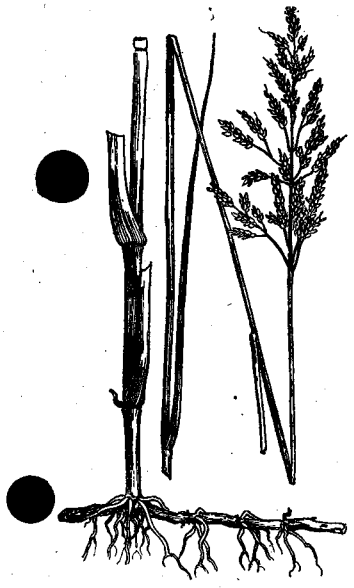
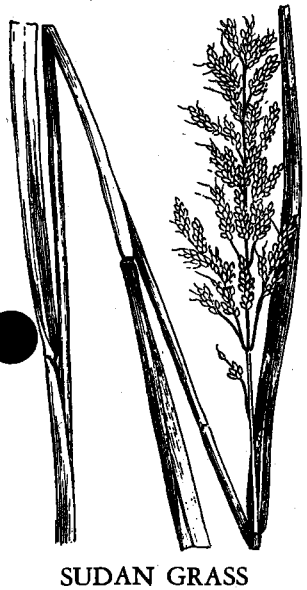
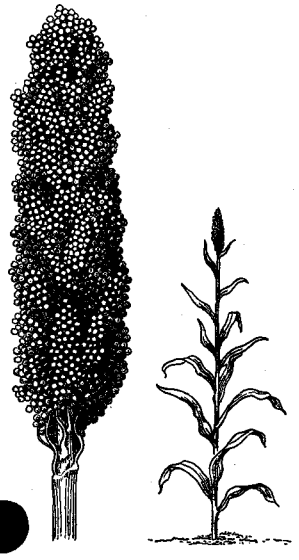


JOHNSON GRASS



SUDAN GRASS



KAFIR CORN

This is the thirty-first in Nature Magazine's series of educational inserts.

Cereals and Kindred Grasses

By E. LAURENCE PALMER

Illustrated by Elizabeth Burckmyer

OF THE many reasons why no one should attempt to write a general article on the cereal grasses and their kin at this time, two stand out as important. One is that our knowledge today of their significance to man is so different from what it was a short time ago that it is difficult to keep up with the times in all respects. Another is that, even if what we wrote here were up to the minute, it might be out of date by the time it got into print.

One of the country's leading nutrition experts expressed the opinion that our knowledge of the nutritive values of cereals was changing so rapidly that no one could hope to write anything in a given month, for publication a month later, with any certainty that it would be up to date.

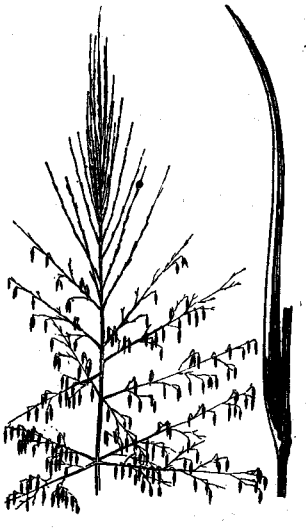
Not many years ago, the chemists and physicists thought that they had reasonably stabilized their concepts as to the nature of matter. Then along came some theories that have changed our whole thinking in that field. The same is true of the cereals and related grasses, whether from the standpoint of those concerned with their nutritive value; of breeders seeking new and more valuable strains; of pathologists developing more disease-resistant strains; of farmers seeking easier ways of harvesting larger crops with less man-power, or of the geopolitician who is attempting to remap a world of peace in which the needs of people in different regions may be satisfactorily met without recourse to war.

While these reasons may discourage some, they also indicate a need for a popular presentation of some of the changes that are now taking place, or have developed recently.

When, in the Revolutionary War, the British forces moved into Philadelphia, John Bartram worried greatly for fear that they might destroy the botanical gardens that he had established near the city. In those days of gentlemanly wars, the British army had been advised by the government in England that one of the things they must not destroy were the collections of Bartram.

When the "super men" of central Europe moved east into Russia, there were no indications that they would respect the researches of the Russians, or preserve those things that contributed to the advancement of civilization generally. They demonstrated this amply in their treatment of the priceless collections in Naples. It is gratifying to learn, however, that when the Germans moved into Minsk they failed to find the results of the researches of a Russian by the name of Zhebrak. Zhebrak and his prized material had already moved to the east. This Russian scientist had managed to cross the the standard hard macaroni wheat, known as *Triticum durum*, with

OATS



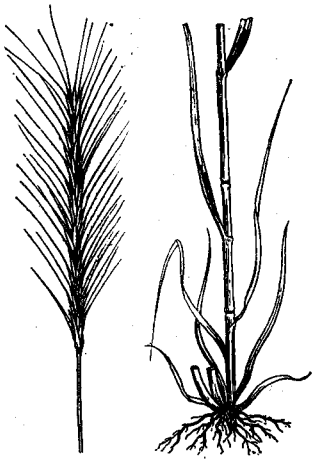
WILD RICE

WHEAT

RICE

BARLEY

SWEET SORGHUM



RYE

a wheat from the Circassian highlands, known as *Triticum timopheevi.* The result was a wheat that he called a hybrid Soviet wheat, *Triticum sovieticum.* This may be interesting to the botanist from an academic standpoint, but it is more interesting to the farmer to note that the grains of this new hybrid weigh nearly three times what ordinary wheat grains weigh.

We are not told in the reports available whether this means that the yield per acre of edible wheat is tripled. We are told that the new wheat is highly resistant to all known fungus diseases. This alone may lead to an increase in yield. We are glad to know, too, that Zhebrak has been working with other crosses that hold promise of considerable importance, and that our American experimenters, using the same *T. timopheevi* and crossing it with our own wheats, are getting valuable results.

The point is that we know how to produce new kinds of plants that may help us live happily ever after. We know so much more than did our workers two decades ago that the possibilities of the immediate future are obviously immense. We have come this far by combining the finding of the specialists. Geneticists, physiologists, nutritionists, cytologists, chemists, physicists, practical millers, and others whose individual interests are highly divergent, have focussed their efforts profitably in the hope of getting more satisfactory food, and getting it more abundantly and more easily—and these are laudable goals.

In the course of these developments, certain general changes must be noted. One might assume that it was always desirable to produce a grain of wheat three times as big as the normal grain. Not many years ago, the slogan of successful agriculture was to make three blades of grass grow where one had grown before. All of this was directed towards increase in bulk. In the last decade, this thinking has been changed. We are now more concerned with the production of foods of a high nutritive value than we are with the production of great volume or weight. If a small grain has the same nutritive value as a grain three times its bulk, the smaller grain may be more desirable in world trade, since it occupies only one-third the shipping space and can therefore be moved more economically. The days of buying anything on the basis of bulk are going, just as are the days of buying things primarily on the basis of their superficial appearance.

We all know the story of beriberi, the painful and fatal disease so definitely associated with those whose diet was largely polished rice. We know how much more satisfactory the whole rice is as a food, even though it does not appeal so much to the eye. The same holds for whole wheat and white bread, and for a number of other things. We are going to judge our foods of the future on the basis of their performance rather than on the basis of their appearance. We should hasten the time when this is more generally so.

It is possible that our scientists may be able to improve the nutritive value of the more attractive foods. We are already doing this in our "enriched" breads, our "enriched" oleomargarines and in other "enriched" foods. If business interests can be kept from dictating too closely the laws passed by our leaders, the time may come when we can have an abundance of cheap, wholesome food that is attractive to the sight, welcome to the palate, and available to everyone. Special privilege, lack of support to research, selfishness and ignorance may postpone the arrival of this millenium, but cannot permanently keep it away.

When the white man came to America, he brought with him many of the plants now grown here. Wheat, barley, rye, rice, oats and the like had long been cultivated in the Old World. To this list, corn was added as a native of America, but none of these plants could compete in yield with those now available to any farmer. The development of hybrid corn boosted the yield of that plant in the Corn Belt in the last two decades possibly more than it had been increased in the previous century. It is absurd to assume that we have reached the pinnacle of production here, or that production should be limited by law until the time comes when any man, here or abroad, who needs corn or other cereals in his diet can get the amount he needs with whatever contribution he is able to make to society in return for it. If the middle-man gobbles up the profits and denies a reasonable profit to the farmer or other producer or processor, adjustments will most certainly be made by an informed public.

Some of the existing public agencies are doing much to develop an informed public. The American Red Cross, for example, issues a booklet—"Food and Nutrition"—that is a masterpiece of what such a popular manual should be. It need not be paraphrased here, but it presents in a superior way the story of the vitamins, calories and other units recognized by

the nutritionist. It does it in a language and form that can be understood by the average intelligent layman. Just as the research specialists combined their efforts to produce a superior wheat plant, so in this little booklet the specialists in teaching of nutrition combined their efforts to reach the public. The result is gratifying. Similarly, excellent literature has been prepared for use by children. For example, the New York State College of Agriculture publishes an excellent bulletin for 4-H Club members entitled "What Foods to Eat and Why." Life insurance companies have contributed useful helps, designed, of course, to extend the premium-paying period of their customers. One cannot, however, give blanket approval to all of the reputed merits of this and that commercial food product advertised in the press and on the radio.

There is no doubt but that the war has stimulated our mastery of many of the problems of an adequate nutrition. We have had to produce compact, adequate rations that can be made available to men who must carry their food supply with them if they are to win battles. We can not move the modern elaborate cafeteria into the foxholes. We have had to show men who were at the front how to recognize and harvest foods from local sources at widely separated places in the world. In most of these cases our men have been able to find some cereal, or some closely-related plant, growing where it can be used to supplement the concentrated foods available in the ration kit. A boy may not recognize the woody plants nearby as being like those at home, but he will recognize wheat and corn and know that they can give him food.

It is true that no one cereal will grow in all parts of the world, but there are few places where man lives where some one cannot be grown, and the area over which they can be grown is being constantly expanded. The Corn Belt is expanding as we get new kinds that can grow in a shorter season, can withstand more heat, or can survive more drought. The same is true of wheat, of oats, of sorghum and of similar plants.

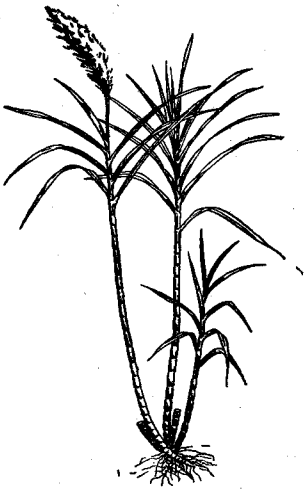
The botanist, no doubt, may resent inclusion of sorghum, sugar cane and Johnson grass in this list, since we do not normally use the fruits of these plants as food. Nevertheless, the plants are grasses, and do yield food to man and beast to a most appreciable degree.

There are some who contend that it is not desirable to increase the yield of plants such as those here considered. They point to the depressions that have accompanied cheap wheat and corn as evidence that production should be limited rather than expanded. Such persons lack the vision needed by those in places of leadership today.

It is certain that we have hardly begun to explore the possibilities of the uses of these plants other than as food. Commercial production of alcohol from cereals, for fuel and industrial purposes, is now negligible. The use of straw in the making of cellulose products is insignificant. The contributions that a rapidly expanding plastics industry may expect from these grasses has barely been explored. Significant new uses of even the old species now raised so generally by farmers the world over may well revolutionize the dependence of civilization on these plants. We may better consider the cereals as providing the "staff of life" if we interpret "staff" to be something on which we may rest our weight.

Cereal crops, when grown continuously, have contributed

DURRA, AND (BELOW, LEFT TO RIGHT) BROOM CORN MILLET, BROOM CORN AND FOXTAIL MILLET



SUGAR CANE

seriously to the depletion of the fertility of our soils. With the continued depletion of many of the rich soils of America by unwise farming and by poor soil control, there will be need for the development of new cereal plants that can maintain the existing yields although the soils available for such crops are much poorer. If we add to this the demands that may arise from newly-recognized uses, then, the need for improvement of the plants is even more urgent. When our natural resources of fuel oil in the petroleum fields have been dangerously depleted, and when it is obvious that these resources cannot be restored, one of the better alternative sources may be the larger grasses that produce a sustained yield that may help meet the fuel needs of civilization. True, we may depend increasingly on power generated by water, but there will always be a high demand for fuels that do their work by oxidation, and the cereals may eventually help greatly in meeting this demand.

Investigations of the importance of the cereal plants in the immediate future will be of many kinds. We have already suggested the improvement of yields by the activities of the geneticists. We have hinted at investigations of industry, seeking new uses and calling for new knowledge about the processing of the plant products. In addition to these, there will be an abundance of new discoveries (Continued on page 424)

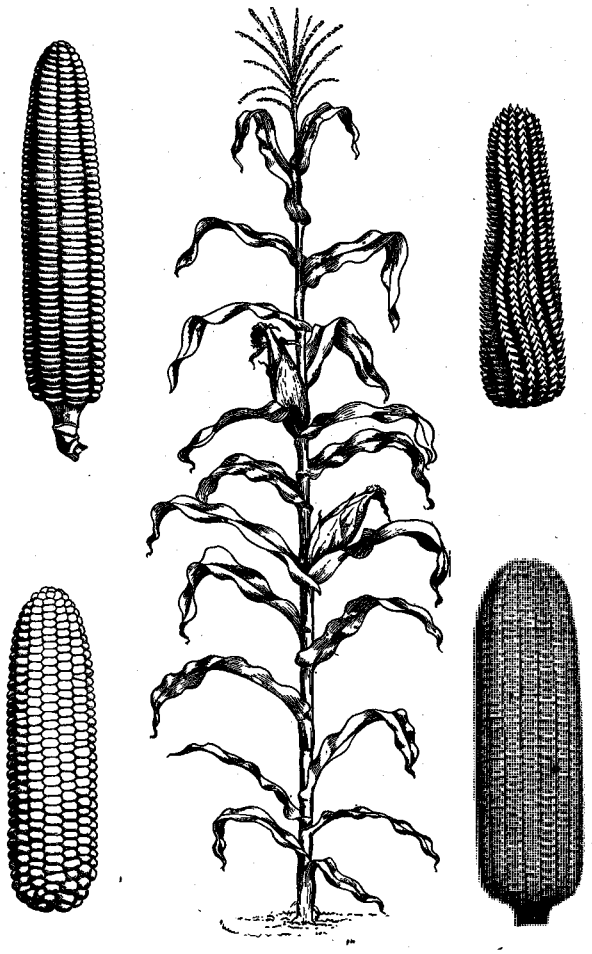
COMMON NAME SCIENTIFIC NAME	SWEET CORN *Zea mays* var. *saccharata*	POP CORN *Zea mays* var. *everta*	FLINT CORN *Zea mays* var. *indurata*	DENT CORN *Zea mays* var. *indentata*
DESCRIPTION	Height: to around 8 feet, intermediate between pop corn and dent corn. Leaves: clasping at the base, curving downward. Roots: fibrous, with special prop-roots near ground.	Height: to 6 or 7 feet, but usually the shortest of the corns. Leaves: smaller than in the other kinds of corn. Roots: in general, similar to type already described.	Height: to 12 feet or more; with stems; coarse, succulent. Leaves: large, mature relatively early and are reasonably hardy and strong. Root systems: sometimes deep.	Height: commonly well over 12 feet with coarse, succulent leaves and stems that are excellent for ensilage and good, strong, sometimes deep root systems that can combat drought.
RANGE	Native of America. Common trade varieties: Golden Bantam and Crosby Evergreen. For early crops, favors well-drained sandy loams; for late crops, a richer, water-holding type.	Native of America but now grown farther north than was the original corn plant. Soil requirements in general similar to those of sweet corn.	Native of America. Flint corn is grown for grain farther north than are the different kinds of dent corn. It requires a deep, rich, sandy loam, with humus and sufficient water for best results.	Native of America. This is the important corn of the Corn Belt and the backbone of the hog and cattle industry. It does best on the deep, rich soils of the long-season mid-West.
REPRODUCTION	Annual. Staminate flowers, in tassels at top of plant. Pollen: wind-blown to "silk" or tip of pistils in "ear" lower on the plant. Mature ear: 5 to 8 inches long. Mature kernel: yellow, wrinkled, horny, more or less translucent. Immature kernel: soft, milky, sweet, edible. Seed to harvest: 90 to 100 days. Kernel is a fruit, achene.	Annual. Flowers: in general similar to those of sweet corn. Number of ears to a stalk may be a hereditary character. Mature ear: 5 to 8 inches long; relatively slender. Kernel: when ripe, hard, smooth, sharp-tipped and crowded into many rows. Hard surface essential to good "popping." Seed to harvest: 90 to 100 days.	Annual. Flowers: in general, like those of other corns. Ears: long, slender, generally yellow-brown when mature. Favored varieties are Hall's Gold Nugget and King Philip. Kernels: smooth and hard on the top, closely crowded on relatively slender cob. Seed to harvest: about 90 to 100 days, or a relatively short season.	Annual. Flowers: in general, like other corn flowers. Ears: relatively short and thick, with cob proportionately small but actually large. Kernel: indented on the top, yellow, white or red. Requires 145 days, or more, from seeds to harvest.
CULTURE AND ENEMIES	Kernels planted in hills 3 feet apart, 3 to 4 per hill, 1 or 2 inches deep, after frost danger. Planting at 2-week intervals prolongs harvest. Cultivate at least 4 times when soil is dry; first deep, then shallow after roots develop. Animal enemies include grasshoppers, earworms (in South), wireworms; plant enemy, corn smut.	Kernels are planted in hills or rows, 3 feet apart. About 5 kernels to a hill, to depth of 1 or 2 inches, after frost danger. Cultivate as with other kinds of corn. Pop corn should not be harvested until the kernels are mature but before danger of frost. Keep in well-aired, cool, dry place. Animal enemies much same as for sweet corn.	Kernels planted in hills or rows. If in hills, about 3 to 5 are planted in hills about 3½ feet apart, to a depth of 1 or 2 inches. If planted in rows, there should be about 1 plant to every foot of the row. Planting should be made after danger of frost. Cultivation: as with other kinds of corn. In the East, stalks are harvested for ensilage.	Kernels are planted in hills or rows. If in hills, 3½ feet apart. About 4 to 7 quarts will plant an acre. Planted in rows about a foot apart. Planting after frost danger. For about a quarter of a century, the average yield per acre in the United States was between 25 and 30 bushels. Depends upon man to develop disease-resistant strains.
FOOD VALUE AND ECONOMIC IMPORTANCE	Sweet corn fair energy builder for man and cattle; fair source of calcium and phosphorus for bones and nerves. Used to make alcohol, syrups, gums, starches and oils from fruits. Ton of corn yields about 90 gallons of alcohol for explosives, fuel and other uses. Paper from stalks; explosives from pith; special charcoal from cobs.	As food for man, pop corn is essentially a producer of starches that provide the usual carbohydrate parts of a diet. Pop corn is not normally fed to cattle, although the vegetative part of the plant has some silage value. Cutworms that work at night cut plants off close to the ground. Plant enemy, corn smut.	As food for man, the kernel is fair as a muscle builder (protein); excellent, as a blood builder (iron) and as a maker of energy (carbohydrate); fair for bones and nerves (calcium and phosphorus). It is fair for Vitamin A and good for Vitamin B. In West may be eaten by cattle in the fields. The ears are picked when mature, and stored.	It is not sound economics on a nationwide basis to feed corn to hogs, but it pays the farmers of the Corn Belt. As food for man dent corn is escentially like flint corn, although the volume of dent corn is much the larger.

JOHNSON GRASS *Holcus halepensis*	SUDAN-GRASS *Holcus sudanensis*	BROOM CORN *Holcus sorghum* var. *technicus*	SWEET SORGHUM *Holcus sorghum* var. *vulgaris*	KAFIR CORN *Holcus sorghum* var. *caffrorum*
Height: to 7 feet. With tough, persistent, creeping, sheathing rootstocks. Stems: ½-inch thick, smooth and leafy. Leaves: smooth, with roughened edges, conspicuous midribs, 1 foot or more long and ½ to 1 inch wide. Generally vigorous in appearance. But for perennial rootstock plant resembles sorghum.	Height: to 10 feet, exceeding the similar Tunis grass *H. virgatus*. Leaves: many, up to ½-inch wide. In general much like Johnson grass but without the perennial, spreading, tough rootstocks that make it a pest. The narrower leaves provide an easy superficial identification character.	Two varieties include: Standard, with a height up to 15 feet; and Dwarf, with a height up to 7 feet. Stems: solid and tough. Root system: in general, similar to that of corn, but more likely to be deep rooted.	Height: to 15 feet. Leaves: numerous, and broader than in most of its close relatives. Stem: coarse, pithy and well-supplied with a sweet juice; conspicuously jointed. Root system: much like that of corn, but may be more branching to form a continuous, shallow underground mat.	Some grain sorghums may grow to height of 15 feet. Kafirs are stout, with somewhat juicy stems, crowded leaves, with juice almost sour. Milo sorghum is less leafy than Kafir. Feterita, another variety, reaches a height of 14 feet and is either slender or stout, by some classed as a Durra. (See Durra.) (Hegari is variety figured.)
Native of southern Europe and Asia but now all too firmly established in southern states and elsewhere. Was introduced into United States about 1830 by Governor William Johnson of Alabama and Governor Means of South Carolina with thought that it might provide a superior pasture and hay grass.	Native, coming from South Africa and becoming established as a crop grass in the limited rainfall of our area north to central Kansas. The related Rhodes grass of central Africa does well in the dry soil of the southern part of the Gulf States.	Native of tropical Asia and Africa. Grown extensively in Europe, for the most part in Italy, Austria, Hungary and Germany. In America, Standard is commonly grown in Illinois and adjacent states; Dwarf, in Oklahoma, Kansas and Texas. Requires a fertile soil and abundant moisture. Grown in United States since 1797.	Native of Africa and southern Asia and introduced into America probably about 1875 for serious culture. Among the leading cultivated forms are Amber and Orange. It has been developed from the same species that produced broom corn, durra and Kafir corn. It is important in the South and Southwest. Grown in Egypt before 2200 B.C.	Kafir and most of the grain sorghums are native of Africa, but Kafir is probably the most commonly grown variety in the United States. Grown in India, China, Africa, and in America in the Great Plains area between the Rocky Mountains and the 98th meridian. Texas, Oklahoma, Kansas and Nebraska favor the crop .
Flowering panicle: open, spreading, to 2 feet long, with 2 or 3 branches at a joint, and more or less drooping. Spikelets: in pairs at the joints, or in 3s at the ends each containing one flower that produces a fruit. Grain: free, closely resembles sorghum grain. Spikelets: usually awnless. Blooms: June, July.	Fruiting and flowering cluster of Sudan grass about 1 foot long and half as wide; that of Tunis grass, 2 feet or more long and slender. In both, the spikelets bear awns for the most part and both are annuals. In Sudan grass, the spikelets are usually brown; in Tunis grass, green.	In Standard, the "brush" or flower panicle is 18 to 30 inches long, slender and flexible; in Dwarf, 1 to 2 feet long and much stiffer and broader. The rays or branches of the panicle or brush are naked below, stiff, and arise from almost a common point, but branch at the ends. Spikelets awned.	Flowers are borne in terminal, loose, drooping panicles, with the spikelets showing the protruding red or yellowish-red fruits from between the dark red or black enclosing scales. Amber matures early; Orange later; Gooseneck and Redtop later. Black Amber matures in 85 to 90 days; Red Amber, 90 to 100; Orange Sorgo, 110 to 115.	Mature panicles are compact, dense, crowded with spikelets and with the large grains. Varieties of Kafir include Red, White, Pink and Blackhull. Others have pink grains. The spikelets are loosely hairy, awnless, with the supporting scale about ½ as long as the grain that is broad to spherical. Annual. Pink matures in 110 days.
Thrives on great variety of soils, rich or poor, wet or dry. Does not grow during drought but grows rapidly immediately after rains. Rarely persists where ground freezes to 6 inches. Yields 2 to 4 crops of hay a year which, if cut young, is palatable and nutritious. Does not stand grazing well. Sow 1 to 1½ bushels per acre.	Sudan grass has ornamental possibilities, but its greatest value lies in its forage properties. Being an annual, it yields well to crop rotation practices and while the amount of forage produced may not equal that of Johnson grass, the quality is better and the plant may easier be kept in control.	Standard is planted in rows, 3½ feet apart, with the plants 3 inches apart; Dwarf, in rows, 3 feet apart with plants 2 inches apart. From 3 to 5 pounds of seed are used to plant an acre. In harvesting Standard, the tops of two rows are bent towards each other to form a "table" 2½ feet up.	Seed is planted in drills much like corn, when it is in rows, put rows closer. Broadcast seeding requires 75 to 100 pounds (1.5 to 2 bushels) to the acre; close rows, uncultivated, 50 to 75 pounds; wide rows cultivated, 8 to 20 pounds. It may be planted after corn and yield of forage is higher than with corn.	Kafir was brought to the Great Plains area of the United States about 1875. Commonly drilled into the soil. Provides excellent ensilage and a fair quality of forage. The area devoted to growing grain sorghums of the United States approximates that devoted to rye. From 4 to 6 pounds of seeds are needed to the acre for grain; 50 to 70 pounds for fodder.
Eradication: by prevention of seeding, by pasturing a year or two, then plowing to depth of 3 or 4 inches to expose roots to frost, disking in early summer and then planting to a crop such as cotton that is cultivated, or cowpeas that smother with dense growth. May be poisonous to cattle in dry weather. Hogs relish rootstocks.	It is possible that this plant may prove of increasing value as a crop in areas where water is not sufficiently abundant to support more common crop plants. It probably does not play an important part in wildlife management, but does give a quick hay crop when this is needed.	Raised for the brush, useful in making brooms. A crop of Dwarf should yield 400 to 500 pounds to the acre. It is sold in bales of 300 to 400 pounds of material, cured in layers to 3 inches deep after the seeds have been threshed out.	Raised for fodder, for ensilage, as a smother crop, for a fermented drink, for production of syrup. Sugar production from sorghum is possible but too expensive. As pasturage, is dangerous after frost as there may be poisonous properties developed. This disappears when plant is cured for storage as fodder. Sought as winter food by ducks in some localities.	Grains: used commonly for feeding stock, poultry, and to some extent, humans, the grains being fed whole or crushed. Breakfast foods, pancakes and bread of Kafir, locally common. Stalks: properly cured make excellent fodder. Grain: 16.8% water; 6.6% protein; 3.8% fat; 70.6% carbohydrate; 2.2% ash.

COMMON NAME SCIENTIFIC NAME	DURRA *Holcus sorghum* var. *durra*	SUGAR CANE *Saccharum officinarum*	FOXTAIL MILLET *Setaria italica*	WILD RICE *Zizania aquatica*
GENERAL DESCRIPTION	Durra includes Milo and Feterita, according to some authorities. Stems: slender to mid-stout. Pith: dry. Leaves: 8 to 10. Smaller in all respects than the Kafir, although Feterita may be almost as high. Pith: not sweet. Some durras are mature when no more than 2 feet high. Leaves: commonly break off before maturing.	Height: to 15 feet. Stems: solid and heavy as in corn, with leaves springing singly from the solid joints. Leaves: stiff, to 2 inches broad, and 1 or more feet long, smooth on both surfaces, but sharp on edges, with a prominent midrib, and long tapering point. Sheath of leaf: overlaps and is hairy at the top.	Height: to 5 feet. Stems: smooth, conspicuously jointed, somewhat branched at the top. Leaves: many, broad, flat, long, pointed, to over 1 foot long and to 1 inch wide, rough, with large sheathed bases. Root system: relatively small.	Height: to 9 feet. Leaves: to 2 inches wide, and to 40 inches long, flat, green, and curving backward from the base that sheaths the stem. Roots: relatively short, easily pulled. Two varieties recognized, variety *interior*, of the mid-West, being about 2 times height of the eastern *angustifolium*.
RANGE	Durra is native of the Nile Region in Africa from which we get the varieties most commonly grown. Yellow Milo, Jerusalem Corn and Feterita are all kinds of Durra. Closely related Shallu from India and tropical Africa, and Kaoliang from China and Manchuria, have not established themselves.	Probably native of southeastern Asia. Important sugar producing areas now are British India, Java, Cuba, Hawaii, Puerto Rico, as well as in Africa, Australia and South America. In United States, sugar is produced most abundantly in Florida and Louisiana. It cannot survive where there are killing frosts.	Worldwide in cultivation. Foxtail millet or German millet was said to be one of five species of plants that the Chinese Emperor sowed each spring in a public ceremony established 2,700 years before the beginning of the Christian Era. Other common millets are Hungarian and Japanese millets.	From the mouth of the St. Lawrence to central Manitoba, south to Kansas and Virginia and around coast to Louisiana. Common in shallow water, on muddy shores, or in water to 3 feet deep and in salinity up to 3.5% that of normal sea water. Water salty enough to be tasted is not suitable for wild rice.
REPRODUCTION	Panicle of Durra is compactly oval, erect or goose-necked (bent over). The grains are flat or flattened, large, unlike those of Kafir and are commonly white or reddish brown and are covered by the greenish, strongly-nerved scale at the base. Stems ripen with or before the grain, 72 to 82 days. Total growing period, 102 to 150 days.	Flower cluster: an open panicle, fluffy, 1 to 2 feet long, the little spikelets being conspicuous because of their white, downy tufts of hairs. In agricultural practice, reproduction is by cuttings usually from the tops of the plants. Sometimes, the underground parts are divided and used to start new plants. Perennial.	Flowering panicle compact; interrupted or lobed, heavy and usually purple, yellow or green, to 1 foot long, and to 2 inches wide. Fruits: about 1/16 inch long, smooth, yellow, brown, red or nearly black, egg-shaped, but somewhat flattened on one side. Annual. Matures 6 to 10 weeks after being planted.	Flowers: borne in loose open clusters, at the top of the plant, the uppermost bearing the pollen and the lower ones bearing the valuable fruits. Fruits enclosed in thin, papery, minutely-roughened scales. Flowering takes place in July and August in the northern part of the range. Annual.
CULTURE AND ENEMIES	Durra is smaller than Kafir, less valuable as forage, and earlier, but is better adapted to growing on dry areas particularly where the growing season is short. Plants are drilled so that they will be about 4 to 6 inches apart if grown for grain or forage, with 4 to 6 pounds of seed per acre.	Fields are plowed deeply, even to depth of 2 feet. Stable manure best fertilizer if potash and phosphorus are returned from the sugar-mill trash. Stem sections, 4 tons to an acre, are laid every 2 feet in rows 4 to 6 feet apart and covered with earth and fertilizer. Clean cultivation is necessary. Crop matures in a year.	In United States, millets are grown mostly for forage or in a crop rotation where a quick, green vegetation is needed. Varieties include black-seeded Hungarian grass; red- or orange-fruited Siberian or Turkestan millet; and the yellow-fruited, German or Golden Wonder millet.	One of the most commonly cultivated of the wild foods for game. Usually is planted by broadcasting the fruits in fall or in early spring. Ducks that have fed on wild rice and wild celery are supposed to be superior food for man. Whole grain: 9.5% water; 12.9% protein; 1% fat; 75.2% carbohydrate; 1.4% ash.
FOOD VALUE AND ECONOMIC IMPORTANCE	Durra grows slowly until settled warm weather. It then matures quickly. It is harvested by cutting and shocking and the shocked material is threshed. Durra makes good poultry food and, in some areas, the fields attract ducks for the waste grains left.	One of the most important food plants grown between 33° North and South of equator. Sugar content lost rapidly in first 24 hours, so must be removed near the growing field. Rollers remove 75% of sugar first time. Remainder is removed by further rolling and spraying with hot water. Sugar most efficient energy producing food available to man.	In India, Japan, Korea and China, millet is raised extensively for human consumption, but in America, its place is that of a quick crop to replace an early crop failure, or for forage, or for grains for poultry. It is excellent for planting at field margins and in suitable waste places, as food for certain upland game birds.	One of the more important of foods for most plant-eating wildlife. The fruits and plant parts are eaten but the fruits are most important. They attract waterfowl of all sorts, song birds, upland game birds, muskrats, deer and moose over a wide area for a considerable season.

RICE *Oryza sativa*	OAT *Avena sativa*	WHEAT *Triticum vulgare*	RYE *Secale cereale*	BARLEY *Hordeum vulgare*
Height: to 4 feet. Erect, growing from stools. Fruiting stem: angled, smooth, almost entirely enclosed by sheaths of leaves that are smooth and conspicuously nerved. Leaf blades: long and about ½-inch wide, more or less roughened. One seed will produce several of the erect stems. Over 2400 varieties recognized. Wet and dry land forms.	Height: to 5 feet. A single fruit produces from 3 to 7, erect, jointed, hollow, fruiting stems from a base of fibrous roots. Leaves: numerous, 6 to 12 inches long, and about 1½ inches wide, blue-green, rough, flat, with sheaths that are loose and extend practically from one joint to the next.	Height: to 4 feet. Flowering stems: erect, unbranched, hollow, except at the joints, to ⅛-inch in diameter. Leaves: to 15 inches long, by ½-inch wide, taper-pointed, with a long loose sheath that is finely hairy or smooth. Roots: usually mostly near the surface, but in favorable soils may penetrate to 7 feet, grow in whorls.	Height: to 6 feet. Flowering stems: erect, unbranched, smooth, except near the top, slender. Leaves: to ½-inch wide, long-pointed, soft, nearly smooth, blue-green, many, curved. Roots: fibrous, well-matted. Tallness of rye in fact and in appearance is always characteristic.	Height: to 3 feet. Flowering stems: arising in clumps up to 15 or 20, unbranched, smooth or roughened under the flowers. Leaves: short, long-tapering, pointed, to ¾ inch broad; sheaths, loose and smooth. Leaves: appear broader than in other grains and more conspicuously gray-green.
Has been under cultivation in China at least 4000 years, and as it grows wild in southern China it is probably native of the area. It was introduced into India, then into western Asia, then Europe. It was brought to America for growing in 1694 near Charleston, South Carolina. Average summer temperature above 77°F.	Probably native of central and western Asia. Although early Greeks and Romans used oats for feeding domestic animals, there is little evidence that they were used as long as most other cereals. Early American colonists brought oats. A red-rustproof oat of South was developed from African *A. sterilis*. Grown north to 69° in Alaska.	Cultivated since the first records of history and known to have been grown in China at least in 3000 B.C. It is mentioned in the first book of *The Bible*, and was grown in western Asia, Europe and in northern Africa long before it was introduced into America. It grows to within 200 miles of the Arctic Circle; in mountains at Equator.	Comparatively recent among the cultivated plants. It was not known to the early Greeks and Romans. It probably originated in western Asia and southeastern Europe. It will generally grow on poorer soils than those required by other cereals. It does best on loam soils. Pennsylvania, Wisconsin and Michigan are rye states.	One of the oldest cultivated plants. Carvings on Egyptian tombs show the plant. Mentioned in earlier books of *The Bible*. Probably cultivated as early as wheat and earlier than oats or rye; probably originated in Asia Minor from a form now wild there, *H. spontaneum*. Was brought to earliest Massachusetts and Virginia colonies.
Flowers: in compact panicles. Hull: usually yellowish-brown and the inner grain is white and hard. Rice in the hull is known as "paddy." Without the hull, it is called "cleaned rice." Carolina Gold rice, commonly grown in the Carolinas, has golden yellow hulls; Japan and Honduras rice grown in Texas and Louisiana have yellow-brown hulls.	Fruiting head: an open panicle, to a foot long, bearing from 40 to 75 spikelets, each spikelet usually consisting of 2 or more flowers, of which 2 bear fruits. In some varieties, only 1 fruit is borne in a spikelet, and in some, 3 are produced. Flowers: open for only a few hours, pollination taking place *before* the flowers open.	Flowering spikes: compact, composed of numerous spikelets, with 2 or more flowers in each spikelet. Spikes: to 4 inches long, cylindrical except in some varieties. Fruit: an oblong grain about ¼-inch long that frees itself readily from the enclosing scales and is usually fuzzy at the top. Self-fertilization is the rule. Annual.	Flowers: borne in a terminal spike to 6 inches long, well-awned, narrow, closely-flowered, with the spikelets with two seed-producing flowerlets and possibly one that does not. Flowers: more likely to cross-pollinate than do most cereals. Fruits: about 1.3 inch long, light brown, narrow, pointed, with narrow groove on face, smooth.	Head of flowers: much like wheat. Head: to 4 inches long, densely-flowered, erect, or nodding, with many stout, erect, very long beards that extend far beyond the end of the spike, some being 6 inches long. Fruit: elliptic, about ¼-inch long, short-pointed, smooth, and furrowed the length of the face, usually enclosed in the hull.
Polished rice has about 12.3% water; 79% carbohydrate; 8% protein; .3% fat; .4% ash; and 1630 calories. Unpolished rice has a higher food value. Seed is sown, 1 to 3 bushels an acre in drills, mid-April to mid-May and water is not applied until rice is 8 inches high. Water to 3 to 6 inches is then flooded in until crop is mature.	In most oats, the grain weighs 60% to 75% the total. Early oats ripen in 90 to 100 days; late, in 115 to 130 days. In late April, oats are drilled or broadcast, 2 to 3 bushels an acre this being sometimes harrowed in 2 or 3 times. Yields average around 30 bushels an acre but may reach 200 in Northwest. Hessian fly and a sawfly are the worst insect pests.	About 60% of American wheat, is winter wheat—most of which is of Turkey Red variety. 1½ to 2 bushels are drilled per acre to depth of 1 or 2 inches to mature in about 100 days of growing weather. Fields are harrowed in drilled direction. The worst enemies are rusts and smuts of wheat, chinch bugs and Hessian flies.	Planted in drills or broadcast at 5 to 6 pecks per acre, planted to a depth of 2 or 3 inches, seldom cultivated. Planted in fall or spring but matures in about 100 growing days of the spring. If planted for fall pasture, seeds are sown in August in the North or in September in the South: If for grain, September, in North, October in South.	Types include two-rowed, four-rowed and six-rowed, bearded, hooded, beardless, hulled, hull-less. There are winter and spring forms. Winter barley is less hardy than winter wheat but more so than winter oats. Winter varieties are mostly six-rowed. Almost any barley can survive winter in the South.
United States imports more rice than it raises, but it is not a major rice-consuming country. Rice bran is fed to cattle. Rice straw is made into rice boards, and straw hats, but rice paper comes from mulberry or bamboo. Polished rice lacks vitamins necessary for preventing the disease beri-beri, which in some stages may be cured by eating unpolished grain.	As food for man, are fair for protein; excellent, for minerals and for carbohydrate; and fair, for calcium and phosphorus, the bone and nerve builders. They are fair for vitamin A and good for vitamin B. About 70% of American-raised oats are used on the home farm. Rusts and smuts are serious fungus pests.	The "staff of life" as food for man is fair for protein, calcium and phosphorus and vitamin A; good, for vitamin B; and excellent, for minerals and carbohydrates. An average yield per acre is about 14 bushels but yields to 30 bushels have been reached. Very important crop in southern Canada.	Average production per acre in good states is 20 bushels, although 17 is considered excellent in others. Rye is used to make "black bread" in poorer countries and in northern Europe, as grain to feed hogs and horses in America, and in making alcohol for whisky to man's detriment. About 2/3 goes to animal food and 1/3 to flour, alcohol.	Plant 6 to 10 pecks an acre in drills, late April; expect maturity in 90 to 100 days after harrowing 2 or 3 times in direction of drill. About half crop used in making malt by germinating the seed partly. In Mississippi Valley, important in hog foods. As human food, fair for protein, phosphorus and calcium, excellent for mineral.

(Continued from page 419) associated with the culture of the plants in different areas and with the recognition of the need of farm practices different from those we may have considered standard. We have cut down the hedgerows between our fields of grain and have left the fields bare and windswept. The winter snows have melted on the other man's land and the water table under our grain field has been correspondingly lowered. We may have cut the shrubs along the fence row because of the danger of their harboring certain fungus pests that may have used the hedgerow plants as intermediate hosts. But what good does it do to protect the plant from fungi if we deprive it of the needed water and protection from freezing that may result if the hedgerow is maintained to help hold the snow? The same hedgerow may also serve to gentle the winds and thus avoid undesirable wind erosion of the valuable topsoil. True, it may be unnecessary to use hedgerows to hold snow and soil in large grain-growing portions of the country. But in areas where water supply is critical, and where disease-resistant cereals may be available, a new practice may be developed that has been frowned on in recent years.



TYPICAL CORN PLANT AND, UPPER LEFT, FLINT CORN; LOWER LEFT, SWEET CORN; UPPER RIGHT, POPCORN; LOWER RIGHT, DENT CORN.

This insert is unique in this series in that so far it has dealt primarily with broad policies associated with the organisms under consideration. The detailed significance of most of the plants is to be found in the chart section and need not be repeated here. It may be emphasized that the cereals have an interesting significance in the literature of the world and in man's history. As a matter of fact, the culture of these plants goes back about as far as does the history of any of man's activities. The Bible and all other early literature refer to the plants as being so valuable that they might even be considered the "staff of life." Heads of wheat are represented in the decorative and symbolic art of the earliest humans in the Old World, and corn enjoys a similar antiquity in the Americas. The tribal songs and dances of primitive peoples are directed with surprising frequency to the commemoration of successful crops for the year, or towards an appeal for successful crops for the new season. The need for food from these plants is recognized as being approximately as essential as is the need for success in war, whether we consider the rituals of the early human beings or whether we watch the prices of wheat and munitions in the stock exchanges of the modern world.

It is certain, however, that when the present war is over the first ships sent to carry relief to the unfortunate peoples of the despoiled world will be loaded to the gunwales with the products of the cereal grasses. Anyone who doubts that the arrival of these ships will be less welcome than the arrival of the munitions of war and destruction surely lacks normal imagination. Since it is probable that these plants will undoubtedly play a new role in the economy and thinking of the world in the next decade, it is highly desirable that a generous proportion of our population become more informed on them than is possible to present in the eight pages of this insert. This should be considered as the merest introduction to a group of plants that have been and will continue to be the most valuable of all plants known to man.

Some twenty-five centuries ago, a certain king who had spent much of his life merrily boring out the eyes of his enemies, carving up his favorite soothsayers, and generally making himself unpopular, was, according to the *Bible*, brought to the lowest human level when he was forced to eat grass like the oxen. King Nebuchadnezzar, who was asked by his loving subjects to "live forever" in spite of the way he had treated many of them, need hardly be pitied for the diet he was forced to follow. In fact, there are those in modern times who are suggesting, without intending to be facetious, that we may sooner or later be following his example.

True, our books and our logic tell us that when we eat a nice, juicy steak (assuming that such things still continue to exist), or when we drink a glass of milk, we are merely eating grass that once grew in a field before it was eaten by some domestic bovine. An English agronomist, D. B. Johnstone-Wallace, has suggested that eventually we may be cutting corners in this food business. He has cut fresh-growing grass tips of young plants, dried them quickly, ground them into a flour and baked the flour into cookies. He has reason to believe that the nutritive value of his cookies compares favorably with that of milk. Should the time ever come when our food specialists may be able to get growing grasses to yield directly a food comparable to that now attained by feeding the grass to domestic animals and then extracting it from them, our whole scheme of food economics may be changed. If the products of our farms are to take the place of exhausted resources of our mines and oil wells, it may be fortunate if we can evolve some short cuts that will yield better foods more efficiently. The possibilities here are unique. One thing is certain, changes in our appreciation of the cereals and kindred grasses are as inevitable as they are in anything we might suggest, even though many possibilities have become realities in recent years.