Alternative Crops and Crop Production For North Dakota

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North Dakota enjoys the ability to grow many crops, more than most other states in the Great Plains. Yet wheat, barley and sunflower predominate the landscape. Concentrating efforts on a small number of crops has increased yield, mechanized and streamlined field operations, and greatly reduced the labor required to produce a given quantity of grain. These benefits have come at a cost, however. In most instances we've increased soil erosion, increased the risk of disease and other pest problems, and produced an economy reliant upon government subsidies to ease the burden of the few markets available.

To address these problems, a strategy of research and development is needed to analyze the current situation and guide research for long-range solutions. We've begun at the ecosystem level with a comparison of current agricultural practices to the native prairie of North Dakota (Figure 1). While agroecosystems have been managed for less than 100 years in most of North Dakota, the native range has undergone natural selection for thousands of years. Traits found in the prairie could be useful in the field. Though many differences between the two ecosystems exist, the agroecosystems possess three principal differences which might be altered with study:

1) agroecosystems have less plant diversity
2) agroecosystems are predominated by annual plants
3) agroecosystems are controlled externally

A multi-disciplinary team has been assembled to address the possibility of changing these features of an agroecosystem. Thus far scientists from crop and soil sciences, entomology, microbiology, cereal science and food technology, polymers and coatings, economics, and sociology are actively involved. Funding has come from federal, state, and private foundation sources. The activities of all these participants is beyond the scope of this article. Instead, this discussion will focus on the agronomic aspects of two current research objectives — alternative crops and alternative crop production methods.

ALTERNATIVE CROPS

Agriculture exists to provide the food, fuel, and fiber needs of society. These needs are diverse, and yet agriculture often tries to satisfy unique demands with the same product. USDA's Office of Critical Materials has a different approach. They survey industry, documenting current and future necessary materials. The information is then passed to the agronomist for a search for the best plant species which might satisfy the demand. Some of the current industrial needs are for oil and fiber crops.

With the advent of oilseed sunflower, North Dakota has developed a large oilseed processing industry. Market demands for oil, however, vary from edible to industrial oils. Several alternative crops are currently being studied to satisfy these markets.

Canola *(Brassica campestris* or *B. napus)*, a low erucic acid, low glucosinolate rapeseed, has been successfully

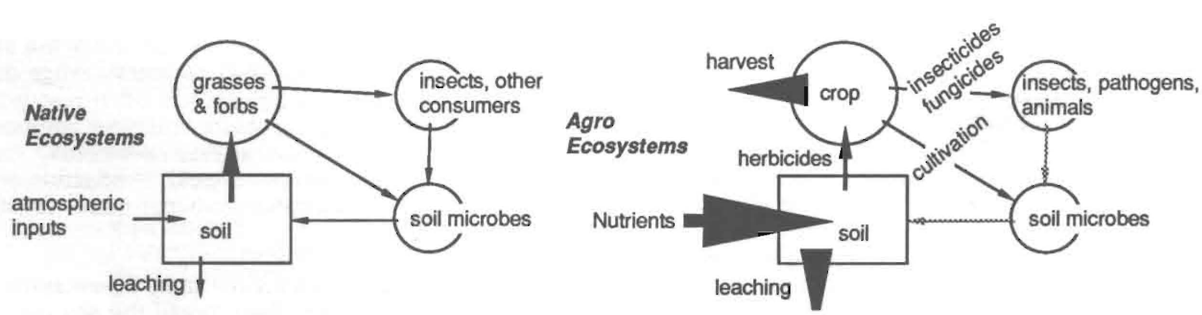

Figure 1. Principal components and resource flow through native and agroecosystems.

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developed and marketed as an edible oil in Canada. U.S. demand for canola oil is also increasing. Current research suggests that canola is best adapted to the northern third of North Dakota. Other areas of North Dakota could compete for these markets with new safflower and sunflower cultivars currently under development.

A renewed interest in flax for use as an edible grain and oil may increase market demand. The possibility of reducing blood cholesterol levels holds promise for additional use of flax in both livestock and human feeds and medicine.

Vegetable oils suitable for replacement of petroleum oils are certain to find a future market. Crambe *(Crambe abyssinica)*, which yields a high erucic acid, has been researched at NDSU since the mid-1960s (Hoag and Geiszler, 1970). It is a drought-tolerant oilseed which can be grown with conventional small grain equipment. It is adapted across most of North Dakota and, unlike oilseed rape, it appears to have good tolerance to flea beetles *(Phyllotreta cruciferae* and others). Uses for crambe oil are under investigation and include coatings, di-electric fluids, lubricants, and use in producing high quality plastics and nylons.

The need for soluble dietary fiber is another market which could be filled with North Dakota grains. Oats are currently in high demand and grown across North Dakota. Barley, specifically bred for beta glucan and without a hull, could satisfy the same need. Such a barley might be best suited to the dry areas of western North Dakota and thus provide an additional market for producers there.

These unique market demands must also be coupled with the needs of North Dakota's agroecosystem. While any new, well adapted crop would diversify crop rotations, certain types of crops could also reduce erosion and cost less to grow. Perennial plant species, the norm of the prairie, could provide such benefits. More legumes, plants which fix their own nitrogen and usually boost yields of subsequent cereal crops in rotation, are also needed.

ALTERNATIVE CROP PRODUCTION METHODS

The addition of new crops to rotations is but one way to increase the diversity of North Dakota's agroecosystem. Another is to develop new methods of crop production with increasing diversity as a goal. Theoretically, increasing the diversity of plant species within a field could reduce insect pests, curb the spread of disease, stabilize production and increase the crops' ability to compete with weeds. These hypotheses are currently being tested through implementation of multiple cropping.

Across North Dakota, sunflower is the crop which attracts the most insect pests. Reducing the populations of those insects attracted to the sunflower at bloom may be one of the possible benefits of strip-cropping sunflower with soybeans. Preliminary observations in 1988 at Carrington revealed no response to insecticide protection at bloom, though the effect may have been dependent upon several hundred acres of neighboring monocropped sunflower.

Strip cropping of sunflower and soybeans also may enhance sunflower yield by the interception of additional radiation. Soybean yields often decrease (Zekend, 1980), but this may be dependent upon the year. In the dry and hot conditions of 1988 at Carrington, stripped cropped sunflower yielded 1,740 pounds per acre with soybeans yielding 20 bushels per acres. The soybeans may have actually benefitted from the cooling provided by the sunflower in 1988.

Intercropping can be a form of strip cropping, but on a smaller scale. It's benefits may include reducing weed competition and disease spread. In better utilizing the resources of water, nutrients and sunlight, it may also be more profitable than monoculture.

Flax, for example, is often not grown because its yield does not compete with that of other crops with similar production costs. Intercropping wheat with flax may provide an alternative production method which could produce flax for little investment. Again, at Carrington in 1988, wheat in monoculture averaged 24 bushels per acre. In combination with flax, wheat yields were decreased to 23 bushels per acre, but an additional 3.5 bushels per acre of flax was harvested. This combination is being studied further to determine the influence on weed competition and potential under higher yielding environments.

Some crop species grown in combination may improve quality and harvestability. Canola or mustard is grown with field peas in Canada. The canola and mustard provide support for the vines of the pea. This support aids in gathering the crop at harvest and in maintaining crop quality by reducing the effects of disease and weathering. In addition, with canola or mustard, peas suffer less mechanical damage as they pass through the combine and grain handling equipment.

Lentils *(Lentilla lens)*, an annual grain legume, often suffers from weed competition and disease problems when grown in monoculture due to its low growth habit and dense canopy. At Carrington in 1988, lentils were interseeded with wheat. Lentil yields averaged only 75 pounds per acre due to dry conditions, but the wheat yields were not reduced from monoculture. Of particular interest was the effect of the wheat on the lentils. Usually matted on the ground at harvest, the lentils were wrapped up in the wheat canopy. This could aid in gathering at harvest and help produce lentils of high seed quality.

Another type of multiple cropping is relay cropping. Unlike traditional double cropping, relay cropping is the sequential seeding and harvest of two or more crops in the same field. Soybeans and dry beans are being studied in combination with winter and spring seeded wheat. The beans are seeded into seedling wheat at normal planting dates. The wheat is direct combined as early as possible and the beans are harvested conventionally. The most potential for this sytem exists in eastern North Dakota or under irrigation where water is not limiting. Even under dry conditions, however, soybeans could provide soil cover and be green manured the following spring, which would better utilize resources than repeated tillage of wheat stubble for weed control.

Beyond the extent of diversity, control of the agroecosystem also differs dramatically from native range ecosystems. In the prairie, flow of nutrients and other resources reaches a steady state among the abiotic and biotic components (Figure 1). In agroecosystems, flow is carefully managed to result in optimum harvested yield. Production of perennial crops is under investigation to better mimic the natural system.

While perennials require the same inputs as annuals, such as nitrogen and water, they spread the acquisition of these needs over a longer period of time. Resource availability and perennial growth thus tend to cycle together. This results in more efficient use of nutrients and water. Unfortunately, perennials also must consume considerable energy to perpetuate themselves. As a consequence, grain yields are usually considerably lower than annuals. Intermediate wheatgrass *(Thinopyrum intermedium)* is currently being studied as a perennial grain (Wagoner et al., 1989). Many other perennial plants have crop potential, including all types of grasses, legumes, sunflower and flax.

Because of yield limitations, perennials may be most quickly adopted as companion crops. Black medic *(Medicago lupulina)* and several other alternative legumes are being investigated as living mulches under annual crop canopies. The requirements of such companion crops are low water use, the ability to perpetuate themselves through self-seeding, and if necessary, ease of control with tillage. A living mulch could provide year around soil cover, which would reduce erosion and fix nitrogen.

In summary, crop production alternatives have long been investigated for North Dakota. Current research initiatives at the Carrington Research Extension Center are guided by an ecosystem level analysis of production constraints. It is hoped that results from these studies will contribute to the economic and environmental security of North Dakota Agriculture.

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physiologists and genetists become cytogenetics. Molecular biology is the current frontier. While agriculture needs answers at these fundamental levels, it also needs a complementary effort at the ecosystem level. The science of ecology has methodologies for studying interactions among all the components of the ecosystem and plays no favorites.

Using the systems approach offered by ecology in agriculture — agroecology — is not a new idea but is one who's time has come. Such a structure cannot only guide the natural scientists through the development of new technologies, but also provides a place for the social sciences. People are part of the ecosystem and place both a monetary and social value on products which flow in and out of the system. Let's scrutinize new technologies through such a team operating from the needed disciplines and up through the agroecosystem level.

This is not a call for an end to our current disciplinary research. It is a recognition of maturity among the agricultural sciences and the need for interaction among all levels of system organization. As the ecologist E.P. Odum puts it, "To understand the forest, we must study the forest; as well as the trees."