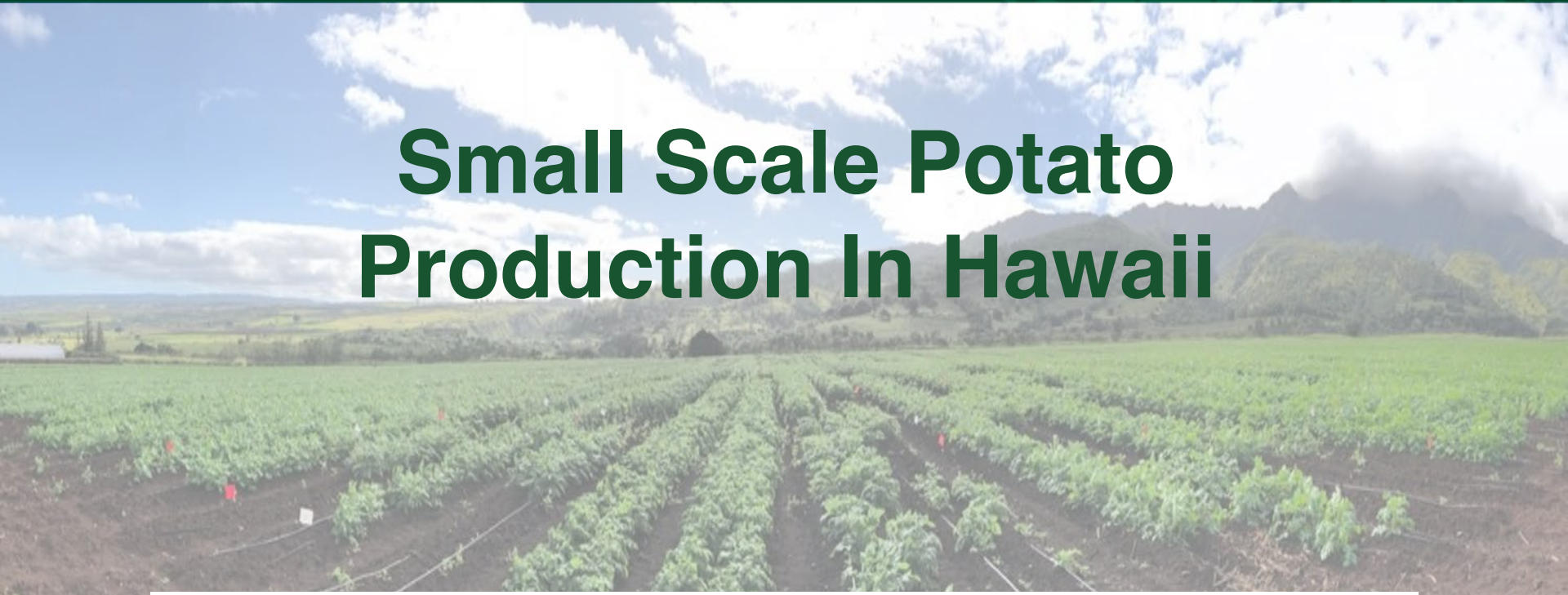
Small Scale Potato Production In Hawaii



Cooperative Extension
University of Hawai'i at Mānoa
College of Tropical Agriculture and Human Resources

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WESTERN SARE
Sustainable Agriculture Research & Education

Department of Agriculture
STATE OF HAWAII

Sustainable and Organic Agriculture Program
College of Tropical Agriculture and Human Resources
University of Hawai'i at Mānoa

Seed Material

- "Seed"
  - Whole Tubers or cut pieces or "sets"
- Sources
  - Certified – true to variety and disease free
- Many Varieties
- Cooler climate seed more vigorous
  - Kula, Hamakua, Waimea
- Size, Shape and Type
  - 2-4 ounce tubers/cut sets shown to be as productive as larger tubers (cost)
  - Fits in planting equipment
  - 1000lb per acre of seed (500 seed/100lbs)
- Maine Potato Lady ($2.23/lb)
  - $854 for 1100lb seed
  - Shipping $1600

Green Sprouting

- Matured in ground and Cured
- Spread tubers in a thin layer or single layer indoors or outdoors under covering
  - Average temperature should be 65-75F with high humidity
- Ambient or supplemented light
  - develop chlorophyll (Green coloring)
  - encourage development of short stocky sprouts from eyes
- Rotate potatoes initially to encourage uniform sprouting
- When sprouts are 1/4-1/2in long move to cool location (50F) till ready to plant

Green Sprouting

- Benefits
  - Faster plant emergence
  - Reduced seed piece rot
  - Shorten period from planting to harvest
    - Up to two weeks
    - Reduced pest pressure and resources
  - Increased number of shoots = increased tubers

Method for Cutting

- Seed should be cut immediately prior to planting
  - If required to hold cut pieces longer than 2 days powdered sulfur can be used to treat cut surface
- Each piece should contain 1-2 healthy eyes or sprouts
- 2-4 ounces each

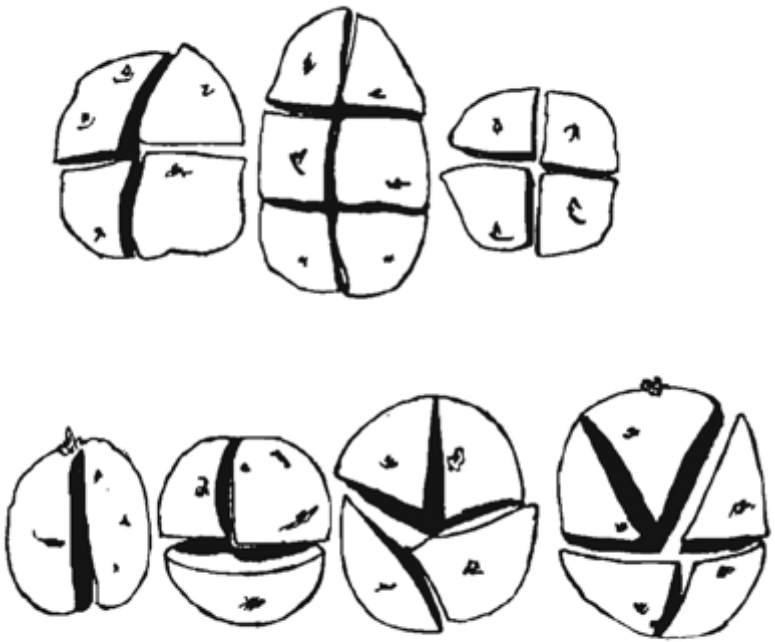


Fig. 17.—Diagram showing how to cut potatoes into seed-pieces.

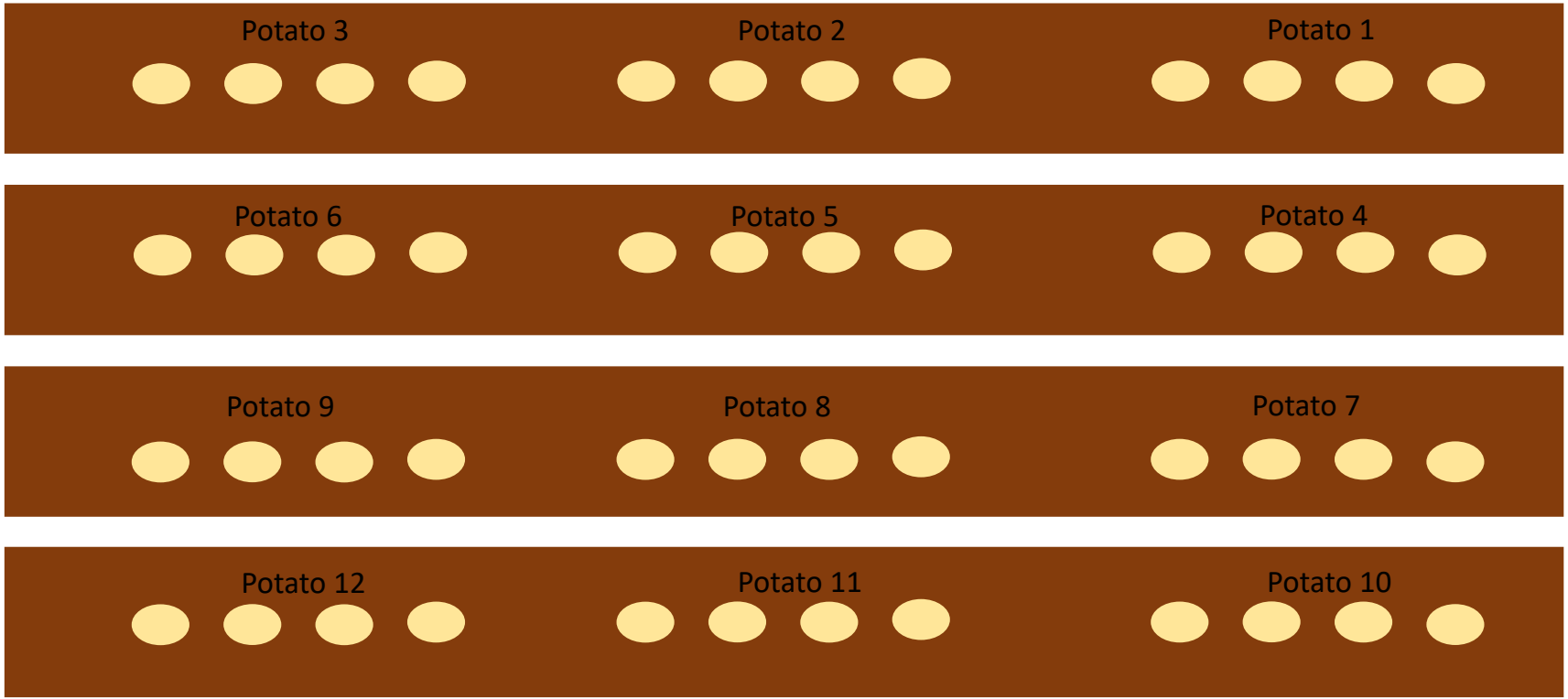
Varieties

- Market demand
- Productivity and quality
- Early Variety (1930)
  - American Wonder (Haiku), Early White rose, Irish Cobbler, Early Rose, Triumph, Garnet Chili
- Medium Late (1930)
  - Burbank, British Queen, Yamato/Hamakua Hybrid No 4 (Blight tolerant cross Burbank and Portuguese purple)
- Varieties being distributed
  - Yukon gold, Red gold, Dark Red Norland, Katahdin, Kennebec
- Conducting an on-farm variety trial

Seed Production/Selection

- Tuber-Method
  - Select the most perfectly shaped seed pieces averaging at least 8ounces
  - Quarter each piece into 4 equal parts
  - Plant each of the four piece consecutively 15-18 inches apart and skip a planting between each selected seed potato
  - Rogue/removed weak plants to retain strong vigorous strains
  - From each of the remaining plantings select 10 of the best potatoes from each for the next seasons planting
  - Continue process till enough seed materials is generated for sale or field planting
- Hill Selection Method
  - Mark superior individual plants out in the field during the growing season
  - Save only tuners from plants that maintain superiority during entire season
  - Plant selected tubers using the tuber method or separate the tubers by individual plant
- Keep good records of production
- Keep an eye out for “sports” or mutations that could become superior

Tuber Method



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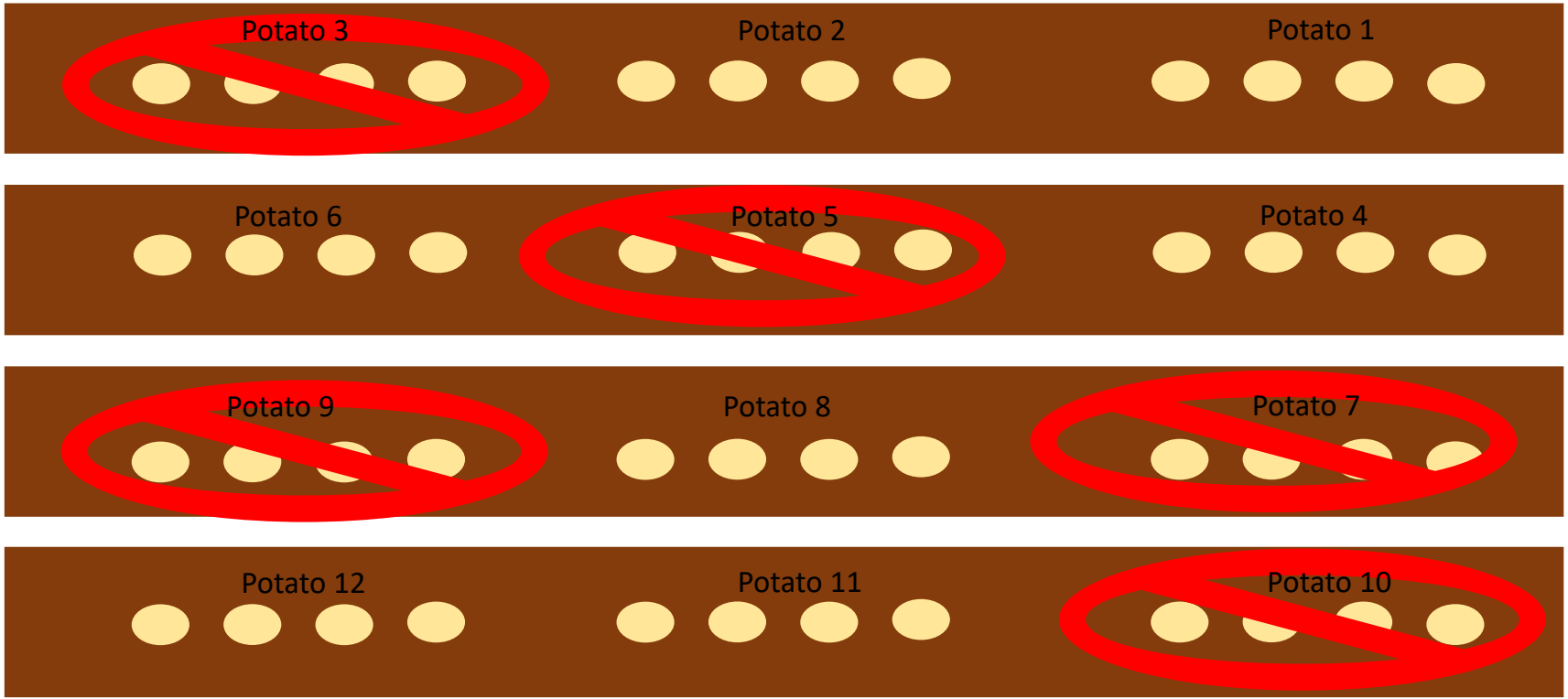

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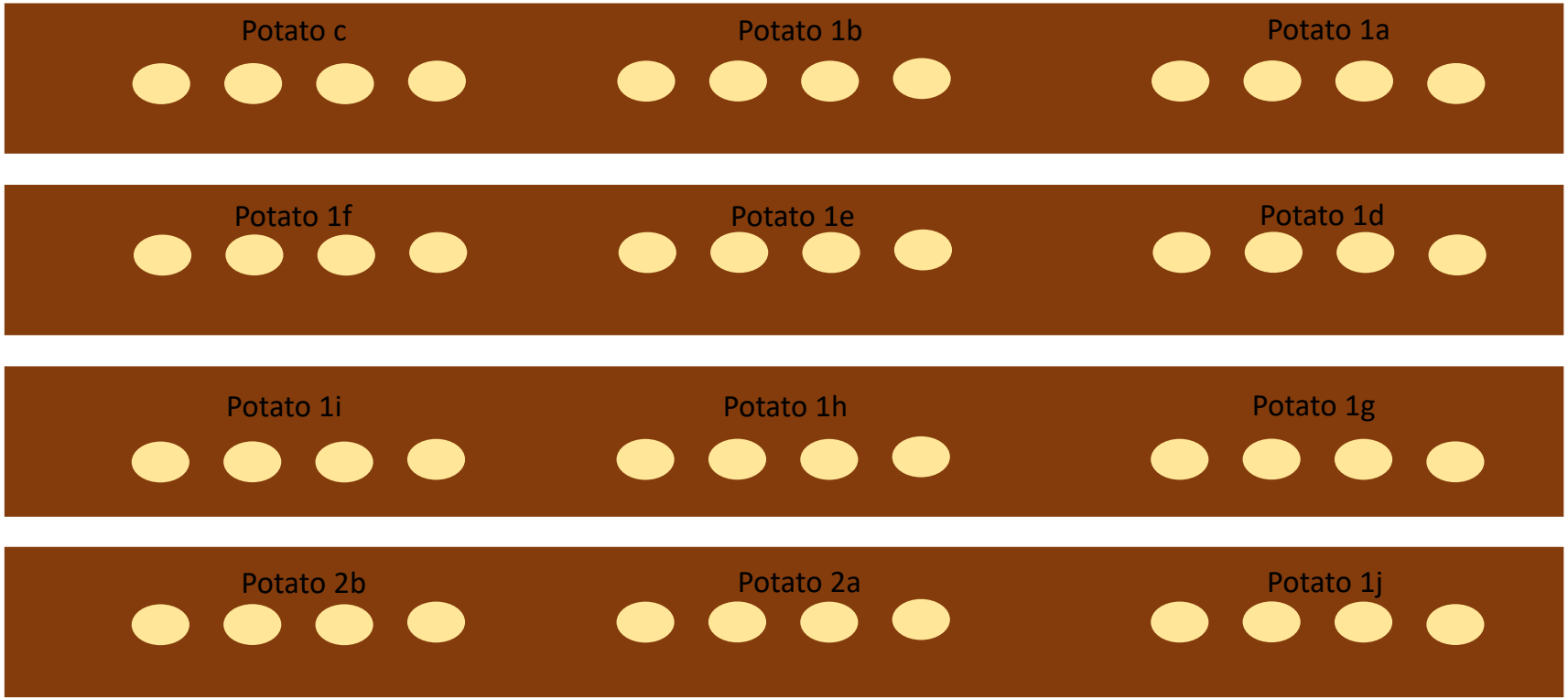


Dormancy

- Most varieties stay dormant 2-4 month regardless of treatment
- Temperature below 40F will inhibit sprouting
- Temperatures 50F and up will speed up the sprouting process
- Ethylene can be used stimulate sprouting in colder location when being planted in winter months
- Green sprouting is another method to break dormancy

Conditions

- Deep, Loose, Well Drained soil
- pH 5.5-6.5
- Optimum air temp 65F
  - Can go as high 75-86F
- June-Sept to warm for lowlands
- Suggestion of two seasons dependent on climate (Cool/Warm and Dry)
  - Main season – February – April planting
  - Early Planting – October – January planting
  - Late Summer in Higher elevations – May - August planting
- Oahu starts November and harvest February

Green-manure

- Improve soil health and physical properties
- Weed Suppression
- Moisture retention
- Crop nutrients
- Disease and pest management
- Incorporated a month prior to potato planting

CRATE

Cover Crop Chart for Hawaii

Koon-Hui Wang and Archana Pant, CTAHR, University of Hawaii

High Elevation → Low Elevation

Grass → Broadleaf → Grass

Legume

A **Black Oat** 75 lb/acre						A R* **Sesame** 4 lb/acre	
A **Barley** 90 lb/acre						A **Buckwheat** 20-30 lb/acre	A **Pearl Millet** 15 lb/acre
A **Cereal Rye** 90 lb/acre	A **Canola** 7-10 lb/acre	A **Hairy vetch** 30-50 lb/acre	A **Woolly pod Vetch** 40-60 lb/acre	P **Jack bean** 50-60 lb/acre	A R **Cowpea** 40-60 lb/acre ('CA Blackeye 5', 'Purple knuckle', 'TS Brown', 'MS Silver')	A **Mustard** 7-10 lb/acre	A **Oat** 90 lb/acre
A **Oat** 90 lb/acre	A **Mustard** 7-10 lb/acre	A **Bell Bean** 150 lb/acre	B **Yellow Sweetclover** 10-15 lb/acre	SP R* **Velvet Bean** 40 lb/acre	A **Soybean** 50-75 lb/acre	A S **Rape Seed** 7-10 lb/acre	A **Black Oat** 75 lb/acre
A **Winter Wheat** 120 lb/acre	A S **Rape Seed** 7-10 lb/acre	SP **Red Clover** 20 lb/acre	P **White Clover** 20 lb/acre	P **Pigeon Pea** 40-60 lb/acre	P **Lablab** 11-18 lb/acre	A S **Oil Radish** 10 lb/acre	A **Grain Sorghum** 25-30 lb/acre
A **Annual Ryegrass** 100 lb/acre	A S **Oil Radish** 10 lb/acre	A R **Austrian Winter pea** 100 lb/acre	P ('Moapa 69') R **Alfalfa** 15 lb/acre	R **Perennial Peanut** 40 lb/acre	A R* **Sunn Hemp** 30-60 lb/acre	A R **Marigold** 3 lb/acre	A R **Sorghum-Sudangrass** 35-60 lb/acre

* = seedig rate

A = annual; B= Biennial; P = Perennial; SP = Short-term perennial.

R = resistant to root-knot but not reniform nematode; (note: only certain cultivars are resistant to root-knot nematodes for alfalfa and cowpea; cowpea is very susceptible to reniform nematode).

S = suppressive to plant-parasitic nematodes

R*= sunn hemp and velvetbean are resistant to root-knot and reniform nematodes; marigold, Tagetes patula, is resistant to root-knot and reniform, *T. erecta* is only resistant to root-knot; sesame is resistant to southern and peanut root-knot nematode (*Meloidogyne incognita* and *M. arenaria*) but not Javanica root-knot (*M. javanica*).


Sunn hemp


Oil radish


Wolly pod vetch


Sudangrass + lablab


Buckwheat


Cowpea + marigold

Soil Prep

- Tillage
  - Improves physical characteristics of soil
  - Helps control weeds
  - Ease of uniform planting
- Moldboard plow or Chisel plow
- Disk

Planting

- Spacing (15,000lbs)
  - 2.5-3ft between rows
  - 12-15 in spacing between plants in row
- Planted by hand or mechanically
- Panted in furrows 3-6inch depth depending on soil physical properties
- Covered by hand using a hoe or covered by disc
  - Hills or mound can be formed during this process

Planters

Furrow

Irrigation

- Drip irrigation typically placed in furrow at planting
  - Can be on surface
- 1inch/week (27,000gal/acre)
  - more frequent water has shown to increase yield compared to less frequent with the same quantity (Ext. Bul. 15, 1931)
- Dependent on rainfall

Fertilization

- 170-200lbs of nitrogen per acre per crop
- 60-240lb P_2O_5 per acre per crop depending on current soil P levels
- 0-60lbs of K_2O per acre per crop depending on current soil K levels

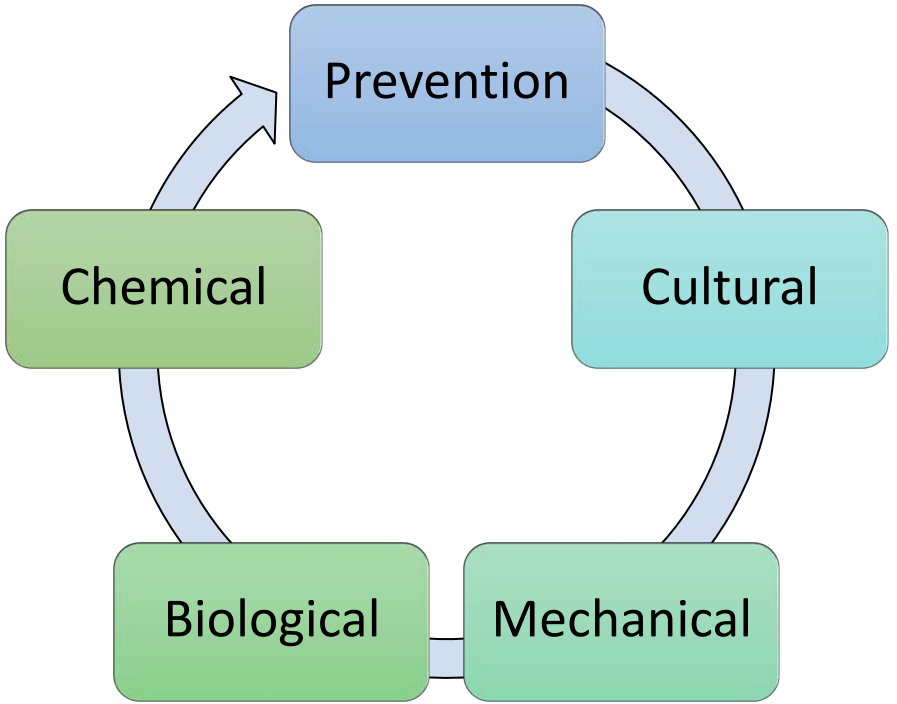
- Nitrogen Program
  - 2/3 at planting
  - Last 1/3 can be split during tuber formation
- Phosphorus at pre plant in the root zone
- Potassium can be applied preplant
  - Potassium chloride (0-0-60) has been shown to reduce specific gravity compared to potassium sulfate (0-0-50)

- Oahu Grower Program via injection
  - 10-34-0 at germination
  - 2 application of NK25 (6.7-0-10.7) split 3 weeks apart

Fertilizer Injection

Integrated Pest Management

- Weeds
- Diseases
- Insects



Weed Management

- Mulches
  - Plastic
  - Straw
- Mechanical
  - Cultivators
- Herbicides
  - Preemergence
    - GoalTender
    - Prowl
    - Gramaxone*

Mechanical Weeding

Tokachi, Japan Organic Potato Production

Disease Issues

- Common Scab (*Streptomyces* spp.)
- Early blight (*Alternaria solani*)
- Late Blight (*Phytophthora infestans*)
- Fusarium wilt/rot (*Fusarium spp.)*
- Black Scurf (*Rhizoctonia solani*)
- Bacterial Soft Rot and Black Leg (*Pectobacterium parmentieri*)

Common Scab (*Streptomyces spp.*)

- Common scab produces tan to dark brown, circular or irregular lesions which are rough in texture.
- Scab may be superficial (russet scab), slightly raised (erumpent scab), or sunken (pitted scab).
- The type of lesion is dependent on potato cultivar, tuber maturity at infection, organic matter content of soil, strain of the pathogen, and the environment.

- <u>Management</u>
  - Start with clean seed
  - Crop rotation
  - Maintain adequate soil moisture
  - Maintain low pH
  - Seed treat with fungicides can help

Early Blight *(Alternaria solani)*

- Fungal Disease found commonly on foliage of tomato and potato
- First appears as small brown lesion on older leaves.
- As lesion enlarge concentric rings develop around the initial infections
- Tuber lesions are dark, sunken, circular and sometimes bordered with purple to grey raised tissue
- Lesion on tuber can increase in storage

- <u>Management</u>
  - Use resistant or tolerant varieties
  - Start with clean seed
  - Control weeds
  - Plow under plant debris after harvest
  - Keep plants growing vigorously
  - Crop rotation
  - Reduced leaf wetness
  - Spray fungicides

Late Blight (*Phytophthora infestans*)

- Most severe disease (Great Potato Famine 1845)
- Sunken dark green to brown lesions on leaves
- Brown lesions on stem
- White fungal growth under wet conditions
- Boarder of lesions can bordered by yellow and appear water soaked
- Does not remain in the soil but persist on plant material
- Prefer wet and cool

- <u>Management</u>
  - Select resistant varieties
  - Crop rotate
  - Manage solanaceous weeds
  - Remove initially infected plants and bordering plants
  - Apply fungicides
  - Kill plants after harvest is complete

Fusarium wilt/rot

- *F. oxysporum*
  - Wilting and tuber rot
- *F. radicicola* and *F. coeruleum*
  - *Tuber rot*

- <u>Fusarium wilt</u>
  - Yellowing of leaves followed by wilting
  - Starts on lower leaves and moves upward
  - thrive in hot damp weather

- <u>Tuber rot</u>
  - Internal light to dark brown dry rot of the tuber
  - May develop at injury site
  - Rotting causes tissue to shrink and collapse
  - Internal cavities in tuber

- <u>Management</u>
  - Plant resistant varieties
  - Crop rotate 4-6yrs

Black Scurf (*Rhizoctonia solani)*

- Irregular black hard masses on the tuber (canker)
- Overwintering structures called Sclerotia
  - Allow pathogen to survive
- Cool wet soils
- Cause dark, sunken lesions on below ground sprouts and stems
  - Cut off nutrients to tubers
  - Reduce transfer of starches to tubers

- <u>Management</u>
  - Harvest as soon after vine kill and skin set
  - Seed disinfection
  - Crop rotation

Bacterial Soft Rot (*Pectobacterium Parmentieri)*

- Wilting
- Water-soaked regions with watery ooze
- Darkened and necrotic basal stem symptoms
- First reported in Hawaii in 2018


FIGURE 3

- <u>Management</u>
  - Crop rotation
  - Plant in well drained soil and avoid standing water
  - Plant whole tubers if possible
  - If cut pieces are used plant in warm soil and or treat with fungicide prior to planting
  - Ensure adequate soil calcium


FIGURE 2

Photo by Kenneth W. Seebold

Pest Issues

- Tuber moth (*Phthorimoea operculella*)
- Nematodes
- Colorado Potato Beetle
- Aphids
- Leaf miners
- Mites

Tuber Moth

- Most serious insect
- Lays eggs on leaves or other parts of plant
- Larvae mine between leaf surfaces or in stems/tubers
- Damage area rots due to secondary diseases
- Most prevalent during May to October
- Tuber: mining just below skin, slight webbing near the eyes

- <u>Management</u>
  - Clean fields of solanaceous plants post harvest
  - Crop rotation
  - Hilling to prevent tuber infestation
  - Avoid soil cracking especially during vine desiccation
  - Sorting post harvest to minimize spread
    - Destruction of infested tubers
  - Apply insecticides during late part of season when vines are dying
  - Early application of insecticides can help to reduce population

Nematodes

- Stunted, yellow or chlorotic foliage
- Galls or swelling on tubers
- Small bumps on feeder roots

- Management
  - Clean seed and field
  - Cover cropping (Sunn hemp, marigold, suddex, radish)
  - Crop rotation
  - Compost
  - Resistant Varieties
  - Chemical control
    - Fumigants
    - Biologicals

Colorado Flea Beetle

- Not reported in Hawaii
- Both larvae and adults eat leaves and can defoliate entire plant
- Larvae are reddish pink with two rows of dark spots
- Adults are yellowish with black stripes, round and 3/8" long
- Active during the summer

- <u>Management</u>
  - Contact HDOA or Local Extension Agent

Harvesting

- Potatoes continue to develop up until vines completely die
- Holding off harvest till the tubers are fully developed recommended but early harvest can be conducted depending on market preference
- Daily increase in yield from flower to full maturity under optimum condition
  - 250-500lbs per acre day
- Check random plants to see maturity
- Take down of vines to stop growth
  - Reglon Desiccant - *Diquat dibromide* (EPA Reg. 100-1061)
  - Flail mower
- Field Curing – Cut water
  - 2 weeks
- Hand harvest
  - Pitch fork or shovel
- Mechanical harvester
- Grading

Double Row Harvester

Single Row Harvester

European Harvester Used in Hokkaido

BCS Tractor/Powered Potato Digger

Post Harvest Treatment

Grading

U.S. No. 1 consists of potatoes which meet the following requirements:

a. Similar varietal characteristics, except when designated as a mixed or specialty pack;
b. Firm;
c. Fairly clean;
d. Fairly well shaped;
e. Free from:
    1. Freezing;
    2. Blackheart;
    3. Late blight, southern bacterial wilt and ring rot; and,
    4. Soft rot and wet breakdown.
f. Free from damage by any other cause. See §§51.1564 and 51.1565.
g. Size. Not less than 1-7/8 inches in diameter, unless otherwise specified in connection with the grade.

https://www.ams.usda.gov/sites/default/files/media/Potato_Standard%5B1%5D.pdf

Post Harvest and Storage

- Clean dry, mature tubers to minimize shrinkage
- Temperature maintained between 40-50F
- Relatively high humidity
  - minimize shrinkage

Pot Culture

Pot Size Selection

- 7-10 Gal
- Plastic or Fabric

Media Selection

- Coco Coir
- Peat: Perlite

Fertilizer Selection

- Organic vs Synthetic
- Slow release vs soluble

March 24

May 2nd

May 6th

June 2nd

Cost of Production

- Average Gross Income for 5 acres
  - $258,750/year
  - Two crops 30,000lbs per acre/crop and
  - $0.86/lb
- Operating Cost for 5 acres
  - $212,705
  - Land prep
  - Planting
  - Fertilizer
  - Weed Control
  - Harvesting
  - Packing
  - Marketing
  - Including overhead
- Gross Margin $46,045

Challenges

- Availability of seed material
  - Shipping
- Market value
  - Compared to Midwest
- Availability of mechanization
- Availability of land
  - Crop rotation

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Questions?