Choosing Among Alternative Crops

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"When it comes to alternative crops, it seems there are at least two schools of thought. On one hand, some are convinced that we now have all the crops we need. When a new need arises, breeding and biotechnology are suggested to alter an existing crop. Soybeans with an altered fatty acid profile, or corn with a different starch are examples of such efforts. The benefits of such an approach include avoiding time consuming domestication efforts which usually accompany the development of new crops. Also, if the 'new' crop is really just an 'old' crop, the infrastructure already exists. Farm equipment is already designed, pesticides are already registered, crop insurance is available, and often government support programs apply towards production.

Another approach argues that, of all the plant species available globally, using only a dozen or more in agriculture is asking for trouble. Though future fields may consist of several variations each of corn, soybeans, and wheat all aimed at distinctly different markets and end uses, the landscape will still react as though it were simply corn, soybeans, and wheat. Such a system would possess a brittle ecology which might snap under the environmental pressure of maintaining so few species. This approach calls for a renewed effort at increasing the numbers and diversity of crops grown. . . (1)"

Long has the development of new crops been a vital part of North Dakota State University. In the heart of a continent with cold winters and warm summers having short nights, long warm days, and sufficient rainfall to nurture a crop without undue disease or insect pests, North Dakota has the capability to grow a wide diversity of annual temperate crop plants. Though North Dakota produced spring cereal grains on well over half of all cropland during 1993, the remaining acreage was divided up among more than 50 commercially produced crops (2). With a limited ability to support all these crops with a research and education program, setting priorities on the emphasis and direction of new crops research is vital to achieving success.

Marketing Approach

One of the more common approaches in deciding which new crop deserves an investment in research and development is listening to the marketplace (3). Agriculture is used to thinking in terms of providing food, fuel, and fiber, but the boundaries of those terms are being stretched beyond traditional definitions. New uses for agricultural crops now include providing the feedstocks for manufacturing of nylons, plastics, paints, lubricants, composite building materials, and just about any other consumable item. Our rediscovery of agriculture's capability of renewable production has spawned wide interest in new products and markets for agricultural goods (4).

While some of the enthusiasm of agriculture's new uses comes from the potential of new crops, most of it is aimed at developing 'new' uses for 'old' crops. Portable fuels such as ethanol from corn and printing ink from soybean oil are but two of the successfully commercialized new uses from crops widely produced. Such market development helps stabilize and diversify demand for these crops. It also makes use of many of the advantages mentioned in the opening quote — it builds on an already existing infrastructure. North Dakota State University is working on developing several new uses from our traditional crops in a campus-wide effort. To be successful, these research programs must listen carefully to the marketplace, then return to the basics of chemistry, biology, and physics on the lab bench.

Ecological Approach

Rather than start with anticipating the needs of the consumer, an ecological approach to choosing alternative crops begins with the crop producer. Farmers are in need of practices which do a better job of conservation at a cheaper cost. Over the long-term, crop rotation is one of the oldest and most effective crop production practices available to control weeds, insects, diseases, and help manage soil fertility. Yet, since the wide-spread use of fertilizers and pesticides, crop rotation seems to have lost much of its meaning. Though wheat/soybean and wheat/barley are both two-year rotations, they differ greatly in impact. Generally, the best rotations are those with the most dissimilar of crops in the most complementary of sequences. North Dakota farmers, particularly in the western and central parts of the state, are in need of a greater diversity of economical crops to grow.

Despite the obvious need, field production research with alternative crops, if not market driven, is often driven by fad, curiosity, personal interest, or other reasons which may not be the most reliable. Using an ecological approach to classify key characteristics of the current and possible new crops might help direct effort towards those crops which may best contribute to the overall cropping system. The growth habit, botanical classification, nutritional impact, and temperature adaptation are four crop characteristics which might first be used to identify the most urgently needed new crop candidates (Table 1).

Growth Habit

A crop's growth habit refers to its life cycle and relationship to the growing season. Most North Dakota crops are annuals, planted in the spring and harvested from late summer through fall. Other growth habits include perennials such as alfalfa, biennials such as sweet clover, and winter annuals such as winter wheat or rye. Though harsh winters limit the number of crops grown that are not annuals, crops of these other growth habits are valuable for their ability to spread the workload at planting, for being competitive with weeds typical in a rotation of annuals, and for conserving the soil through winter cover. Development of a greater number of winter annual, biennial, and perennial crops would help complement the large number of annual already grown.

Botanical Classification

Grouping crops by their botanical classification helps identify sets of crops with common characteristics, often including susceptibility to certain diseases and insects. Most North Dakota crops are either monocots or dicots, commonly referred to as grasses or broadleaves. Just as many grasses share similar diseases, so do many broad-leaved crops. Important differences also exist within each of these broad classifications. For example, some common diseases are shared between wheat and barley, but not wheat and oats. Identification and development of the underutilized botanical types as crop plants would contribute to a more integrated approach to pest management. Both new grass and broadleaved crop plants are needed.

Nutritional Impact

Some crops have the ability to provide a portion of their own fertility needs. Legumes have the ability to carry on biological nitrogen fixation, which fixes nitrogen from the atmosphere, lessening the need for nitrogen fertilizers. Legumes grown in rotation as grain, hay, companion, cover, and green manure crops have varying abilities to provide fertility to crops which follow. Beyond the nitrogen benefits of legumes, other crops have been observed to have an influence on some aspects of mineral nutrition, but have yet to be fully understood. A good example is the impact of buckwheat on the availability of soil phosphorus. Many farmers and some limited research reports from China have inferred a positive impact from buckwheat when grown in rotation.

Temperature Adaptation

Within a farming region, most crop plants are observed to have an optimum planting date and thus a temperature of best adaptation. Even within North Dakota's short growing season, 'cool' season crops, such as wheat, barley, and oats perform best when planted early, while dry beans, corn, and millet perform better when planted later to mature during the warmest part of the summer. Alternating cool and warm season crops in rotation helps keep any specific weed species from becoming overly competitive with the crop. A greater number of adapted warm season crops would be beneficial across the state.

A Combined Approach

While both the marketing and the ecological approaches in choosing among new crop candidates are valid, certainly the wisest approach is to use these in some combination. Sometimes an alternative crop fits both criteria. No doubt the recent success in commercializing crambe in North Dakota was due to the beginning of an industrial vegetable oil market and an oilseed processor willing to contract, process and market the crop. But, farmers would not have been as willing to try the unknown had crambe not been naturally resistant to flea beetles and many other insects, required fewer inputs than sunflower, left a manageable stubble resistant to erosion, and had a positive yield effect on the wheat crops which followed.

Unlike crambe, other alternative crops usually have some deficiency which requires additional research effort before farmer adoption. Millet, winter rye, and leguminous forages offer tremendous diversity ecologically, but have small markets. Conversely, waxy hulless barley, hard white spring wheat, and sweet corn may at some time command premium markets, but provide little in the way of ecological advantage in rotation.

To succeed in agriculture in the future it may not be enough to simply produce, but produce in the cheapest and most environmentally sound way possible. Choosing new crops with a promising marketing outlook can help insure immediate demand, while new crops with advantagous ecological characteristics help contribute to the stability and long-term cost of maintaining the crop production system. Both are important in keeping North Dakota farms productive and profitable long into the future. The diversity of crops needed for tomorrow, however, requires that research priorities and direction be carefully chosen today. Using both a marketing and ecological approach to choosing new crop candidates should be among our strategies.

References

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Table 1. Traditional and potential new crops for North Dakota and some fundamental ecological characteristics [adapted from (5)].

Common Name	Scientific Name	Growth Habit[1]	Botanical Class[2]	Nutritional Impact[3]	Temperature Adapation[4]
Alfalfa	*Medicago sativa* L.	P	B	N	—
Amaranth	*Amaranthus spp.*	A	B	—	W
Barley	*Hordeum vulgare* L.	A	G	—	C
Bean, field	*Phaseolus vulgaris* L.	A	B	N	W
Beet, sugar	*Beta vulgaris saccharifera* L.	A	B	—	C
Buckwheat, common	*Fayopyrum esculentum* Gaertn.	A	B	P	W
Camelina	*Camelina sativa* L.	A	B	—	C
Canary seed	*Phalaris canariensis* L.	A	G	—	C
Canola	*Brassica spp.*	A	B	—	C
Chickpea	*Cicer arietinum* L.	A	B	N	W
Clover,					
red	*Trifolium pratense* L.	P	B	N	C
sweet, white	*Melilotus alba Med.*	B	B	N	C
sweet, yellow	*Melilotus officinalis* Lam.	B	B	N	C
white	*Trifolium repens* L.	P	B	N	C
Coriander	*Coriandrum sativum* L.	A	B	—	C
Corn or maize, dent	*Zea mays* L.	A	G	—	W
Corn or maize, sweet	*Zea mays saccharum* L.	A	G	—	W
Cowpea	*Vigna sinensis* Endl.	A	B	N	W
Crambe	*Crambe abyssinica* Hochst	A	B	—	C
Crownvetch	*Coronilla varia*	P	B	N	—
Emmer	*Triticum dicoccum* Schrank	A	G	—	C
Fababean	*Vicia faba equina* Pers.	A	B	N	C
Fenugreek	*Trigonella foenum-graecum* L.	A	B	N	W
Flax	*Linum usitatissimum* L.	A	B	—	C
Hemp	*Cannabis sativa* L.	A	B	—	W
Lathyrus	*Lathyrus sativus* L.	A	B	N	C
Lentil	*Lentilla lens*	A	B	N	C
Lupine, blue	*Lupinus angustifolius* L.	A	B	N	W
Lupine, white	*Lupinus albus* L.	A	B	N	W
Lupine, yellow	*Lupinus luteus* L.	A	B	N	W
Millet, foxtail	*Setaria italica* (L.) Beauv.	A	G	—	W
Millet, pearl	*Pennisetum glaucum* L.	A	G	—	W
Millet, proso	*Panicum milaceum* L.	A	G	—	W
Mustard	*Brassica spp.*	A	B	—	C
Oats, common	*Avena sativa* L.	A	G	—	C
Oats, red	*Avena byzanitina* C. Koch	A	G	—	C
Pea, field	*Pisum sativum* L.	A	B	N	C
Potato	*Solanum tuberosum* L.	A	B	—	C
Quinoa	*Chenopodium quinoa* Willd.	A	B	—	W
Rape, oilseed	*Brassica spp.*	A	B	—	C
Rye	*Secale cereale* L.	A;WA	G	—	C
Safflower	*Carthamus tinctorius* L.	A	B	—	W
Sesame	*Sesamum indicum* L.	A	B	—	W
Sorghum (milo)	*Sorghum bicolor* (L.) Moench	A	G	—	W
Soybean	*Glycine max* Merrill	A	B	N	W
Spelt	*Triticum spelta* L.	A;WA	G	—	C
Sudangrass	*Sorghum bicolor drummondii*	A	G	—	W
Sunflower	*Helianthus annuus* L.	A	B	—	—
Triticale	*Triticum spp.*	A;WA	G	—	C
Vetch, hairy	*Vicia villosa* Roth	WA;B	B	N	C
Wheat, common	*Triticum aestivum* L.	A;WA	G	—	C
Wheat, durum	*Triticum turgidum* L.	A	G	—	C

[1] Growth habit classified as A = annual, B = biennial, P = perennial, WA = winter annual
[2] Botanical classification either as B = broadleaves or dicots, G = grasses or monocots
[3] Nutritional impact is indicated with the mineral altered, N = nitrogen, P = phosphorus
[4] Temperature adaptation classified either as W = warm season, or C = cool season crops