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ALTERNATIVE AGRONOMIC CROPS

AGRONOMY SERIES

ATTRA is the national sustainable agriculture information center funded by the USDA's Rural Business -- Cooperative Service.

Abstract: *This publication provides an overview of the considerations involved in selecting, cultivating, and marketing alternative agronomic crops. Experimenting with alternative crops can be profitable but involves risk as well. Before venturing into an alternative crop, it is wise to investigate the market and determine whether any new equipment will be required. It is also advisable to talk to others who have grown the proposed crop. Many additional resources for alternative crop information are referenced in this publication.*

By Patricia Sauer and Preston Sullivan
NCAT Agriculture Specialists
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INTRODUCTION

Various factors have stimulated interest in crop diversification in recent years: commodity price instability, decreased or eliminated farm subsidies, increased pesticide-resistance in pests, and losses in genetic biodiversity. At the same time, consumer dietary changes have generated new markets for alternative food products.

Experimenting with an alternative crop involves both risks and opportunities, from both the production and the marketing standpoints. An alternative crop may make a positive contribution by increasing the diversity of the farm's income base, spreading out risks, reducing weaknesses in the farm system, or broadening the base of operations.



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While some alternative crops provide additional markets or greater profitability compared to standard crops, others are not necessarily higher-value crops. Rather, they are added to a rotation to break up insect pest, weed, and disease cycles, to scavenge nutrients for other crops, to improve soil tilth and fertility, or to clean up weedy fields. They are used to spread out the workload, to make farming more fun and interesting, and to add system flexibility, especially with crops that can double as livestock feed or forage in bad crop years.



Farm diversification using alternative crops requires considerable research and planning, from assessing available resources, to selecting potentially feasible crops, to exploring the crop market. Information regarding alternative crops is somewhat limited, especially when compared to that available for crops such as corn, wheat, and soybeans. However, a lot of valuable information can be obtained by networking with other producers.

INVENTORY OF AVAILABLE RESOURCES

It's a good idea to begin by inventorying your available resources. This inventory might include some of the following information (1):

Land, Soil, Water

- How many acres do you own or rent?
- What are the soil types, soil tilth and fertility, erosion potential, and drainage?
- What is your source of water (surface or groundwater)?
- Do you rely on an irrigation system for current needs?
- What is the quality of the water and are there adequate supplies for irrigation?
- How are wastes and wastewater managed on your farm?
- Are water storage and water treatment facilities adequate?

Buildings and Equipment

- Do you have facilities and machinery that are underused and can they be used or adapted for other crops?
- Is grain storage available?
- Do you have access to a company or individual that manufactures specialized equipment or modifies existing equipment?

Labor

- Do you have off-farm employment?
- What are your slow months?

- How many employees do you currently have and are their schedules flexible?
- Do you have access to seasonal employees?

Location

- Is your farm easily accessible and what are the conditions of the roads?
- What is the population within a 50-mile radius and the number of communities?

Financial Status

- What are your monthly and annual income needs and does your farm income meet these needs?
- What is your debt-to-equity ratio?
- Do you have access to additional capital?
- What are your current production costs per bushel/ton/pound/cwt.?

Business Management and Marketing

- Do you have a business plan?
- Do you maintain farm records and prepare and analyze balance sheets, income statements, cash flow records, labor flow records, and unit budgets?
- What does each labor hour you invest earn and what is your rate of return on investments?
- Do you compare major financial and production efficiency factors from one year to another?
- Do you network with other producers?
- How do you market your current commodities?

Entrepreneurial Skills

- Do you think of new ideas and enjoy planning new enterprises?
- Do you enjoy dealing with the public and can you manage people effectively?
- Do you try to find benefits when things don't turn out the way they were planned?
- Do you enjoy problem solving and do you learn from past mistakes?

The *Small Farm Handbook* (2) is one source of additional inventory topics and discusses all aspects of small farm operation and success. It serves as an applied discussion of small-scale farm operation in California for farms that raise organic and ethnic produce and unusual plant varieties. Topics include requirements for successful farming, finances, marketing, growing crops, handling of perishable crops, alternative agriculture, and labor management. Another source is *Farming Alternatives: A Guide to Evaluating the Feasibility of New Farm Based Enterprises* (3). Worksheets are available in this publication to help assess the feasibility of diversifying farm operations. For more information on business planning, request the ATTRA publication entitled *Evaluating a Rural Enterprise*.

CROP SELECTION

Alternative field crops are categorized as cereals and pseudocereals; grain legumes; oilseeds; industrial crops; and fiber crops. The table below lists many of the crops that fall within these categories. Feasibility of a specific crop depends on a number of factors including the suitability of the crop for local growing conditions. Climate, soil characteristics, and pest problems affect crop productivity. Also worth considering is whether the alternative cash crop has other uses as well. For example, a number of the legumes and cereals have value as livestock forage. Should crop quality or markets be too low in a particular year, its usability as forage makes such a crop a

less risky investment. The Appendix provides an extensive list of alternative crops, including area of adaptation, compiled by Kansas State University (4).

The Alternative Field Crops Manual (5), from the University of Minnesota and the University of Wisconsin, is a comprehensive source of production information on 48 alternative agronomic crops adapted to the upper Midwest. Detailed information is provided for each crop, including a brief history, growth habits, environmental requirements, cultural practices, yields, performance, economics and primary markets, and information sources. This manual is probably the single most informative resource available to farmers and Extension agents on this topic. It is also available on the web at <www.hort.purdue.edu/newcrop/afcm/index.html>.

CROP AND INDUSTRIAL USE RESEARCH

New crops and industrial products from these crops are being researched. Due to the complex nature of new crop production and development, progress seems slow. The following processes are involved in the development of an alternative crop: collection of cultivars, plant breeding for disease resistance and desirable plant traits, development of production and cultivation practices, and market considerations.

On national and state levels, a number of organizations transfer current research on

Table: Categorization of alternative agronomic crops

Category	Crops
Cereals and Pseudocereals	Amaranth, blue corn, buckwheat, einkorn, emmer, foxtail, grain millet, khorosan, intermediate wheatgrass, pearl millet, proso millet, quinoa, spelt, teff, triticale, wild rice, reed canary grass
Grain Legumes	Many varieties of dry beans and dry peas, Illinois bundle flower, lentils
Oilseeds	Apeacia, camelina, canola, crambe, rape, cuphea, jojoba, lesquerella, meadowfoam, perilla, rapeseed, sesame, flax, sunflower, safflower
Industrial Crops	Bladder pod, castor, cuphea, euphorbia, fanweed, gopher plant, guayule, gumwood, jojoba, lesquerella, vernonia
Fiber Crops	Kenaf, milkweed, flax

cultivation and production of alternative crops. Some of these groups include:

- **Alternative Farming Systems Information Center** (Beltsville, MD) (15)
- **Carrington Research/Extension Center** (Carrington, ND) (16)
- **Center for Alternative Plant and Animal Products** (St. Paul, MN) (17)
- **Cooperative Extension Service** (contact a local county office near you) (18)
- **Cooperative State Research, Education, and Extension Service, Small Farm Program, USDA** (Washington, D.C.) (19)
- **Indiana Center for New Crops and Plant Products** (West Lafayette, IN) (20)
- **Kerr Center for Sustainable Agriculture** (Poteau, OK) (21)
- **Missouri Alternatives Center** (Missouri residents only) (Columbia, MO) (22)
- **Small Farm Center** (Davis, CA) (23)

Research is also being conducted on industrial products that can be manufactured from alternative crops. Industrial use updates on crops such as castor, lesquerella, crambe, industrial rapeseed, guayule, jojoba, kenaf, and milkweed are available from the New Uses Council. *The New Uses Council's 1997 Bioproducts Directory* (6) lists companies, organizations, researchers, and suppliers of products made from renewable agricultural, forestry, or livestock materials or residues. (The '97 version is the latest "paper" edition. A 1999 web version of this directory is available at <www.newuses.org>.)

The Minnesota Agricultural Utilization Research Institute works to create new uses and new markets for Minnesota's agricultural commodities and alternative crops (7). They publish a free newsletter called Ag Innovation News. They also do market research, technology transfer, and work one-on-one with Minnesota farmers and business people.

Several conference proceedings from the new crops meetings have been published. Many of the papers presented at these conferences are very technical in nature and may be of more use to researchers than to farmers. These proceedings cover a wide variety of new crops and many

aspects of their growth, adaptation, and production. Their titles are:

- *Advances in New Crops*, edited by Jules Janick and J.E. Simon. 1990, 560 pages (8)
- *New Crops*, edited by Jules Janick and J.E. Simon. 1993, 710 pages (9)
- *Progress in New Crops*, edited by Jules Janick. 1996, 660 pages (10)
- *Perspectives on New Crops and New Uses*, edited by Jules Janick. 1999, 528 pages (11)

The Association for the Advancement of Industrial Crops (12) is an international, nonprofit educational and scientific organization that educates its members, the public, industry leaders, and government policy makers on utilization and commercialization of industrial products from agricultural crops. Over half of the membership is involved in research and development of industrial crops. For information on upcoming conferences as well as program abstracts of past meetings, see the AAIC website at <www.aaic.org>.

MARKETS AND MARKETING

The bottom line in raising crops is whether the projected receipts for the crop will be greater than the projected costs for producing it. It is the responsibility of each producer to carefully evaluate the marketing potential for an alternative field crop before getting into production.

Market supply and demand, depth of market in terms of how much of a crop is needed to saturate the market, and market stability are very important topics to research. Availability and location of the nearest market, marketing strategies, and access to processing are also important considerations.

Markets for alternative crops can vary greatly, depending on the crop. For a few examples:

- Approximately 95% of the buckwheat produced in North Dakota and surrounding states is exported to Japan where it is milled into flour and used to prepare noodles for human consumption (13).

- Grain millet grown in Florida and Georgia is becoming a major feed source for broilers in these states, a substitute for maize that reduces the need for high protein supplements in feed (13).
- Proso millet is marketed through elevators where it is grown locally and is used for birdseed.
- Spelt is grown under contract and sold to health food stores as grain, white flour, and processed products such as pancake mix and cereals. It is marketed as a wheat alternative for people who have wheat allergies.

Many alternative crops are marketed by contract to processors or packers. It is unlikely that alternative crops are handled by local elevators or marketing channels. Elevators in some locations will take alternative crops, but they should be contacted before planting specific crops that are intended for delivery to them.

It is common for companies developing products based on unusual alternative crops to integrate vertically. That is, they lease land, use their own managers, and hire local labor. As mentioned earlier, when considering an alternative crop, it is necessary to carefully research all aspects related to the production, processing, and sale of that crop.

There are several resources available that provide information on alternative crop markets and marketing. *The National Organic Directory* (14) is updated annually and focuses on organically grown commodities and alternative crops. Specific marketing information on organically grown wheat, oats, and sunflowers, and a list of some markets for these crops, are available in *Northern Plains Organic Crops Marketing Analysis* (13). The Cooperative Extension Service in some states has compiled a list of buyers of some alternative commodities. Commodity groups may also have such a list. Also, many state agriculture departments and land-grant university agricultural economics departments may have market information for specific crops.

STARTING POINTS TO CONSIDER

Talk to others who are already doing it. If you don't know anyone already involved in the enterprise, locate the state, regional, and national groups involved and get a list of local contacts. Avoid being swayed by hype. If possible, also talk to some folks who have tried and failed. We often learn more from failure than from success.

Read all you can about your proposed enterprise. The popular farm press commonly picks up on new trends and features articles on new crops. Furthermore, there are typically a wealth of newsletters and journals that arise following the introduction of new crops and other enterprises. The Internet also offers a new, rapid means of accessing information on new topic areas. If you don't own a computer, you can usually get internet access at your local library or Extension office.

Learn about the equipment for any new crops. Where feasible, choose crops that only require adjustment or some modification of your current equipment, rather than requiring significant investment in new or different equipment.

Study the markets. Get a good sense of the market possibilities for any crop or product you are considering producing. Identify wholesalers, retailers, brokers, direct marketing options, and other resources that can be helpful. Ask other producers how they market.

Learn the specialty market standards required. Evaluate your ability to meet standards for cleanliness, packaging, crop quality, etc. Some requirements are rather unique. For example, synthetic fertilizers and pesticides may not be used on a field for three years before a harvested crop may be sold as "organically grown."

Establish your market connection BEFORE you grow your crop. This is especially critical for highly specialized commodities like edible soybeans. The seeds of edible soybeans are often

colored differently from conventional beans, making them difficult or impossible to sell through conventional channels as a fallback option.

Become techno-smart. Get comfortable with the idea of using the phone and the computer to market your products.

Be flexible. When dealing with niche enterprises, it is often necessary to move quickly in response to rapidly changing market conditions. Farmers must constantly be on the lookout for ways to improve and innovate.

Think (w)holistically. Consider more than just immediate, short-term profits when investigating new crops and enterprises. Diversification may not actually increase profits. What it can do is make profitability more reliable by smoothing out the ride between good and bad years. There may be additional benefits. Perhaps adding a new crop to the rotation will reduce problem pests...or maybe it will build soil fertility. Develop a whole-farm business plan and study carefully how well a new enterprise can be integrated.

Internet resources. Surf the internet to find organizations, such as ATTRA, that provide information on alternative field crops and sustainable agriculture. Many web homepage addresses are included with the citations in the reference section of this document.

SUMMARY

Farmers interested in alternative crops should inventory their current farm resources and carefully review the production and marketing potential of these crops before planting. Networking is an essential part of this process. ATTRA and other organizations mentioned in this publication have more detailed information on specific crops and the suitability of these crops for certain regions and farm production systems. Seed sources and marketing information can be obtained through elevators, Extension personnel, commodity groups, processors, and other channels.

REFERENCES:

- 1) Hoffman, Steven M. (ed.). 1987. *ADAPT 2: Ag Diversification Adds Profits Today – 100 Ideas for Farmers*. Proceedings of the Successful Farming Magazine Conference, held December 3–4, 1987 in Kansas City, Missouri. (OUT OF PRINT. See local library interlibrary loan department.)
- 2) *Small Farm Handbook*, Division of Agriculture and Natural Resources, Oakland, CA. To order send \$20.00 + \$4.50 S & H to:
ANR Publications
University of California
6701 San Pablo Avenue
Oakland, CA 94608-1239
(800) 994-8849; (510) 642-2431
www.anrcatalog.ucdavis.edu
- 3) Grudens-Schuck, Nancy, et al. 1988. *Farming Alternatives: A Guide to Evaluating the Feasibility of New Farm-Based Enterprises*. Northeast Regional Agricultural Engineering Service, Cornell University, Ithaca, NY.
To order, send \$3.75 to:
152 Riley Robb Hall
Ithaca, NY 14853
(607) 255-7654
E-mail: nraes@cornell.edu
www.nraes.org
- 4) Shroyer, James P. and Donald B. Erickson. 1987. *Specialty and Non-Traditional Crops*. MF-844, Cooperative Extension Service, Kansas State University, Manhattan. January. 6 p.
- 5) *Alternative Field Crops Manual*. 1989–1992. University of Wisconsin-Extension, Cooperative Extension, University of Minnesota Center for Alternative Plant and Animal Products, and University of Minnesota Extension Service.
Available on-line at
<www.hort.purdue.edu/newcrop/afcm/index.html>.
Print copies are available for \$45.00 from:
Center for Alternative Plant and Animal Products
University of Minnesota
352 Alderman Hall, Room 352
1970 Folwell Avenue
Saint Paul, MN 55108
(612) 624-4217 or (612) 625-5747
E-mail: mgo@tc.umn.edu
www.mgo.umn.edu

REFERENCES: (continued)

- 6) Harsch, Jonathan (ed). 1997. *The New Uses Council's 1997 Bioproducts Directory*. To order (\$40.00 for members, \$80.00 for nonmembers) contact:
New Uses Council
Jonathan Harsch
295 Tanglewood Drive
East Greenwich, RI 02818-2210
Ph-401-885-8177, FAX-419-821-5789
www.newuses.org
- 7) Minnesota Agricultural Utilization Research Institute
AURI
PO Box 599
Crookston, Minnesota 56716-0599
(800) 279-5010, FAX (218) 281-7600
www.auri.org
Newsletter: *Ag Innovation News* (free subscription).
- 8) *Advances in New Crops*.
Paper version out of print. Web version available at <www.hort.purdue.edu/newcrop/CropInfoSources/NewCropsBook1990_info.html>
- 9) *New Crops*.
Paper version out of print. Web version available at <www.hort.purdue.edu/newcrop/CropInfoSources/NewCropsBook1993_info.html>
- 10) *Progress in New Crops*.
Available for \$79.95 + \$7 shipping and handling from:
ASHS Press
113 South West Street
Alexandria, VA 22314-2857
703-836-4606
FAX 703-836-2024
E-mail: Ashspres@ashs.org
Web version available free at <www.hort.purdue.edu/newcrop/CropInfoSources/NewCropsBook1996_info.html>.
- 11) *Perspectives on New Crops and New Uses*.
Available for \$99.95 + \$7 shipping and handling from ASHS Press (see above reference). This publication is not available on the web.
- 12) Association for the Advancement of Industrial Crops (AAIC)
AAIC Secretary
c/o U.S. Water Conservation Laboratory
4331 E. Broadway Road
Phoenix, AZ 85040
www.aaic.org
- 13) Stearns, Larry, and David Watt. 1993. *Northern Plains Organic Crops Marketing Analysis: Wheat, Oats, Sunflower*. Agricultural Economics Report No. 293. Department of Agricultural Economics-Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota.
This publication provides useful information on organic production including wheat, oats, and sunflowers in the Northern Plains. A survey of organic producers was conducted in the region. Supply and demand information along with producer experiences, buyer/processor responses and distributor/retailer responses are included. A list of organic buyers is included. To order this free publication, contact:
North Dakota State University
Department of Agricultural Economics
Morrill Hall, Room 217
Fargo, North Dakota 58102
(701) 231-7441
- 14) *National Organic Directory*. Community Alliance with Family Farmers. Davis, California.
This document provides extensive information on organic farming and sustainable agriculture. Included is a list of farmers, wholesalers, farm suppliers, resource groups, manufacturers/processors, commodity groups, and importers/exporters. To order send \$51.15 (includes shipping) to:
National Organic Directory
Community Alliance with Family Farmers
PO Box 363
Davis, CA 95617
Order line only: 800-852-3832
530-756-8518, ext 17
FAX 530-756-7857
E-mail: nod@caff.org
www.caff.org
- 15) Alternative Farming Systems Information Center
USDA's National Agricultural Library
Room 304
10301 Baltimore Avenue
Beltsville, Maryland 20705-2351
(301) 504-6559 Fax (301) 504-6409
afsic@nal.usda.gov
<http://www.nal.usda.gov/afsic>
This information service provides literature searches including information on potential enterprises for diversification, association and agency contacts, and current research by USDA and other organizations.

REFERENCES: (continued)

- 16) Carrington Research Extension Center
North Dakota State University
PO Box 219
Carrington, North Dakota 58421
(701) 652-2951
recenter@ndsuxt.nodak.edu
The center will provide some assistance in determining the adaptability of some alternative crops to specific locations. A report of agricultural research including alternative field crops and extension in North Dakota is published annually. The latest publication available is volume 38, December 1997.
- 17) Center for Alternative Plant and Animal Products
University of Minnesota
352 Alderman Hall, Room 352
1970 Folwell Avenue
Saint Paul, MN 55108
(612) 624-4217 or (612) 625-5747
E-mail: mgo@tc.umn.edu
www.mgo.umn.edu
Newsletter: *BioOptions* (published quarterly; cost is \$10.00).
- 18) Cooperative Extension Service: *see your local county office or refer to NCAT/ATTRA's homepage for a list of extension websites for most states.*
- 19) USDA Small Farm Program Cooperative State Research, Education, and Extension Service
For publications write to:
CSREES
Mail Stop 2220,
868 Aerospace Center, 901 D Street
Washington, D.C. 20250
(800) 583-3071 Fax (202) 401-1602
E-mail: smallfarm@reeusda.gov
www.reeusda.gov/smallfarm
Free newsletter: *Small Farm Digest*
- 20) Indiana Center for New Crops and Plant Products
Purdue University
1165 Horticulture Building
West Lafayette, IN 47907-1165
(765) 494-1329 Fax (765) 494-0391
E-mail: jjanick@hort.purdue.edu
www.hort.purdue.edu/newcrop
The Center's homepage is dedicated to new crops and plant products and includes sections on announcements, upcoming symposia, meetings, a new crops library, copies of New Crop News, and a directory of new crop experts.
- 21) Kerr Center for Sustainable Agriculture
PO Box 588
Poteau, Oklahoma 74953-0588
(918) 647-9123
E-mail: mailbox@kerrcenter.com
www.kerrcenter.com/
- 22) Missouri Alternatives Center
531 Clark Hall
Columbia, MO 65211
(573) 882-1905
(800) 433-3704 (Missouri only)
E-mail: moac@ext.missouri.edu
www.agebb.missouri.edu/mac/agopp/index.htm
Newsletter: *Ag Opportunities* (free for residents of MO; out-of-state subscriptions \$10.00; also available on-line at the website).
- 23) Small Farm Center
University of California-Davis
1 Shields Avenue
Davis, California 95616
(530) 752-8136 Fax: (530) 752-7716
E-mail: sfcenter@ucdavis.edu
www.sfc.ucdavis.edu
Newsletter: *Small Farm News*

**By Patricia Sauer and Preston Sullivan
NCAT Agriculture Specialists**

The electronic version of *Alternative Agronomic Crops* is located at:
<http://www.attra.org/attra-pub/altcrops.html>

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Appendix

PLANT CHARACTERISTICS, USES, AND PRODUCTION PRACTICES OF VARIOUS NON-TRADITIONAL CROPS (4).

Crop	Area of Adaptation	Uses	Crop Characteristics				Suggested Cultural Practices					Pests/Problems/ Special Requirements
			Plant Height	Maturity Days	Seeds/lb	Test wt lbs/bu	Planting Date	Planting Rate lb/a	Final Plant Population/a	Row Spacing	Plant Depth	
Amaranth	Great Plains	Human, livestock feed	4-8 ft	125-150	650,000	-	70 ^o F soil temp	1-2	120,000	15-30"	1/2"	Poor competitor-slow early growth Lygus bugs Shattering, lodging Pythium Cannot tolerate poorly drained soils Susceptible to triazine herbicides Grain drying necessary Excellent grain quality
Buckwheat	Northern U.S.	Human food	2-5ft	90	15-25,000	48	May-June	40-55	-	6-12"	1/2"-2"	Shattering and lodging Susceptible to numerous herbicides Direct harvest or swath Does well on poor or acid soils
Popcorn	Corn Belt	Human, livestock feed	5-7 ft	100-120	2,500-4,500	65	April-May	-	Dryland 16-24,000 Irrigated 22 - 30,000	30"	1-2"	Seed rots and seeding diseases Stalk and root rots Corn rootworm, wireworms and cutworms Drying or forced air usually necessary (under 100 ^o F) Slower cylinder speeds and wider concaves necessary
Mungbeans	Oklahoma-Texas	Human food, livestock forage and green manure	1-3 ft	60-90	11,000	50	June-July	10-15	-	21-28"	1-2"	Seedling diseases Shattering Needs to be inoculated Swath for harvest Keep fertilizer away from seed
Cowpeas	Oklahoma-Texas Southeastern U.S.	Human food, livestock feed and green manure	1-3 ft	90	3-6,000	60	May-June	12-25	-	Drilled or wide	1-2"	Charcoal rot, root rots Fusariumwilt Cowpea curculio, corn earworm Needs to be inoculated Harvesting procedure depends on how the crop is to be marketed
Guar	Oklahoma-Texas	Food additives Industrial-cloth and paper drying, oil drilling, green manure	2-4 ft	120-140	15,000	60	70 ^o F soil temp	8-10	90-120,000	10-20" 36-40"	1-1 1/2"	Bacterial blight, southern blight Guar midge Needs to be inoculated Drought resistance Direct Harvest Fits well into rotations
Fababeans	Pacific Northwest California	Livestock forage and feed	2-6 ft	100-110	1,000	70	April-May.	150-175	--	6-10"	1-2"	Sclerotinia, pod blight White mold; grasshoppers Shattering Needs to be inoculated Responds to irrigation Swath for harvest
Lupines	Gulf Coast states	Livestock forage, green manure	1-2"	75-90	1,500-2,000	60	Feb.-Mar.	90-150	--	Drilled	2-4"	Winterkill; Phytophthora root rot Bitter type contains alkaloids Needs to be inoculated Requires vernalization to produce grain Does well on sandy, well-drained acid soils

APPENDIX (CONTINUED): PLANT CHARACTERISTICS, USES, AND PRODUCTION PRACTICES OF VARIOUS NON-TRADITIONAL CROPS (4).

Crop	Area of Adaptation	Uses	Crop Characteristics				Suggested Cultural Practices					Pests/Problems/ Special Requirements
			Plant Height	Maturity Days	Seeds/lb	Test wt lbs/bu	Planting Date	Planting Rate lb/a	Final Plant Population/a	Row Spacing	Plant Depth	
Millet	Central Great Plains	Livestock forage & feed	2-4 ft	75-90	220,000	50	June-July	10-20	60-90,000	6-12"	<1"	Poor seedling emergence & vigor Birds, kernal smut & head smut Cinch bugs, green bugs Drought tolerant Needs warm soils Sensitive to cool temperatures during heading
Foxtail		Birdseed	2-4 ft	60-90	80,000	56		5-15				
Proso Pearl		Human food (grain type) (forage type)	3-6 ft	75-100	85,000	56		3-6				
Sainfoin	Northwest U.S.	Livestock forage	1-2 ft	Perennial	25,000		Fall & Spring	25-30	1- pits/sq ft	Drilled	1-1½"	Only 1 cutting with slow regrowth; Crown rots Needs to be inoculated Does well on heavy soils with pH of 7.0-8.0
Broomcorn	Central Great Plains	Brush for brooms	6-12 ft tall 3-6 ft dwarf	90-130	25,000	44-50	April-June	2-4	18-40,000	30-36"	1-2"	Considerable hand labor Cinch bugs, green bugs and other sorghum insects and diseases Standard and dwarf types
Kenaf	Southeastern U.S. and Central Great Plains	U.S. textile fiber	8-20 ft	Full season	18,000		May	6-8	75-100,000	20-30"	½-1"	Root knot nematode, Rhizoctonia, Gray mold Will not tolerate standing water or waterlogged soils Fast growing and competitive
Kochia	Great Plains	Livestock forage	2-4 ft	Frost			May-June	4-8	52-150,000	drilled	¼-½"	Contains sodium & potassium oxalates; nitrate poisoning may occur Grazing cattle may develop sore eyes and noses Requires several clippings to keep plant from becoming too stemmy and fibrous
Comfrey	Northern & Northeastern U.S.	Livestock forage	2-4 ft	-	-	-	April-May	-	-	30-48"	2-4"	Inferior crop quality and yields Grazing destroys plants Ensiling difficult due to high moisture content Propagated vegetatively due to poor seed yields Root cuttings should be 1½-6" long
Cotton	Southern U.S.	Fiber, vegetable, and industrial oil	2-4 ft	120-130	4,000	28-33	May-June.	15-25	50-70,000	30"	1-3"	Rhizoctoria, Phythium, Fusarium Extremely sensitive to 2,4-D Specialized harvesting equipment needed
Sesame	Southwest U.S.	Edible & industrial oil Confectionary (seed)	3-5 ft	90-120	160,000	37	70°F soil temp	1	40-50,000	20" or wider	1-2"	Poor competitor; frost injury Bacterial & fungal leaf spots; Charcoal rot; fusarium & Verticillium wilt; Aphids, thrips & stink bugs Requires 150 frost free days Contract market Shattering & non-shattering varieties Drought tolerance Can be irrigated
Safflower	Western U.S.	Edible & industrial oil	2-5 ft	110-150	8-13,000	45	60°F soil temp	15-40	130-170,000	6-12"	1-2"	Poor competitor for 3-4 weeks Does not tolerate standing water Rust, Verticillium wilt & Phytophthora root rot Plant early Moderately drought tolerant Good standability Salt tolerant Can be irrigated

APPENDIX (CONTINUED): PLANT CHARACTERISTICS, USES, AND PRODUCTION PRACTICES OF VARIOUS NON-TRADITIONAL CROPS (4).

Crop	Area of Adaptation	Uses	Crop Characteristics				Suggested Cultural Practices					Pests/Problems/ Special Requirements
			Plant Height	Maturity Days	Seeds/lb	Test wt lbs/bu	Planting Date	Planting Rate lb/a	Final Plant Population/a	Row Spacing	Plant Depth	
Flax	Northern Great Plains	Industrial oil, fiber	1-3 ft	90	82,000	56	March-April	35-50	-	6-8"	¾-1 ½"	Poor competitor Fusarium wilt, rust, pasmo & aster yellows; cutworms, wireworms, grasshoppers Do not plant on poorly drained soils. Frost injury during seedling stage Plant early Crop rotation required Not salt tolerant Direct harvest or swath
Sunflower	Great Plains	Edible oil, Confectionary (seed)	3-7 ft	90-100	5-8,000	24	April-July	-	15-25,000	30"	1-3"	Sclerotia, Rhizopus head rot, Phoma black stem, head moth, head clipping weevil, stem and root weevil Can be planted as full season or doublecrop Responds to irrigation Extensive root system Crop rotation needed
Crambe	Canada & Northern Great Plains, Midwest Southeast	Industrial oil	3 ft	120	86,000	27	April	8-15	650,000	6-14"	½-1"	Lygus & cabbage maggot Very few pest known Seed shattering Direct harvest or swath Can be irrigated
Rape Brassica napus Brassica campestris	Canada & Great Plains	Industrial & edible oil	21/2-5 ft	280 80-90	160,000 240,000	50	Aug.-Sept. Feb-March	3-8	-	6-14"	¾-1½"	Poor competitor Blackleg, Sclerotinia, flea beetle Seed shattering Plant early to insure winter survival Needs well-drained soils, Swath for harvest Crop rotation required to prevent diseases Some potential for forage
Meadowfoam	Pacific northwest	Industrial oil	1-1 1/2 ft	July	-	-	Sept-Oct	30-40	-	6-7"	¼-½"	Shattering Adapted to poorly drained soils Requires insect pollination Swath for harvest
Castor bean	Southern & Southwestern U.S.	Industrial uses	3-5 ft (dwarf varieties)	125-150	1,000	50	April-May	10-15	-	>30"	1-3"	Alternaria and bacterial leaf spot Cotton root rot, southern blight Cutworms and wireworms Seeds contain ricin (poisonous) Direct harvest Responds to irrigation, but excessive Water will hurt yields Requires 140-160 frost free days

