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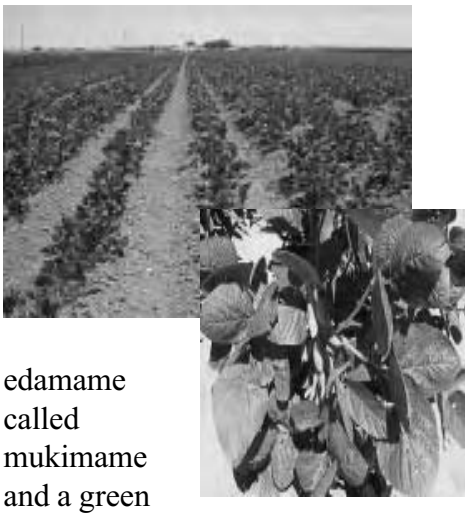
agronomy news

Market Improving For Edamame

Has the time arrived for this new crop?

NEW CROPS ISSUE:

This rather modest green podded soybean is currently taking the West Coast by storm. Recent reports by a broker in California indicate consumers have taken to these salty, boiled beans in a big way. Bill Sherliff of the Soy Foods Center has indicated a surprising market surge for chilled, fresh podded soybeans.



Edamame, or vegetable soybean, has a long history in many Asian cultures as hors d'oeuvres. Japan has been consuming edamame (pronounced Ed-a-Mom-ae) for over 400 years. National consumption in Japan has averaged 110,000 metric tons annually (Nakano, 1991). These vegetable soybeans are generally sold in the pod as fresh or frozen beans. Beans are harvested when the bean pods are green and Brix readings (soluble solids) are generally between 8.5 and 12.0. For consumption, edamame is boiled for 5 to 7 minutes in highly salted water, drained and are served either hot or cold. Other vegetable soybean products are a shelled version of edamame called mukimame and a green bean paste, zunda-mochi (Masuda, 1991).

Edamame quality is measured in Japan with three primary concerns: flavor, sweetness and texture. To accommodate these concerns, breeders have based cultivar selection on five criteria: appearance, taste, texture, flavor and nutritional value. Sucrose, glutamic acid and alanine determine taste. Flavor is most desirable when it is "flower-like" and "beany" (Masuda, 1991). The boiled beans are a good source of vitamin C (ascorbic acid),

(Continued on page 2)

Edamame

(Continued from page 1)

vitamin E (tocopherol) and dietary fiber. Trypsin inhibitors and other antinutrional factors do exist in edamame, but can be eliminated with cooking. To market, the pods should be bright green, have a light (white to grey) colored pubescence, be free of defects and contain a minimum of two beans per pod. Texture studies at Colorado State University indicate a preference for a "buttery" texture attainable by delaying harvest (Maga, 1996, personal communication). The changes in texture preferred by U.S. consumers will decrease the concentration of cis-jasmone and hexenyl-acetate responsible for the flowery flavor (Masuda, 1991). Boiling induces production of furans and ketones, which produce a new range of odors. The Colorado beans have a nutritional composition similar to Japanese edamame. The Colorado beans are somewhat higher in sugars (carbohydrates) and fat than the Japanese standards but these analyses show no significant changes. Nutritionally, edamame is very sound. Table 1 illustrates the nutritional value of this crop.

Table 1. Proximate Analysis of Colorado Vegetable Soybean

Composition	Value	Composition	Value
Energy (Kcal/100g)	573.0	Phosphorus (mg/100g)	148.0
Water (g/100g)	71.1	Iron (mg/100g)	1.2
Protein (g/100g)	12.4	Sodium (mg/100g)	1.5
Lipids (g/100g)	7.1	Potassium (mg/100g)	145.0
Carbohydrates (g/100g)	8.3	Carotene (mg/100g)	89.0
Fiber (g/100g)	3.2	Vitamin B1 (mg/100g)	0.27
Dietary fiber (g/100g)	13.8	Vitamin B2 (mg/100g)	0.14
Ash (g/100g)	1.6	Niacin (mg/100g)	1.0
Calcium (mg/100g)	72.0	Ascorbic Acid (g/100g)	17.0

The Colorado Edamame Project

Colorado, due to elevation and latitude, is generally characterized as a Group 1-2 in the north and a Group 4 in the southern half of the state. Extremes of climate, limited rainfall and distance to market have restricted edamame's introduction to Colorado. The dry climate and isolation, however, have also provided levels of yield and quality that stimulated interest in specialty markets for soybeans. Developing specialty soybeans required identifying potential markets. The developing immigrant and tourism industries for Asians on the West and East Coasts of the United States should require over 3,000 tons of edamame per year. Edamame is typically planted at rates of 75 to 85 lbs/acre. With seed costing as much as $6-12/lb, good seed is essential. Planting should occur when soil temperatures exceed 60 degrees F. We have found the inoculation of seed with a bacterial biopesticide does an excellent and low cost job of protecting these plants from bacterial blight — our 'number one disease problem. Edamame should be grown under irrigation to insure excellent quality. It is a seventy-day crop, so water quantity is less important than timing. We have also found the quality is better under furrow irrigation than sprinkler. This was primarily due to blight problems and we have yet to test the biopesticide under sprinklers. Green bean harvests typically occur when 85% of the pods are fully expanded but still green. A sample of the pods can be boiled for 3 minutes and a Brix reading for solids taken. The food industry requires a minimum Brix value of 8.5%. We have no problem with a low Brix in Colorado. Yields have averaged 7.2 tons of salable beans per acre in southern and western Colorado and 4 to 5 tons on the Front Range.

(Continued on page 3)

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Edamame

(Continued from page 2)

For purposes of analysis, all green bean yields were adjusted to salable beans (discarding defective bean pods) and analyzed for Brix, texture, and salable beans. Texture was measured by sensory panel analyses in the Department of Food Sciences, Colorado State University. Dry bean harvests were conducted at the initiation of pod shatter (>10%). Dry beans were cut and tarped until dry and threshed using an axial flow system. All dry bean yields were adjusted to 10% moisture for analysis.

Green bean yields were significant for location effect and yield quality as measured by Brix. Results are summarized in Table 2. No location, year or cultivar interactions were noted. Data are summarized over years. A midseason (75 days) type bean gave higher yields than other edamame types. The Brix values, however, are significantly lower than the earlier maturing types. For fresh market sales, the early types are superior and the main crop edamame are best for frozen consumption. The cooler nights in Ft. Collins resulted in higher solids (sugars) than at Rocky Ford where yields were higher. In general, fresh market consumers preferred the Ft. Collins beans.

Dry bean yields varied by cultivars, years and locations. Data are summarized in Tables 4 and 5. Dry bean production was used to supplement potential green bean production and as an alternative seed market. Seed management is very important as seed quality has a value. Germination percentage should not fall below 75%. Seed moisture maintenance is very important. Our dry climate wreaks havoc on viability. Split beans and damaged beans were removed to enhance seed quality as salable yield.

Processing Edamame

Edamame is marketed fresh or frozen. Fresh beans were harvested and selected for salable quality. Fresh beans of SE 4 from Ft. Collins were packaged in re-sealable plastic bags in lots of 4.5 lbs/bag. Plastic packs were flooded with air, 20:80 CO_2:N_2 gas and 40:60 CO_2: N_2. Replicated packs were refrigerated at 3-5C and sampled at 2-day intervals with subsamples of 0.25 lbs/sample removed and prepared for consumption. Brix % and sensory observation were used as quality measures. It appears from Table 6 that for commercial edamame

Table 2. Yield results for edible beans at Rocky Ford, CO, 1994- 1998

Trait	Whole Yield (t/a)	Salable Yield (t/a)	Quality (Brix %)	Texture Score 1-10
Cultivar				
RF SE 4	10.2 a	6.8 a	8.4 b	8 a
RF SE 2	8.4 b	4.6 b	8.4 b	7 b
RF SE 5	7.8 b	5.2 b	9.3 a	9 a
RF SE 1	5.9 c	4.0 c	9.1 a	6 b
RF SE 3	4.1 c	2.1 d	8.1 c	4 c

P=0.05, significant differences.

Table 3. Yield results for edible beans at Ft. Collins, CO, 1994-1998

Trait	Whole Yield (t/a)	Salable Yield (t/a)	Quality (Brix %)	Texture Score 1-10
Cultivar				
RF SE 4	8.1 a	4.8 a	8.3 b	6 a
RF SE 2	6.1 b	3.9 b	10.1 a	7 b
RF SE 5	6.9 b	3.4 b	10.5 a	8 a
RF SE 1	4.1 c	2.8 b	9.1 a	8 b
RF SE 3	2.2 c	1.0 c	7.1 c	4 c

P=0.05, significant differences.

(Continued on page 4)

Edamame

(Continued from page 3)

production, most cultivars are capable of 10 to 14 days in cold storage without significant loss in quality. The varieties with a high initial Brix were capable of longer shelf life.

Frozen soybeans were capable of long term storage and we processed them using IQF (Instant Quick Frozen) technology. Frozen beans have a freezer life of seven to nine months without quality loss if maintained at 0 degrees F.

Summary

Edible vegetable soybeans are feasible for production in Colorado. The dry climate and high altitude provide a low pathogen, high quality environment. Markets for this new crop exist within the United States and could conceivably require 40,000 acres to fill the current market niche.

The crop can be processed either as fresh (chilled) product, a precooked chilled product or as frozen product. New U.S. consumers appear to prefer a more mature bean which has a more "buttery" flavor and texture as opposed to traditional Japanese consumes who prefer a sweeter, more flowery flavor and crisper texture. Dry bean sales are not limited to edamame but can also be used in other soybean protein-based products such as tofu. The dry soybeans used in tofu, however, make a very inferior edamame.

Table 4. Yield of dry soybeans at Rocky Ford, Colorado, 1994-1997

Trait	Whole Yield (t/a)	Salable Yield (t/a)	Germination (%)
Cultivar			
RF SE 4	2.2 a	1.7 a	82 b
RF SE 2	1.5 b	0.9 a	85 a
RF SE 5	1.3 b	0.7 a	85 a
RF SE 1	0.9 b	0.4 b	76 b
RF SE 3	0.4 c	0.1 c	78 b

P=0.05, significant differences.

Table 5. Yield of dry soybeans at Ft. Collins, Colorado, 1994-1997

Trait	Whole Yield (mt/ha)	Salable Yield (mt/ha)	Germination (%)
Cultivar			
RF SE 4	1.6 a	1.1 a	78 a
RF SE 2	0.9 b	0.6 a	75 a
RF SE 5	0.6 b	0.5 a	65 b
RF SE 1	0.3 c	0.2 b	62 b
RF SE 3	0.1 d	0.06 c	72 b

P=0.05, significant differences.

Table 6. Brix Quality of Fresh Green Vegetable Soybeans from Ft. Collins, Colorado, 1997

Trait	Day 0	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12	Day 14	Day 16	Day 18	Day 20
Cultivar											
RF SE 4	10a	10a	10a	10a	10a	9a	9a	8a	6a	4a	3a
RF SE 2	11a	10a	10a	9a	9a	8a	8a	8a	6a	4a	3a
RF SE 5	11a	10a	10a	9a	8a	7b	7b	7a	6a	4a	3a
RF SE 1	9a	9a	9a	8b	8b	7b	7b	6b	6a	4a	3a
RF SE 3	6b	6b	6b	6b	5b	5c	5c	4c	4b	3a	3a

P=0.05, significant differences.

References

Masuda, R. 1991. *In* Vegetable Soybean: research needs for production and quality improvement. S. Shanmuga Sundraam, ed. Asian vegetable Research and Development Center. Taipei, Taiwan.

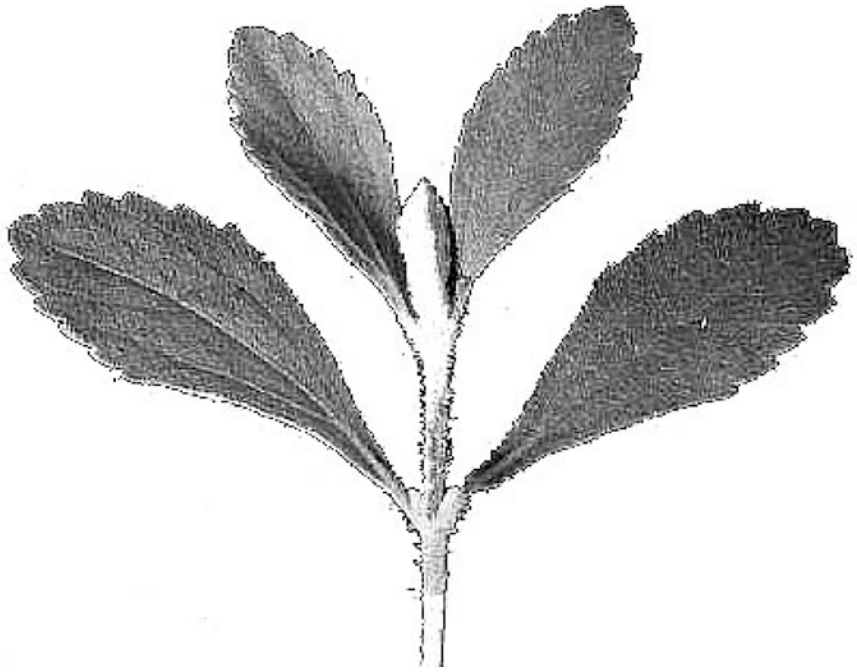
Nakano, H. 1991. *In* Vegetable soybean area, production, demand, supply, domestic and foreign trade in Japan. In Vegetable Soybean: research needs for production and quality improvement. S. Shanmuga Sundraam, ed. Asian vegetable Research and Development Center. Taipei, Taiwan.

Duane Johnson
New Crops Extension Specialist

What Happened To Stevia?

Alfalfa-like plant produces sweeteners and pesticides.

Stevia (Steve-ee-ah) or Rebaudi's stevia was a prospective crop for Colorado back in the early 1980s. It contains a natural, complex sugar relative that is 250 times sweeter than sucrose, reducing the sugar needed to sweeten a product (Shock, 1982) and essentially making it calorie free. Stevia is a native of Paraguay and is widely used in Japan, Korea, Europe and South America. The sweetness from stevia flavors beverages, chewing gum, pickles, tea and other foods (Peterson, 1995). Prior to 1991, stevia was an obscure imported crop traded in the United States as an herb for sweetening tea. Then the Food and Drug Administration (FDA) issued an import ban on stevia that was in effect until 1998. According to Natural Foods Merchandiser (Vol. XVI, No.4, April, 1995), FDA embargoed stevia "not for safety reasons but in response to complaints from mainstream businesses and industry, smacking more of disgruntled competition than concern for American public welfare."



Stevia received a sanction as Generally Recognized as Safe (GRAS) in 1998, making its production legal as a food product in the United States. It has been consumed in Asia as a sweetener for over 200 years and in South America for over 600 years. More recent interest has come from modern chemical technologies. Stevioside can be used to produce gibberellins, a natural growth hormone for plants. So, what is stevia and how do we grow it?

Stevia looks like a cross between mint and alfalfa and is managed the same way. In reality, however, it is a member of the sunflower family. It is a frost sensitive perennial and because it comes from an equatorial origin, does not flower in Colorado. As a result, stevia must be transplanted annually in the spring. Fortunately, tissue culture of stevia is not complicated and transplants can be produced at a relatively low cost. Since it does not overwinter and does not produce seed, stevia has no chance of becoming a weed. The sweetness comes from a complex sugar molecule called stevioside, a three-carbon ring attached to several glucoside groups (Shock, 1982). The steviaside and related compounds occupy about four to sixteen percent by weight of the leaves and stem of the plant. Research at the University of California indicates the sweetening power of stevia (220 pounds of stevioside per acre) would be the equivalent of 28 tons/acre of sucrose sugar per acre. No wonder there were "complaints from mainstream businesses and industry".

Stevia should be grown as an

(Continued on page 6)

Wheat Straw Used To Create Agro Plastic

Requires less energy to produce than traditional plastics, and final product weighs less, too.

A new method of combining wheat straw with either polypropylene or polyethylene has been developed by Donna Johnson, a biochemist and head of Pinnacle Technology in Lawrence, Kansas. The product can be molded into downspouts, boat seats, interior automotive panels and various other applications. The products will be marketed as "Agro Plastic". World plastic consumption is expected to rise to 135 million metric tons by the year 2000.

Plastics typically use fillers such as calcium carbonate, mica, glass or talc to reduce costs. Filler content can range from one third to one half of the product. Wheat straw also has the advantage of extending the product by as much as 20 %. Reduction in plastics consumed translates to a reduction in product weight making shipping cheaper. It also requires less energy to manufacture. Agro Plastics also can be produced as much as 25 % faster than conventional blends and produce product with less wear and tear on equipment.

With 63.6 million acres of wheat harvested in 1998 and a rate of one half ton of straw removed per acre, 31.5 million tons of straw could be available as filler. The inventor estimates wheat straw would have a value of between $40-$60 per ton delivered to the plant.

You can find out more at www.westbioenergy.org or by calling Pinnacle at 785-832-8866. You can also contact Jerry Loos in Lincoln, Nebraska at 402-471-3356 or email him at jloos@mail.state.ne.us

Duane Johnson
New Crops Extension Specialist

Stevia

(Continued from page 5)

irrigated crop in Colorado. It grows in climatic temperatures from 21 degrees F to 110 degrees F. The plant typically grows 2 to 3 feet in height and remains vegetative from spring through fall. In northern California, flowering was initiated in early October. High levels of nitrogen (225 lbs/a), phosphorus and potassium are required for commercial production. Highest yields in California and in preliminary tests in Colorado were at 16 plants/square yard and one cutting. Yields of 7200 to 8300 lbs/acre of leaves and stem were obtained. Harvest is similar to alfalfa production.

Where do we go from here? Stevia is likely to become a factor in the sweetener industry. Depressed prices for sucrose will likely slow its growth unless sucrose becomes uneconomical. It has potential to replace some non-caloric sweeteners since it is not heat labile (it does not denature in a hot beverage like aspartamine) and it can be produced economically as a dry product (unlike fructose). The advent of using steviosides as substrates for new biochemical products such as synthesized hormones is also likely to increase market interest.

For more information on stevia, check the following:

Shock, C.C. 1982. Experimental cultivation of Rebaudi's stevia in California. Univ. of California, Davis Agronomy Progress Report No. 122.8 pp.

Peterson, Natasha. 1995. Industry unites to solve the mystery behind FDA ban on stevia. Natural Foods Merchandiser. Vol. XVI, no. 4, p.1.

Markakis, Pericles.1987. The sweetener revolution. Science of Food and Agriculture. January, 1987. Pp 16-20.

Duane Johnson
New Crops Extension Specialist

Echinacea: The Wonder Crop Of The Next Century?

Uses for this sunflower relative with medicinal qualities are increasing.

Echinacea, or purple coneflower, was recognized early by native Americans as a plant with useful medicinal properties. Consequently, wherever the Indians traveled purple coneflower followed. A quick trip to Colorado's plains, foothills or mountains is evidence of their passage. In the 1990s, we are recognizing echinacea for its pharmaceutical, insecticidal and ornamental values. Two of eleven species are considered for this multipurpose crop and only three of the species contain commercial potential. Echinacea purpurea and E. augustifolia are considered the most potent for these species. The market for these crops involves sales of roots, leaves, and flowers, so it is truly a multipurpose crop. While not yet cleared by the Food and Drug Administration (FDA) as a pharmaceutical product, the root of echinacea contains compounds that appear to improve the human immune system to virus infection. The root is so valuable that sales of wild plants are threatening the genus with extinction of at least two species. Consequently, considerable work is underway publicly and privately to develop domestic production. The leaves and seeds have more recently shown insecticidal properties that may hold

promise as a natural pesticide. All-in-all, echinacea may best be classified as a "natural medicine", providing general health benefits. The root is currently the primary market and is sold internationally.

Echinacea is generally cultivated from seed. As a member of the sunflower family, the seed resembles a small sunflower seed. Germination of that seed has been a problem as you might expect from a wild seed source. Typically, because of seed cost and low germination, the plants are initiated in a greenhouse environment. Research at Purdue University (Sari, 1997) indicated germination of fresh seed is highest when the seed is treated with 0.001% ethaphon and 2.5% GA3 at 70F for 4 weeks prior to planting.

Planting rates are still not defined, but the Echinacea will probably be grown as a row crop with plants spaced initially at 12 inches between plants within rows for root production. Root harvest typically is made after three to five years. That may put more pressure on the sales of seeds and leaves for those intervening years, but the market is very poorly defined for this area.

Water requirements are also poorly defined but observation in natural settings indicates adequate moisture increases yields. I would recommend potential growers look at the related wild sunflower populations to see what the impact of moisture might have. Likewise, fertility requirements are poorly defined and we have virtually no information on pests, although the natural pesticides of the plant and natural stand observations of Colorado's E. purpurea populations show very few pest problems. Increasing plant density and monoculture may change that.

For more information on echinacea, contact one of the following people via the Internet:
James Simon at
simon@hort.purdue.edu .

Kathleen McKeown at
kmckeown@pssci.umass.edu .

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New Crops Extension Specialist

Colorado and Nebraska Get New Crops Grant

Fund for Rural America monies will be used for crop demonstrations, value added crop development, and advisory panels.

The Fund for Rural America (FRA) two years ago was considered a replacement program for the farm subsidies. The FRA provided no guarantees for farmers but did provide opportunities for farm communities to develop economic resources outside of the federal system. The floods of '96 pulled funds from the FRA to help with that disaster, weakening the program. In 1998, the same funds were cancelled to help with farm relief. The program appeared to have no funding and no grants were anticipated. A confederation of nonprofit organizations continued to pursue the idea and, during the eleventh hour, granted funding for a FRA center grant. The Jefferson Institute of Missouri is leading this effort. The Jefferson Institute is a nonprofit organization dedicated to promotion of new crop development. The University of Missouri is the leading institution for the fund, with subcontracts to additional three regional efforts. Missouri will head the eastern Great Plains efforts, Purdue will head the central Midwest, Nebraska and Colorado will jointly manage the central Great Plains and Oregon State will lead in the Pacific Northwest. This was the only FRA program funded in 1998 and will provide $1.52 million funding for the next four years. This project has been supported extensively by Undersecretary of Agriculture Miley Gonzalez.

Colorado and Nebraska's efforts will be to establish new crop demonstration areas, fund new crop advisory panels and to develop value added crop products. We are anticipating the potential for development of three panels: one in western Nebraska, one in central Colorado and one joint Colorado/Nebraska team. Demonstration plots will be established after funding agreements are in place with the University of Missouri. If you have potential crops or advisory groups with interest in this project, please contact Duane Johnson (duanej@agsci.colostate.edu).

Contacts about the Jefferson Institute: Rob Myers (CEO at the Jefferson Institute) at 573-449-3518 or email at rlmyers1@ix.netcom.com

Information about the new crops initiatives at USDA:
Deputy Secretary Rich Rominger (or Linda Delgado, his executive assistant) at 202-720-6158.

Undersecretary Miley Gonzalez (Undersecretary for Research, Education and Extension) or Eileen Kennedy (Deputy Undersecretary Secretary to Mr. Gonzalez) at 202-720-5923.

Duane Johnson
New Crops Extension Specialist

events

Dirt to Dollars: Soil management Strategies for Crop Producers. Series of interactive workshop on soils. No cost to participants. Weld County Extension Office, Island Grove Park, 425 N. 15th Avenue, Greeley. 6-8 p.m., February 2, 4, 11. Understanding your farm's soil fertility on February 2. Boy, that ground is hard...compaction on February 4. Soil and Water, an Initimate Relationship on February 11. Call 970-356-4000 ext 4465 for more information or to register

Enterprise Shortcut Budgets Are Useful Tools in Production Decisions

Litmus test for choosing new crops is simple: What is the market value?

The development of any new crop industry is dependent on the market. Unlike common grains, there is no elevator that will buy your production if there is no established market. To determine if a grower wants to get into a new crop and to what extent that entry will be, a handy short form for crop budgeting is helpful. The sample form here shows two levels of profit generation when developing sunflowers into oil. Each section is an independent profit center and profits beyond the farmgate take into account purchases from the level above. This is an exercise and may not constitute actual costs and returns but illustrates a point new crops projects must consider. Other examples are available at http://www.colostate.edu/Depts/SoilCrop/extension/AltCrops/newcrop.html.

Potential Sunflower Motor Oil Market: 10% to 20% of 1.2 billion gallons annually

FARM				
Cost/Benefit per Acre	$ value or cost/lb	Units/Acre bu/a	Gross $/a	Net $/a
Farmgate Value	4.20	42	176.40	
Production cost	3.54	42	148.68	
Net farm Income/a				27.72
PROCESSING				
Processing Crude Oil	$/lb	lbs/a	$/a	
Crude oil value	0.35	480	168.00	
Crude meal value	0.10	780	78.00	
Sum process value Cost			246.00	
Seed to oil cost	0.06	480	28.80	
Seed to meal cost	0.11	780	85.80	
Sum cost			114.60	
Net				131.40

Traditional vegetable oils are primarily used as food products, as paints and solvents, as animal feeds, and in some lubricants (hydraulics, cutting oils, etc.).

Duane Johnson
New Crops Extension Specialist

web sites

NewCROP (New Crop Resource On-line Program) is a free Web resource available for new and specialty crops. It was developed by Purdue University and is maintained by them. The homepage address is http://www.hort.purdue.edu/newcrop . Linkage to each crop is achieved by using a comprehensive index of plants listed by common and scientific names (CropINDEX) or through a search engine (CropSEARCH). Each crop link has factsheets, monographs, articles and published manuscripts developed by experts worldwide.

Other accessible databases include CropIMPORT-EXPORT (information on import permits, phytosanitary permits, quarantine and inspection information). FarmMARKET (a listing of US Farm markets), FamineFOODS (1,250 plants useful during tough times), CropREFERENCE (crop bibliographies), CropEXPERT (directories of experts worldwide), and CropEVENTS (what's happening). They also maintain an electronic bulletin board at NewCROP LISTSERV.

The webmasters at the Purdue site are Jules Janick (jjanick@hort.purdue.edu) and Jim Simon (simon@hort.purdue.edu).

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