months of January and February with brilliant red to orange-red blossoms. Seed production of *C. calothysus* is prolific and tends to volunteer in and around un-cultivated irrigated areas. It is for this reason *C. calothysus* may become invasive and may not be a good candidate for hedge-row or alley cropping practices. Currently, both accessions are approximately 750 cm. tall and 1220 cm wide.

*Flemingia macrophylla*, HA-4750 and HA-5116, an attractive leguminous shrub continues to growth well at the PMC. Its compact columnar growth makes it an ideal hedgerow plant. If is easily propagate by seed and can attain a height of approximately 450 cm in 18 month of growth. It can tolerate moderate wind flow and only lodges somewhat on the leeward side. It will tolerate moderate amounts of coppicing and produces and abundance of re-growth. Because, of its upright growth, this plant would make and ideal infield windbreak screen. Unfortunately, *F. macrophylla* is a prolific seeder and has been documented to volunteer outside of side of its intended area.

FY2006

The two species that we intend to study further are gliricidia and vetiver.

There has been extensive research done for vetiver. At the Hoolehua PMC, it has proven to be able to withstand extreme cutting/ pruning. Although its nutrient content may not be as high as a legume, it does very well as a vegetative barrier. It has a deep, fibrous root system that retains soil very well. This particular accession does not produce viable seed and has a relatively low tendency to spread. As an introduce species it poses a relatively low threat to the PIA. Further study needed to determine its ecological range in the PIA.

Gliricidia has proven to be a tree that persists very well after heavy pruning over a extended period of time. It is a prime candidate for agroforestry. Trees can be planted in rows for an infield windbreak system or a natural fence. Clippings from these rows can be used for mulch to provide nutrients for primary crops, or they can be fodder for livestock. As an introduce species it poses a relatively low threat to the PIA according to the PIER and HEAR lists. Further study will be conducted to examine other accessions of *Gliricidia sepium* for nutrient content, growth rate differences, and ecological range.

## Contour Hedgerow / Alley Cropping Trial
## Evaluation 2005

| | | | DIMENSIONS (cm) | | | RESISTANCE | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Species | HA-# | DT. PLT | HT | LG | WD | VI | DI | IN | LDG | UN |
| Flemingia macrophylla | HA-5116 | 1989 | 480 | 545 | 505 | 2 | 2 | 2 | 4 | 2 |
| Sesbania grandiflora | HA-4751 | 1989 | 1015 | 1335 | 1140 | 3 | 2 | 3 | 3 | 3 |
| Sesbania grandiflora | HA-4752 | 1989 | 410 | 185 | 190 | 3 | 2 | 3 | 3 | 3 |
| Gliricidia sepium | HA-5806 | 1998 | 990 | 2120 | 1370 | 2 | 2 | 2 | 4 | 3 |
| Gliricidia sepium | HA-4745 | 1989 | 840 | | 1425 | 2 | 2 | 2 | 2 | 2 |
| Gliricidia sepium | HA-4747 | 1989 | 860 | | 1500 | 2 | 2 | 2 | 2 | 2 |
| Sauropus androgynus | HA-5217 | 1992 | 300 | 610 | 355 | 4 | 2 | 3 | 3 | 4 |
| Cnidoscolus chayamansa | HA-5218 | 1992 | 160 | 315 | 190 | 2 | 2 | 2 | 2 | 2 |
| Bactris gasipaes | HA-5755 | 1996 | 520 | 410 | 350 | 3 | 2 | 2 | 3 | 3 |
| Calliandra calothysus | HA-4748 | 1989 | 655 | 1200 | 1080 | 3 | 2 | 2 | 3 | 3 |
| Calliandra calothysus | HA-4743 | 1989 | 705 | 1215 | 1335 | 3 | 2 | 2 | 3 | 3 |
| Flemingia macrophylla | HA-4750 | 4750 | 415 | 445 | 375 | 3 | 2 | 2 | 4 | 4 |
| Flemingia macrophylla | HA-5116 | 1992 | 480 | 545 | 505 | 2 | 2 | 2 | 4 | 2 |

HT - Height
LG - Length
WD - Width

VI - Vigor
DI - Disease
IN - Insects

UN - Uniformity
LDG - Lodging

## Contour Hedgerow / Alleycropping Trial HIPMC-P-8903-CP FY 2006

FIELD: 8 DATE: 31-May-06

| | Species | HA-# | HT | LG | WD | VI | UN | lant Inju | BE | 50% FB | 50% FP | 50% FM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Flemingia macrophylla | HA-5116 | 527 | 700 | 580 | 5 | 3 | IN-1 | | | 31-May-06 | |
| 2 | Sesbania grandifolia | HA-4751 | 970 | 1440 | 1130 | 4 | 5 | N | | | 31-May-06 | |
| 3 | Sesbania grandifolia | HA-4752 | 457 | 200 | 170 | 5 | 5 | N | | | 31-May-06 | |
| 4 | Gliricidia sepium | HA-5806 | 855 | 2110 | 1480 | 2 | 3 | W-2 | | | | 31-May-06 |
| 5 | Sauropus androgynus | HA-5217 | 260 | 660 | 410 | 3 | 3 | IN-1 | | 31-May-06 | | |
| 6 | Cnidoscolus chayamansa | HA-5218 | 240 | 450 | 320 | 2 | 2 | W-1 | 13-May-06 | | | |
| 7 | Gliricidia sepium | HA-4745 | 906 | 1200 | 1160 | 2 | 2 | N | | | | 31-May-06 |
| 8 | Gliricidia sepium | HA-4747 | 825 | 1160 | 1480 | 2 | 2 | N | | | | 31-May-06 |
| 9 | Bactris gasipaes | HA-5755 | 596 | 450 | 410 | 3 | 3 | N | | | | |
| 10 | Calliandra callothyrsus | HA-4748 | 654 | 1200 | 1210 | 2 | 3 | N | | | | 5/51/06 |
| 11 | Calliandra callothyrsus | HA-4743 | 687 | 1240 | 1210 | 2 | 3 | N | | | | 31-May-06 |
| 12 | Flemingia macrophylla | HA-4750 | 425 | 420 | 435 | 4 | 4 | IN-1 | | | 31-May-06 | |

NOTES:

#1 Flemingia has minimal leaf-eating insect damage

Sesbanias have very sparse uniformity, but seem relatively vigourous

#4 Gliricidia lost a big branch due to high winds

Sauropus and Cnidoscolus have minimal leaf-eating insect damage

#12 Flemingia has minimal leaf-eating insect damage

| | | | |
|---|---|---|---|
| HT - Height (cm) | V- Vigor | Plant Injury Code | BE - Buds Emerge |
| LG - Length (cm) | UN - Uniformity | D - Disease 1 - Light | FB - Flowers Bloom |
| WD - Width (cm) | Rating Scale | IN - Insect 5 - Moderate | FP - Fruit Produced |
| | 1 - Excellent | R - Rodent 9 - Severe | FM - Fruit Mature |
| | 5 - Average | DR - Drought | |
| | 9 - Poor | M - Machine | |
| | | W - Wind | |
| | | N - None | |

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

| | | | |
|---|---|---|---|
| **Study ID Code** | HIPMC-T-9601-WI | | |
| **Title** | *Dodonaea viscosa* Windbreak Establishment, Kamililoa | | |
| **National Project No**. | Cropland 1.1 | | |
| **Study Type** | Advanced | | |
| **Study Status** | Active | | |
| **Location** | HIPMC | | |
| **Study Leader** | Glenn Sakamoto | | |
| **Duration** | August 1996 through 2008 | | |
| **Cooperators** | -Hawaii Soil Water Conservation Districts | | |
| **Land Use** | Cropland | | |
| **Vegetative Practices** | Primary | 650 | WINDBREAK/SHELTERBELT ESTABLISHMENT |
| | Secondary | 342 | CRITICAL AREA PLANTING |
| | | 350 | 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 2.1, Section C of the HIPMC Long Range Plan. | | |

**Objective:**
To assemble and evaluate adaptable species of *Dodonaea viscosa* for low rainfall zones that receives less than 30 inches per year and to increase seeds for advanced testing.

**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. Interest in native plants has been increasing in recent years in both commercial and private sectors of the State. The demands for native species, for both ornamental and conservation use, has prompted further studies by the Hawaii PMC. *Dodonaea viscosa* has the potential to fill this need. The fibrous spreading root system, rapid growth, and spreading canopy of *D. viscosa* 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*, or more commonly known as aalii, 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. *D. viscosa* is found throughout the tropical regions of the world. Until recently, *D. viscosa* was 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. It is adapted to a wide range of habitats, from sea-level to nearly 8,000 feet and tolerating annual rainfall of 12-98 inches.

**Experimental Design**

| | | |
|---|---|---|
| **Treatment 1** | Title: A1 | Description: 1-foot spacing; irrigated |
| **Treatment 2** | Title: A2 | Description: 2-foot spacing; irrigated |
| **Treatment 3** | Title: A3 | Description: 3-foot spacing; irrigated |
| **Treatment 4** | Title: B1 | Description: 1-foot spacing; non-irrigated |
| **Treatment 5** | Title: B2 | Description: 2-foot spacing; non-irrigated |
| **Treatment 6** | Title: B3 | Description: 3-foot spacing; non-irrigated |

**Materials and Methods**

*Dodonaea viscosa* seeds will be randomly collected from various plant populations on the southern slope of the Kamililoa district of Molokai. Elevations range from approximately 1,000 to 3,000 feet. A base fertilizer (16-16-16) application will be incorporated into the soil at a rate of 1 pound per linear foot. Plants will be irrigated by drip-tape (33gpm per 1000ft): first 3 months – 5hrs/day per week; at 4-12 months – 8hrs/day per week; after 12 months – 18hrs/day per week. The trial will consist of two sections: Irrigated Plants and Non-irrigated Plants. To establish plant growth, the non-irrigated section will be irrigated for the first year which after that time the irrigation will be cut-off. The two sections will be planted in a single row with each section being divided into three plots according to spacing scheme: 1-foot spacing (70 plants); 2-foot spacing (35 plants); 3-foot spacing (23 plants). Trial Start Date: August 23, 1996 – shade-house propagated seedlings, 6 months old, were planted into Field 7

## DISCUSSION:

### Windbreak Potential

*Dodonaea viscosa* performed well in all planting schemes with only minimal leaf damage caused by rose beetles during the initial three months. Foliage and lateral branching were abundant throughout the stand and exhibited uniform growth within each planting scheme. Within six months after planting, in the 1-foot and 2-foot spacing in both section A and B, spaces between plants had been filled in. At 11 months, lateral branching of plants in the 3-foot spacing were over-lapping each other and obtained a height in excess of 6 feet. As a wind barrier, *D. viscosa* provided good wind protection after one year of growth in all planting schemes. The 1-foot and 2-foot planting configuration did fill in within the rows sooner (six months), but branches and main trunks were not mature enough to provide adequate wind protection. Planting *D. viscosa* at close spacing did promote faster height growth. After two years of growth, lodging of the lateral branches on the leeward side became noticeable, but did not affect the performance of the windbreak.

### Drought Tolerance

FY2000

The 3-foot spacing plants of Section B had completely died out.

FY2001

The 2-foot spacing plants of Section B all died except for 4 plants.

Drip irrigation in Section B was terminated on July 30, 1997 and survived only on natural precipitation. The total amount of precipitation at the PMC during 1998 and 1999 amounted to 19.36 inches. This amount is 46% below the normal annual rainfall for the Molokai PMC. *D. viscosa* continued to survive but in poor vigor. Plant foliage was greatly reduced and present only on terminal ends of the branch tips. Section B was not providing adequate wind protection.

The data collected indicated that spacing affects the growth of Dodonaea considerably. With all planting schemes, the plants seem to reach similar heights and widths. There was a significant difference in mortality rate. A higher percentage of trees died if planted closer together compared t those planted father apart. Also, stumps grew larger when planter farther apart.

The information that was gathered is valuable, but there needs to be more testing with spacing using replicated trials to confirm the findings from this particular trial. Plants were retained for further observation for longevity, vigor and seed yield.

## Yearly Rainfall – inches

| 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|
| 36.00 | 27.76 | 10.00 | 9.36 | 7.98 | 11.21 | 21.39 | 22.26 | 48.04 | 28.23 | 22.59 |

## *Dodonaea viscosa* Growth Averages

### Height - cm

| Section | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | 40 | 210 | 337 | 337 | 348 | 478 | | | 390 | 385 | 395 |
| A2 | 25 | 200 | 347 | 349 | 290 | 453 | | | 375 | 360 | 370 |
| A3 | 40 | 180 | 325 | 325 | 348 | 422 | | | 390 | 380 | 390 |
| B1 | 30 | 230 | 261 | 261 | | 300 | | | 315 | 320 | 310 |
| B2 | 28 | 200 | 225 | 225 | | | | | 250 | 230 | 245 |
| B3 | 22 | 190 | 224 | 224 | | | | | | | |

### Width - cm

| Section | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | 10 | 225 | 523 | 523 | 588 | 800 | | | 900 | 745 | 730 |
| A2 | 10 | 215 | 523 | 523 | 611 | 778 | | | 905 | 935 | 940 |
| A3 | 10 | 205 | 463 | 463 | 542 | 688 | | | 740 | 840 | 845 |
| B1 | 15 | 225 | 250 | 250 | | 467 | | | 460 | 825 | 825 |
| B2 | 15 | 198 | 263 | 263 | | | | | 330 | 345 | 330 |
| B3 | 15 | 195 | 269 | 269 | | | | | | | |

### Vigor

| Section | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | 5 | 5 | 5 | 5 | | 5 | 4 | 3 | 3 | 3 | 3 |
| A2 | 5 | 5 | 5 | 5 | | 5 | 4 | 3 | 3 | 3 | 3 |
| A3 | 5 | 5 | 5 | 5 | | 6 | 5 | 4 | 3 | 2 | 2 |
| B1 | 5 | 5 | 5 | 9 | | 8 | 7 | 7 | 5 | 3 | 3 |
| B2 | 5 | 5 | 5 | 9 | | 8 | 8 | 9 | 5 | 3 | 3 |
| B3 | 5 | 5 | 5 | 9 | | | | | | | |

Vigor Scale: 1-Excellent 5-Average 9-Poor

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

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**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 RESOURCE CONSERVATION SERVICE
STUDY PLAN

| | |
|---|---|
| **Study ID Code** | HIPMC-T-9802-WI |
| **Title** | *Myoporum sandwicense* Windbreak Establishment, Naio |
| **National Project No**. | Forestland 1.1 |
| **Study Type** | Initial Evaluation |
| **Study Status** | Active |

| | |
|---|---|
| **Location** | HIPMC |
| **Study Leader** | Glenn Sakamoto |
| **Duration** | August 1998 through 2006 |
| **Cooperators** | -Hawaii Soil Water Conservation Districts<br>-Denise Light, NRCS Molokai F.O. Soil Conservationist |

| | | | |
|---|---|---|---|
| **Land Use** | Cropland | | |
| **Vegetative Practices** | Primary | 650 | WINDBREAK/SHELTERBELT ESTABLISHMENT |
| | Secondary | 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 test the windbreak effectiveness of *Myoporum sandwicense* and also to determine its longevity and seed germination characteristics.

**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. Interest in native plants has been increasing in recent years in both commercial and private sectors of the State. The demands for

native species, for both ornamental and conservation use, has prompted further studies by the Hawaii PMC. Commonly found throughout the all the major Hawaiian islands except Kahoolawe, *M. sandwicense* grows naturally at sea-level up to 7,000 feet. It has the potential to be an effective native windbreak because it can grow to heights up to 30 feet and is also somewhat wind and drought tolerant. *M. sandwicense* seeds are relatively easy to germinate and propagate.

**Materials and Methods:**
*Myoporum sandwicense* (acc# 9079712) seeds were collected by Denise Light from the Kapuaokoolau district on the east End of Molokai. Seedlings will be planted in a single row with 6 feet spacing between each plant to simulate a windbreak situation. Plant spacing will be replicated 4 times. Each replication will consist of 16 plants and separated by at least 2 'guard' plants. Irrigation will be supplied by a ¾ inch poly-tube and emitters (2gph) at each plant. For the first 3 months irrigation will be applied 4hr/day once a week. From 4-12 month, irrigation will be applied 8hr/day once a week. After 12 months, irrigation will be applied 18hs/day once a week. At nine months after seedlings are planted, an application of fertilizer (16-16-16) will be applied at a rate of 42 grams (1.5oz.) per plant. Trial Start Date: October 27, 1998.

Germination Characteristics
No special scarification method will be administered to M. sandwicense seed. The purpose of the trial will to determine if there are differences in germination rates between seeds that are planted fresh with the pulp on, fresh with the pulp off, naturally dried seeds on the plant, and air dried seeds with the pulp removed. Four hundred seeds of each treatment will planted in individual cells. With the exception of the air dried seed, all seeds will be planted one day after collection from the field.

## DISCUSSION

Germination tests indicate poor germination rates for all treatments.

| Treatment | Date Planted | Germination rate (1/25/01) |
|---|---|---|
| Naturally dried seed from plant | 12/1/99 | 2 % |
| Fresh seed with pulp | 12/1/99 | 1.5 % |
| Fresh seed, no pulp | 12/1/99 | 3 % |
| Fresh seed, no pulp, air dried 2 months | 2/1/00 | 1.75 % |

### Windbreak Potential

During the first twelve months after transplanting, *Myoporium sandwicense* experienced good vigor with no major disease or insect problems. The terminal trunk of *M. sandwicense* is sturdy and supports itself well without lodging. Lower lateral branches tend to droop to the ground, but still provided wind protection. We learned that pruning of the lower lateral branches promotes vigorous top growth, but does not promote any re-growth of lower pruned branches. After one year of growth *M. sandwicense* reached an average height of 112cm and 150cm wide and filled in

well between the1.8 meter (6feet) plant spacing. During the first year 6% of the plants died. Twenty-one month old *M. sandwicense* had a average height of 169cm and 186cm wide. The vigor had declined somewhat but the entire stand still provided wind protection. Sooty mold was prevalent during the late summer months but declined after the rainy season. Sooty mold did accelerate leaf drop of the older leaves but did not affect overall vigor of the plant.

We have learned that S. sandwicense is a relatively slow growing shrub/small tree. It has high potential for restoration of wildlife habitats and critical area habitats. Farmers could also utilize this plant as an infield windbreak or a natural screen.

We will continue to evaluate this planting to observe plant longevity and vigor.

Number of Live Plants

| Treatment | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|
| REP I | 16 | 16 | 16 | 15 | 15 | 12 | 11 | 11 |
| REP II | 14 | 14 | 13 | 12 | 12 | 9 | 9 | 6 |
| REP III | 14 | 14 | 14 | 14 | 14 | 6 | 6 | 5 |
| REP IV | 16 | 16 | 14 | 14 | 14 | 11 | 11 | 11 |

Average Height - cm

| Treatment | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|
| REP I | 103 | 175 | 179 | 210 | - | 253 | 260 | 255 |
| REP II | 106 | 148 | 178 | 202 | - | 248 | 250 | 250 |
| REP III | 117 | 175 | 185 | 217 | - | 264 | 260 | 250 |
| REP IV | 107 | 173 | 195 | 230 | - | 271 | 265 | 260 |

Average Width - cm

| Treatment | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|
| REP I | 151 | 173 | 228 | - | - | 332 | 325 | 330 |
| REP II | 142 | 177 | 250 | - | - | 340 | 340 | 340 |
| REP III | 156 | 207 | 256 | - | - | 346 | 345 | 350 |
| REP IV | 141 | 193 | | - | - | 373 | 370 | 365 |

Average Vigor

| Treatment | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|
| REP I | 4.8 | 5 | 5.5 | 5.2 | 4.6 | 4.5 | 4.5 | 4.5 |
| REP II | 4.5 | 5 | 4.6 | 5.7 | 4.5 | 5 | 4.5 | 4.5 |
| REP III | 4.1 | 5 | 5.1 | 6 | 5.2 | 4.9 | 4.5 | 4.5 |
| REP IV | 4.6 | 5 | 4.9 | 6 | 5.5 | 4.8 | 4.5 | 4.5 |

Vigor Scale: 1-Excellent 5-Average 9-Poor

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

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| | |
|---|---|
| **Study ID Code** | HIPMC-9803-CR |
| **Title** | Vetiver zizanioides 'Louisiana Sunshine' for HI |
| **National Project No**. | Cropland 2.1 |
| **Study Type** | Advanced Evaluation |
| **Study Status** | Active |

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

| | | |
|---|---|---|
| **Land Use** | Cropland | |
| **Vegetative Practices** | Primary | VEGETATIVE BARRIER |
| | Secondary | |
| **Resource Concern(s)** | Resource | Consideration / Problem |
| | Soil | Soil Erosion / wind |
| | Air | Air Quality / air pollutants |
| | Water | Water Quality / Run-off |
| **Long Range Plan** | Study falls under Objective 2.1, Section H of the HIPMC Long Range Plan | |

**Objective:**
Evaluate and increase vetiver grass for conservation use in Hawaii and Pac Basin. Louisiana Sunshine vetiver grass will be evaluated under field plantings throughout the State of Hawaii.

**Status of Knowledge:**
Constructed terraces and other similar methods to control erosion are often costly, require large machinery to construct, make farming operations difficult and must be maintained or they lose effectiveness over time. They may also take substantial amount of land out of crop production, a drawback that makes them undesirable, especially to small farmers. In addition, some farmlands are too steep to construct terraces. There is a need for plants that will tolerate close, within-row spacing and form a tight hedge that will trap silt and form a natural terrace over time. Leguminous shrubs may appeal to farmers because they can be used for mulch and green manure or high protein cattle feed when trimmed or hedged. However, stiff-stemmed grasses are generally considered to be better filters. Trials are needed to demonstrate this practice and determine its erosion control effectiveness.

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** | *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<br>-Hawaii Soil Water Conservation District | | |
| **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)<br>Description: no nitrogen (control) |
| **Treatment 2** | Title: Acc# 9079789 (P2)<br>Description: 25 lbs. of nitrogen per acre |
| **Treatment 3** | Title: Acc# 9079789 (P3)<br>Description: 50 lbs. of nitrogen per acre |
| **Treatment 4** | Title: Acc# 9079789 (P4)<br>Description: 100 lbs. of nitrogen per acre |

**BLOCK B**

| | |
|---|---|
| **Treatment 1** | Title: Acc# 9079807 (B1)<br>Description: no nitrogen (control) |
| **Treatment 2** | Title: Acc# 9079807 (B2)<br>Description: 25 lbs. of nitrogen per acre |
| **Treatment 3** | Title: Acc# 9079807 (B3)<br>Description: 50 lbs. of nitrogen per acre |
| **Treatment 4** | Title: Acc# 9079807 (B4)<br>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) is from the PMC in the Hoolehua area and the variegated sample (acc# 9079807) is from the Bauman's residence in the Kamililoa area. Both accessions will be planted separately into two rows to compare growth characteristics. The cuttings will be planted as windbreaks to simulate actual wind situations. Therefore, the replications will be aligned in a single row. A base fertilizer (10-20-20) application of (50) pounds of nitrogen per acre will be incorporated into the soil of both rows. Cuttings will be cut to (18) inches in length.

They will be planted (6) inches deep with (2) foot spacing between each cutting. Both rows will be drip-irrigated. Each treatment will have (9) 'trial' cuttings. 'Buffer' cuttings will separate the treatments within the rows. The nitrogen source will be from Ammonium Sulfate (21-0-0). Each fertilizer treatment will be applied (4) times at (3) month intervals. The trial will be replicated (4) times.

The trial will be evaluated 3 months after each fertilizer treatment is applied. Plant height and width will be measured and plant vigor will also be evaluated.
Trial start date: March 7, 2006.

## DISCUSSION

### FY2006

The objective of this trial is to compare the different effects that various nitrogen supplements will have on two accessions of panax. We have discovered a design flaw in the trial. With the two accessions being planted completely separate from each other, we cannot be totally certain that the effects that occur are due to accession or location differences. The trial is 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 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 is hindering the plants ability to recover. This may be due to one 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 is progressing fine with no or very little damage. A number of leaves are showing some sort of 'spotting' effect. The cause is unknown, but will be monitored closely if any detrimental effects occur. There is some leaf damage due to leaf eating insects, but does not seem to affect plant vigor. As of yet, the measurements indicate no significant difference between the fertilizer treatments on the non-variegated accession.

# 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 and new shoots……RJ | |
| 8/7/06 | Sprayed Finale: 3oz/gal – 5 gallons south side of both accessions and 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 | Sprayed Finale: 2oz/gal – 3 gallons South side and north side of both accessions…….NB | |
| 9/13/06 | SECOND NITROGEN TREATMENT FIRST EVALUATION | KD, NB, JB |

Average Height:

| | | | |
|---|---|---|---|
| P1 -83.325cm | P2 – 81.080cm | P3 – 80.593cm | P4 – 79.058cm |
| B1 – 53.750cm | B2 – 51.235cm | B3 – 52.360cm | B4 – 53.192cm |

Average Width

| | | | |
|---|---|---|---|
| P1 – 67.085cm | P2 – 67.347cm | P3 – 64.740cm | P4 – 63.655cm |
| B1 – 35.138cm | B2 – 39.445cm | B3 – 47.64cm | B4 – 37.778cm |

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NATURAL RESOURCES CONSERVATION SERVICE
STUDY PLAN

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| **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 |

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| **Location** | HIPMC |
| **Study Leader** | David Duvauchelle |
| **Duration** | 2006 - 2008 |
| **Cooperators** | Bob Joy – Hawaii Plant Materials Specialist<br>Glenn Sakamoto – Hoolehua PMC Manager<br>Craig smith - PIA West Agronomist |

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| **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 | |

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| **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 *Sporobolus 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

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| **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 10ft long x 10ft wide with 16 plants per plot. Plants will be planted in a block form, 4 x 4 plants. The accessions 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.

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 new 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 4 months between cuttings. In addition to forage yields, after each cutting, point frequency measurements will also be made to determine rhizome cover.

## DISCUSSION:

In July 2006, 588 dibble tubes were planted for each accession of S. virginicus. Each accession was replicated 6 times with 98 dibble tubes for each replication. The results for the new propagation method are as follows.

| REP | ACC | LIVE Propagules | PERCENT | AVERAGE % |
|---|---|---|---|---|
| 1 | MOOMOMI | 55 | 56.12 | |
| 2 | MOOMOMI | 51 | 52.04 | |
| 3 | MOOMOMI | 49 | 50 | |
| 4 | MOOMOMI | 64 | 65.31 | |
| 5 | MOOMOMI | 76 | 77.55 | |
| 6 | MOOMOMI | 74 | 75.51 | 62.76 |
| 1 | KAHOOLAWE | 50 | 51.02 | |
| 2 | KAHOOLAWE | 56 | 57.14 | |
| 3 | KAHOOLAWE | 52 | 53.06 | |
| 4 | KAHOOLAWE | 56 | 57.14 | |
| 5 | KAHOOLAWE | 52 | 53.06 | |
| 6 | KAHOOLAWE | 28 | 28.57 | 50.00 |
| 1 | MAUI | 42 | 42.86 | |
| 2 | MAUI | 41 | 41.84 | |
| 3 | MAUI | 46 | 46.94 | |
| 4 | MAUI | 53 | 54.08 | |
| 5 | MAUI | 60 | 61.22 | |
| 6 | MAUI | 46 | 46.94 | 48.98 |
| 1 | PAPOHAKU | 81 | 82.65 | |
| 2 | PAPOHAKU | 56 | 57.14 | |
| 3 | PAPOHAKU | 74 | 75.51 | |
| 4 | PAPOHAKU | 77 | 78.57 | |
| 5 | PAPOHAKU | 80 | 81.63 | |
| 6 | PAPOHAKU | 76 | 77.55 | 75.51 |
| 1 | OAHU | 16 | 16.33 | |
| 2 | OAHU | 42 | 42.86 | |
| 3 | OAHU | 23 | 23.47 | |
| 4 | OAHU | 23 | 23.47 | |
| 5 | OAHU | 11 | 11.22 | |
| 6 | OAHU | 14 | 14.29 | 21.94 |

Overall there is a dramatic increase in live propagules as compared to the old methods of propagating S. virginicus. The numbers also indicate that the accession collected from Papohaku, Molokai has a significantly higher success rate compared to the other accessions. At the end of the trial, we will perform a second propagation test to confirm these results.

# 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.