DIVERSIFYING AGRICULTURE WITH ALTERNATIVE CROPS

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Summary

Cropland diversity has diminished with the advent of mechanized agriculture. In some cases, a single crop is grown year after year in the same field. The lack of diversity in crops rotated in a field has allowed pests to build up, reduced yields, and in some cases increased soil erosion and reduced soil quality. Recognizing these problems, efforts are underway in many farming regions to add more diversity to mechanized cropping systems. In some cases, a well-known commodity crop, such as a small grain, can be added to the rotation. However, there is great opportunity for agriculturalists to employ new or alternative crops. While some of these alternative crops were domesticated by earlier civilizations for food use, many of these crops have multiple uses. Oilseeds, for example, can serve as a source of many renewable products that replace petroleum derived materials. Cereal grains are good sources of starch based materials, and are vital to human and animal diets. Alternative legumes can improve the soil and are good sources of protein. Other crops with non-food uses include fiber and bioenergy crops. Although many of these alternative crops need further research and development to be commercialized widely, taken as a group they offer an excellent set of choices for diversifying cropland around the world.

1. Introduction

Diversification of the agricultural landscape can be a key strategy to improve sustainability. Although some farming regions, such as fruit and vegetable growing areas, are already diversified, there are many farmers dependent on just one or two crops. Of the roughly 90 million hectares of land in the U.S.A. planted to annual crops

(not forages or pastures), almost 80% is planted to just three crops: corn, soybeans, and wheat. A similar lack of diversity occurs in many areas of the world where mechanized "modern" farming has taken hold.

Agricultural systems throughout human history have tended to be much more diverse than present mechanized farms, while non-mechanized types of present day agriculture usually include many plant species. There are probably several reasons why we have evolved to the present system. One factor has been the increased specialization and cost of farm machinery, though it is worth noting that many alternative crops can be grown with present farm equipment. More significant factors in the move towards monoculture agriculture include the lack of marketing options, the extensive research support for traditional crops, and the emphasis in government programs on commodity crops.

As the international agricultural marketplace has become more dominated by large companies, there has been increasing pressure on grain buyers and processors to handle relatively few crops. New processing plants are often built to serve just a single crop, despite the fact that many seed crops can be processed in a very similar fashion. For example, soybean processing facilities can often be modified at reasonable cost to handle other oilseeds.

Fortunately, many farmers and agricultural agencies are beginning to recognize the value of cropland diversification. There are a number of benefits of diversification that contribute to economic, environmental, and social sustainability, as described below. There are a wide variety of underutilized plants with economic potential, some domesticated and some wild, that can be part of a diversification strategy. Some of these crops are briefly described here, with an emphasis on those that can be grown with conventional grain crop equipment. The crop descriptions are organized into general groupings such as oilseeds and legumes, with brief mention of alternative fiber and energy crops as well.

2. Benefits of Diversification

Although there have been a few efficiency gains by growing just a few commodity crops, there are many benefits from diversification, often with little loss in efficiency. The most powerful diversification motive for many farmers is the opportunity to gain additional income by growing a new or alternative crop. Although yield on a pound per acre basis may not be as high for most alternative crops, the price per pound is often higher than the commodity crop. For some specialty crops, such as fruits, vegetables, ornamental, or nut crops, the income per acre can be dramatically higher, though the down side is frequently more intensive labor demand. If the potential gross income is not higher for the alternative crop, the production cost may be lower. For example, adding legumes to a rotation can reduce the need for costly nitrogen fertilizer, and rotations including three or more crops usually have much less pest problems, which reduces pesticide needs. On the negative side, post-harvest transportation costs are often higher since markets are usually more distant. Other benefits of diversified cropping systems can include increased erosion control and reduced risk from extremes in weather conditions or market prices. A summary of the main characteristics of several crops, with potential for more widespread use, is presented in Table 1.

Scientific name	Common name	Primary use(s)	Origin	Relative Yield	Relative Value
Oilseeds					
Brassica spp.	canola	vegetable oil	Europe	high	medium
Helianthus annus	sunflower	vegetable oil, birdseed, snack food	N. America	high	medium
Carthamus tinctoria	safflower	vegetable oil, birdseed	Middle East	medium	medium
Linum usitatissumum	flax	wood preservative, food, fiber (linen)	Europe	low	high
Camelina sativa	camelina	industrial oil	Europe	low	high
Guizotina abbysinica	niger	food, birdseed	Africa	low	high
Sesamum indicum	sesame	food, vegetable oil	Middle East	low	high
Crambe abyssinica	crambe	slippage agent	Mediterranean	medium	medium
Lesquerella fendleri	lesquerella	lubricants*, constiuent of plastics*	N. America	low	high+
Limnathus alba	meadowfoam	cosmetics, biological pest control*	N. America	low	high
Simmondsin chinesia	jojoba	cosmetics, lubricants	N. America	low	high
Vernonia galamensis	vernonia	paints*, coatings*	Africa	low	high+
Cereal grains					
Pennisetum americanum	pearl millet	livestock feed, food crop, forage	Africa	high	low
Panicum milaceum	finger millet	food crop, potential forage	Africa	low	na
Setaria italica	foxtail millet	food crop, birdseed, forage	China	medium	low
Eragrostis tef	teff	food crop, forage, temporary cover crop*	Africa	low	high
Echnichloa crusgalli	Japanese millet	food crop, wildlife planting	Asia	medium	medium
Panicum ramosum	browntop millet	food crop, wildlife planting	Asia	medium	medium
Triticosecale X	triticale	food crop, livestock feed	wheat/rye cross	medium	medium
Fagopyrum esculentum	buckwheat	food crop, used as whole groats or flour	Russia	low	medium
Amaranthus spp.	amaranth	food crop, forage, leafy vegetable	Mexico	low	high
Chenopodium quinoa	quinoa	food crop, leafy vegetable	S. America	low	high
Legumes					
Phaseolus vulgaris	beans	food crop, both dry seed and green vegetable	C. America	medium	high

Vigna unquiculata	cowpea	food crop, forage, wildlife and cover crop	Africa	high	medium
Vigna radiata	mung bean	food crop, dry or green seed, sprouts	India	medium	medium
Vigna angularis	adzuki bean	food crop, confectionary foods	Asia	medium	high
Cyamopsis tetragonolobus	Guar	guar gum as food stabilizer, thickener	India	medium	medium
Cajanus cajun	pigeon pea	food crop, forage	India, SE Asia	medium	na
Lupinus spp.	Lupine	livestock feed, forage, green manure	Mediterranean	high	medium
Vicia faba	fava beans	livestock feed, food crop	Mediterranean	medium	medium
Cicer arientinum	chickpeas	food crop	Mediterranean	medium	medium
Fiber crops					
Hibiscus cannabinus	Kenaf	paper, other fiber products	Africa	very high	medium
Cannabis sativa	Hemp	fiber from stems, oil from seed	Asia	high for fiber	medium
Crotolaria juncea	sunn hemp	cordage, paper, other fiber products	India	high	medium+
Asclepias syriaca	Milkweed	substitute for goose down fill	N. America for commercial types	low	high

*Uses with an asterik are those for which there is a potential market, but the market is not yet commercially established.
+The crop has a good potential value per unit weight, but did not have established markets in western countries at the time this article was written.

Table 1: Summary list of the new or alternative crops discussed in this article, including the region the crop originated in and primary uses

Economic benefits. Diversifying the number of crops on the farm, particularly for different markets, such as food vs. feed vs. oilseed uses, can help offset fluctuations in market price for a given commodity area. For example, a corn and soybean producer would find the market for both crops closely tied to the demand for livestock feed, while the price of a food crop (such as buckwheat) or an industrial oilseed (such as crambe) might be unaffected. New crops with potential for industrial use can broaden the marketplace for crop use, because they can serve as a source of renewable resources, often substituting for nonrenewable petroleum-based products. Individual producers can sometimes obtain higher profit potential for a new crop compared to a traditional crop, particularly if direct marketing is involved (current examples of this include quinoa and amaranth). Conversion of crop acreage into new industrial crops can reduce surplus production of current commodities.

Environmental benefits. Crop diversification can be environmentally beneficial by reducing the use of pesticide and fertilizer inputs, reducing erosion, and in some cases, minimizing need for irrigation. The pesticide reductions can occur because diversifying a crop rotation reduces pest pressures by breaking up insect, weed, and disease cycles. More diversity of plants in the landscape also provides more opportunity for beneficial insects to develop. Nitrogen fixing crops, such as lupines for grain use, can contribute nitrogen fertility as part of a crop rotation.

Erosion can be reduced by diversifying rotations, planting multiple crops or trees in strips across contours of a slope, and when using a cover crop or winter annual crop like canola that provides vegetative cover on land otherwise left bare and vulnerable to erosion in winter. Many new crops, including millet, amaranth, mung beans, and sesame, have the advantage of doing well under moisture-limited conditions, thus reducing or eliminating the need for costly irrigation.

Community benefits. For rural communities, there are the potential benefits from development of locally-based processing, packaging, or other value-adding activities. Since production of new crops starts on relatively small acreages, processing also begins on a small scale and typically with entrepreneurial input.

This is in contrast to traditional commodities that are usually transported to distant, large-scale processing plants. In a few instances, farm cooperatives have sprung up to develop local processing and marketing for new oilseeds such as crambe and canola. Farms that grow multiple crops also have labor demand spread throughout more of the year, creating better opportunities for on-farm employment.

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Biographical Sketch

Dr. Robert L. Myers is executive director of the Thomas Jefferson Agricultural Institute, a non-profit U.S.A. research and education center formed in 1997 to develop and deliver crop diversification programs. The Jefferson Institute is based in Columbia, MO, but works with farmers and cooperators across the country. Prior to his current activities, he was national director of the U.S.A. Department of Agriculture Sustainable Agriculture Research and Education program. He previously was on the agronomy faculty at the University of Missouri, serving as project leader for alternative crop development. Dr. Myers' work with new crops over the past decade has primarily focused on variety evaluation and production methods, alternative grains, and oilseed crops, such as canola, sesame, sunflower, flax, amaranth, buckwheat, and millets. Dr. Myers has M.S. and Ph.D. degrees in agronomy from the University of Minnesota, and grew up on a family grain farm in the central U.S.A.