Taro and Yams

Dioscoraceae
Dioscorea
species (600 species)

Yam - Dioscorea species
Sixty species cultivated for food and pharmaceuticals

- Monocot
  - Plant - herbaceous perennial
    - Climbing vine, 10 m
    - Leaves ovate with cordate base
    - Tubers vary in shape
    - Growth cycle Vines die at end of rains or when cold
      - Tubers dormant and resume growth when favorable
    - Dioecious (mostly)

Yam Production Field

Cultivated Dioscorea species

- Food species
  - Asia
    - alata
    - Cultivated spp
  - Africa
    - cayenensis
    - rotundata
    - Cultivated species
  - Americas
    - trifida

- Pharmaceutical species
  - composita
  - deltoides
  - elephantipe
  - floribunda
  - speculiflora
  - sylvatica

Major Food Species
Domesticated about 3,000 BC

<table>
<thead>
<tr>
<th>Common name</th>
<th>Species</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water yam</td>
<td>alata</td>
<td>Southeast Asia</td>
</tr>
<tr>
<td>Winged yam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow Guinea yam</td>
<td>cayenensis</td>
<td>West African forest</td>
</tr>
<tr>
<td>White Guinea yam</td>
<td>rotundata</td>
<td>West African savanna</td>
</tr>
<tr>
<td>Cush-cush yam Yampi</td>
<td>trifida</td>
<td>Tropical America</td>
</tr>
</tbody>
</table>
Origins of Important Yam Dioscorea species
Domesticated separately in each continent

D. alata

D. rotundata

D. cayenensis

D. trifida

Origin of Species

- **White Guinea Yam - D. rotundata**
  - Hybrid origin
  - Savanna-zone Dioscorea spp
  - Forest spp. D. cayenensis in W. Africa
  - D. rotundata is most important species in Africa
- **Yellow Guinea Yam - D. cayenensis**
  - Second most important species
  - Also hybrids between White and Yellow Guinea Yams

Origin of Species

- **Water Yam, D. alata**
  - Cultivated species
  - Hybrid origin
    - Species in North Central part of southeast Asian peninsula
  - Reached East Africa in 1,500 BC

Adaptation

- **Lowland wet-dry tropics**
  - Transition between forest and savanna
- **Temperatures**
  - 25 to 30°C
- **Rain**
  - 2-4 month dry season
  - 1150 mm (46")
  - Drought tolerant

Adaptation

- **Soil**
  - Friable and deep soils
    - Allows proper tuber expansion
    - Penetrate soils as expand
  - Excellent drainage
    - Does not tolerant waterlogging
  - High fertility and organic matter
    - First in crop rotation
    - Same nutrient removal as cassava
    - Mycorrhizal infection
    - Sensitive to low pH if aluminum is high
Dissemination of *Dioscorea* species
Domesticated separately in each continent

Contingential Movement
- Exploration period
- Asiatic and African yams used on ships for Vitamin C - world transfer
- *D. alata*, *D. cayenensis* and *D. rotundata* taken to Caribbean by slave trade

World Yam Yield and Production

<table>
<thead>
<tr>
<th>Region</th>
<th>Yield (Mt/ha)</th>
<th>Production (1,000 MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>9.2</td>
<td>38,643</td>
</tr>
<tr>
<td>Africa</td>
<td>9.2</td>
<td>37,314</td>
</tr>
<tr>
<td>Americas</td>
<td>8.9</td>
<td>1,019</td>
</tr>
<tr>
<td>Asia</td>
<td>15.6</td>
<td>225</td>
</tr>
<tr>
<td>Oceania</td>
<td>16.0</td>
<td>286</td>
</tr>
</tbody>
</table>

World Yam Yield and Production
- 90% in Nigeria, Benin, Ghana, and Ivory Coast

Propagation
- Asexual
  - Most common
    - Setts - division of tubers (250 g)
    - 20% of previous crop saved
  - Other propagules
    - Seed yams - small tubers
    - Stem cuttings
- Yield affected by
  - Sett size
  - Sett type

Yam Production in the World

Yield increases with larger sett size

Villanueva, 1986

FAOSTAT, 2003
Yield increases with type of sett
Crown or proximal end has preformed shoot initials and begins growth quicker.

Planting
At least half grown in mixed cropping systems
- Density
  - 10-15 cm deep
  - Mounds or ridges
    - 0.6 to 1.3 m tall
    - 0.75 to 1.0 m apart
    - 1 - 1.5 m between rows
  - Pre-sprouting common in early planting in W Africa (Nov - Jan)

Trellising increases yield
- Support systems
  - Stakes 2 - 4.5 m long (6-15’)
  - May substitute old maize stalks, tree stumps

Growth Cycle
- Grown as an annual
- Initial growth slow
  - Weed control is critical
- Tuber formation
  - Begins in 10 weeks
  - Continues to shoot dieback
- Maturity in 6 - 11 months
  - Varies with spp and variety

Harvesting
- Harvest time
  - End of rainy season or early dry season
  - Plant has growth stopped
    - Leaves begin to yellow
  - Time is flexible
    - Once plant senescent, roots deteriorate
- Early harvest called “milking”
  - Remove lower part of tuber (2-4” below crown)
  - Upper part grows to end of season
  - Second growth produces small tubers
    - Often used as seed yams

Harvesting
- Manual process
- Dug with wooden spades or digging sticks
- Injury to tuber
  - Infection due to rot
  - Shorter post harvest life
Storage

- Stored for several months
  - Harvested tubers dried a few hours
  - Stored in well-ventilated water proof building
  - Under shade in open
- Temperature
  - Optimal is 15°C
  - Chilling injury <10°C
- Sprouting can be problem - rub off

Pests

- Tolerant to most pathogens
  - Yam rust, yam leaf spot, yam mosaic
- Yam beetles serious in parts of Nigeria
- Rodents

Uses

- Food
  - High in starch
  - 99% of production for food
  - Baked, fried, boiled (fufu)
- Some species are toxic
  - Alkaloid dioscorine $C_{13}H_{19}O_2N$
  - $D. hispida$ poisonous
  - Boil to leach out alkaloid

Pharmaceuticals

- Traditionally used for medicinal purposes
- Steroid sapogenin compound
  - Diosgenin
  - Extracted from Central American spp
  - $D. composita$ and $D. floribunda$
  - Perennial climbing vines
  - 4% sapogenins in tubers
  - Base for drugs such as
    - Cortisone
    - Sex hormones (Birth control pills)

Advantages of Yams

- Efficient producer of starch
- Drought tolerant
- Stored for several months without refrigeration.

Disadvantages

- Labor intensive
  - Harvest
  - Need to trellis
- Need high fertility
- Sensitive to waterlogging
Taro

Araceae
Colocasia esculenta

Plant
- Perennial herb
- Leaves
  - Large
    - 25-85 cm long
    - 20-60 cm wide
  - Long petioles
  - Edible

Plant
- Corms
  - Rings of leaf scars and scales
  - Cormels from lateral buds
  - Thick brown outer covering
- Acridity
  - Calcium oxalate crystals
  - Cooking or fermentation eliminates

Origin of Taro
- Indo-Malayan region
  - Eastern India and Bangladesh
  - Domesticated 4,000 to 7,000 years ago
- About 2,500 years ago
  - East to China, Japan, SE Asia, Oceania
    - Hawaii about 1,500 years ago
  - West to Arabia, eastern Mediterranean, and Egypt

Origin of Taro
- About 2,000 years ago
  - Along coast to East Africa
  - Across continent to West Africa
- Beginning 1600s
  - Used as provisions on ships during slave trade
  - Moved to Americas

Hawaiian Legend
- Wakea (Sky Father) and his daughter Ho'ohokulani conceived a child
  - Child was deformed & lifeless
- Small plant arose from child’s grave
  - It was a taro plant
  - Became everlasting breath of Hawaii
- Hawaiian’s direct descendants
Origin and Dispersal of Taro
Domesticated 4,000 to 7,000 years ago

World Taro Yield and Production

<table>
<thead>
<tr>
<th>Region</th>
<th>Yield Mt/ha</th>
<th>Production 100bs mt</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>6.0</td>
<td>9,040</td>
</tr>
<tr>
<td>Africa</td>
<td>5.1</td>
<td>6,813</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nigeria (3,908), Ghana (1,724)</td>
</tr>
<tr>
<td>Americas</td>
<td>10.7</td>
<td>25</td>
</tr>
<tr>
<td>Asia</td>
<td>15.0</td>
<td>1,926</td>
</tr>
<tr>
<td>Oceania</td>
<td>6.4</td>
<td>274</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Papua New Guinea (173)</td>
</tr>
</tbody>
</table>

FAOSTAT, 2003

Propagation
- Vegetative
  - Hulis
    - Top cm of corm and 20-25 cm petiole
    - Larger sett size leads to greater yield

Planting
- Planted throughout the year
- Density
  - 2-3’ square (50-75 cm)
    - Higher density better for lowland (wet) culture
    - Can be intercropped as well

Harvest and Uses
- Harvest
  - By hand
  - Throughout year
- Uses
  - Boiled, baked, toasted, or fried
  - Poi, a pounded, paste like food made from boiled taro (now rare)
  - Flour - biscuits, soups, bread
  - Chip industry developing

Nutrition
- Cooked corms
  - Source of starch
    - More digestible than other root crops
    - Baby formula and other foods
    - Good for those with digestive problems
    - Can be significant source of protein
- Cooked leaves
  - Same as spinach
Traditional Medicinal Use

- Taro stems
  - Slows bleeding, helps clotting of platelets
  - Relieves stinging from insect bites.
- Poi
  - Settles stomachs - aids digestion
  - Reduces diarrhea symptoms

Any Questions?

World Sweet Potato Yield and Production

<table>
<thead>
<tr>
<th>Region</th>
<th>Yield Mt/ha</th>
<th>Production 1000s mt</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>14.6</td>
<td>136,899</td>
</tr>
<tr>
<td>Africa</td>
<td>4.5</td>
<td>10,833</td>
</tr>
</tbody>
</table>
  - Burundi (795), Nigeria (2,081), Rwanda (1,161), Tanzania (895), Uganda (2,476)
| Americas     | 8.2         | 1,808               |
  - Argentina (587), Brazil (1,684), Cuba (282), Peru (244)
| Asia         | 18.5        | 122,966             |
  - China (113,417), India (3158), Indonesia (1,774), Japan (5,095), Vietnam (1,004)
| Oceania      | 5.4         | 608                 |
  - Papua New Guinea (487)
| N. America   | 16.8        | 619                 |
  - USA (419)

Trellising increases yield

Seed bed preparation affects yield

Plant Density and Yield in Lowland and Upland Taro

FAOSTAT, 2003

Villanueva, 1986

9x18 cm = 44,889 pl/ha; 9x27 cm = 26,667 pl/ha; 7.5x27 cm = 17,778 pl/ha
Larger sett size gives greater yield (upland taro)

Villanueva, 1986