NEW USES FOR CORN

Much of the great genetic variation found in corn has yet to be exploited. This implies that much of the increase in genetic yield potential will continue to come from the steady application of proven breeding principles by breeders through selection of improved lines from many crosses. Genetic engineering offers new possibilities for adding genetic traits, but to date most of those changes have been in defensive or compositional characteristics — herbicide resistance, insect resistance, increased and improved nutrient levels, etc. — and not in ways that directly increase yield potential. Research to identify genes that influence yield and how they work, and to harness this technology to increase yield potential is in progress.

Corn as a crop has not changed much in ways that are visible. Hybrids have improved slightly in harvest index as a measure of efficiency (the percentage of total above-ground dry matter to that of the grain), the best hybrids have a harvest index of 50 to 55%. However, large ears need an adequate stalk for support and adequate leaf area to fill grain, so harvest index is likely approaching a maximum that is not a great deal higher than at present. This means that plants with higher net photosynthetic rates or longer duration of leaf area will be needed in order for yields to continue to increase. In Manitoba, producers have exceeded 200 bushels per acre in yield test competition, so it is possible to project future yields in excess of 200 bushels per acre in the more favourable growing areas. There are many different types of corn that vary in physical and chemical characteristics. But the different types generally differ from one another in only one or two genes, so that all types generally require similar management practices.

Hundreds of edible and non-edible products are made from corn and new uses are emerging rapidly. Physical and chemical processes used to break down the grain greatly, increasing the value of the original product. Wet milling and dry milling techniques are used to separate components, which are then further processed. Wet milling, with water and heat, produces cornstarch that is used in industrial applications (manufacture of paper and adhesives) or as a food material (thickeners, extenders, corn syrups, and sweeteners). Dry milling produces corn oil, corn meal (for corn chips, flakes and tortillas), and corn grits for brewing. The whole grain is used to produce whiskey, gin and vodka, ethanol production (blended with gasoline to produce a biofuel) and for manufacturing bioplastics. Corncobs are used in the production of solvents, abrasives and absorbents. Cornstarch is an ideal substrate or food for microorganisms that are used in fermentation processes (pharmaceutical and industrial chemical production). The starches in corn can also be converted using chemical techniques into an assortment of other chemicals. Corn is a domestic renewable resource with value added properties on processing. Special types of corn are produced under contract, to earn a premium, the grain must be kept separate from other types until it is delivered to the market.

Dent and Flint are the principal types of corn. In North America, dent is the principal corn type grown. It is characterized by the indentation in the crown of the kernel caused by the collapse of the central core of the endosperm on drying.

Globally, corn is the most widely used energy supplying feed for livestock, but rations based on corn normally must be supplemented to improve both the quality and quantity of protein. Dent corn contains about 9 percent protein, while swine, beef cattle and poultry rations require 11 and 20% protein; this additional protein must be provided by some other high protein supplement. Although genetic corn stocks are available that contain as much as 27% protein, they generally have lower starch content, which generally means lower yields. In fact, an improvement in the protein content of corn may be of little advantage for non-ruminant animals such as swine and poultry, unless the amino acid balance is also improved. Most of the protein in corn is located in the endosperm, and this type of protein is low in the amino acids lysine and tryptophan, both of which are essential in nutrition of non-ruminant animals, such as swine, poultry and humans. Poultry rations also need supplementation with the amino acid methionine.

HIGH-LYSINE CORN

The term quality protein maize is sometimes used to designate newer, high-lysine corn that is improved in yield and kernel characteristics. They have protein with increased lysine content and are a more complete feed source for livestock. Genetic engineering is being used to improve the balance of amino acids in corn protein by altering proportions of different proteins in the kernel. These new corn types will increase and improve the feed efficiency of livestock.

HIGH OIL CORN

The increased interest in fat or oil high in the polyunsaturated fatty acids for human use has been reflected in the greater use of vegetable oils, including corn oil. Normal corn contains about 4-4.5% oil. Hybrids with 1.5-2 times this amount of oil, and with yields competitive with those of normal hybrids, are commercially available. Feeding trials with swine and chickens show that higher oil content increases feed efficiency. High-oil corn commands a premium in the market, with the premium often based on actual oil content. Equipment for use in testing oil (and protein) content at the elevator has been developed to aid in marketing this grain. More recently, in response for healthier corn (i.e. reduce trans-fats in food high-oleic or low-linolenic oil), hybrids have been developed.

LOW-PHYTATE CORN

Much of the phosphorus in corn grain is stored in the form of phytate, which is digested poorly by monogastric animals (pigs, poultry, humans, etc.) and thus passes through the animal. This results in more phosphorus in the environment, where it can cause nutrient enrichment that stimulates algal growth and thus lowers surface water quality. The phosphorus in low-phytate corn is digested more efficiently, lowering the need to feed supplemental phosphorus and thus producing less phosphorus in the environment.

WHITE CORN

White corn is the principal corn grown for food processing — corn flakes, tortilla, and corn meal. Other food types are waxy corn (amylopectin and amylose). Waxy corn is used in industrial processes or for processing in to edible cornstarch and used as a substitute for tapioca, a product derived from cassava roots. Amylose corn, because of the special properties of the starch, is important in some food products and industrial processes.

HIGH-STARCH CORN

Corn is one of the most efficient crops in converting sunlight energy into energy that is usable by humans and animals. Traditionally, this energy has been used as a feed or food source. But, the recent rapid expansion of the biofuel industry in North America (Manitoba) has industry looking for corn with high yields and high starch content that would yield high quantities of ethanol on distillation. Genetic manipulation and traditional corn breeding techniques are being used to develop these new high yielding and high starch hybrids.

These are examples of the types of dent corn that may proliferate as genetic engineering makes possible large rapid changes in kernel composition. Similar changes will also be possible in amino acid profiles (protein quality) as breeders react to demands for specialty types of corn. The number of possible genetic combinations is very large, and it is likely that many such “designer” corns will be commercially produced in the near future, with opportunities for producers to capture some additional value by growing such crops.

FLINT CORN

Flint corn kernels are hard, smooth and rounded. They have a hard, vitreous endosperm layer that surrounds a small centre of soft starch. The ears are relatively long and slender with a small number of kernel rows. Flint corns were probably grown extensively in North America in Colonial times but are of little importance today.

SWEET CORN

Sweet corn is harvested when kernels are in the milk stage, before much starch deposition, and is used fresh or for freezing or canning. Newer hybrids, especially those for home garden use and fresh market, usually contain one or more genes that make conversion of sugars to starch in the kernels very slow. These types tend to be very sweet, and they retain good eating quality much longer than older varieties due to the inability to form much starch.

POPCORN

Popcorn is essentially a small-kernel flint type. It is used primarily for human consumption as freshly popped or as the basis of popcorn confections. There are two major kinds of popcorn grain — pearl or “hulless”. Pearl popcorn types and the larger “South American” types have rounded, flinty kernels that usually are deep yellow or orange-yellow in colour. “Hulless” popcorns, also sometimes called “rice types”, have pointed, somewhat curved kernels and are usually white.

Currently, most of Manitoba grown corn is used for feed or for distillation — whiskey and ethanol (biofuel) production. But with global warming, it is possible that in the future, some of the specialty corn for industrial and food uses could become important crops in the province.