The storage of seed with excess moisture because of rainfall just before harvest may result in the lowering of seed quality or the destruction of the seed. Most distributing organizations have proper storage bins, including facilities for drying moist seed with forced air.

All of the varietal maintenance and production programs we have discussed are efficient and successful. If the farmer plants genetically pure seed of the variety or varieties recommended for his soil and climatic conditions, he is sure he has the best possible seeds.

The production of planting seed of leaf and stem fiber crops is on an experimental basis in the United States. There is no large commercial production of fiber crops other than cotton in the Nation. Flax and hemp are no longer produced for fiber in this country, but seed stocks of the best varieties that have been developed by research agencies are maintained.

Kenaf has shown some promise of being a good substitute for jute in the event of emergency needs. Considerable research on this crop has led to varieties that are high yielding and resistant to some of the major diseases that attack the crop. The seed can be harvested with machines, but the acreage is so small that only limited amounts of seed are maintained.

Other fiber crops—sansevieria, ramie, phormium, and jute—are propagated vegetatively. Research in mechanizing the propagation, growing, and harvesting of some of them is carried out by public agencies.


Rex F. Colwick became Head of Cotton Harvesting Investigations of Harvesting and Farm Processing Branch, Agricultural Engineering Research Division, at State College, Miss., in 1959.

Producing and Harvesting Seeds of Oilseed Crops

J. O. Culbertson, H. W. Johnson, and L. G. Schoenleber

The leading oilseed crops grown in the United States are soybeans, peanuts, flaxseed, safflower, castorbeans, and sesame. A large amount of oil is obtained from cottonseed, but cotton is a fiber crop, and we do not consider it here.

The seeds and oil from them have many uses.

Soybean oil is used in margarine, shortening, paints, varnishes, and other industrial products. Although soybeans are generally classified as an oilseed, the monetary value of the protein, or meal, equals or exceeds that of the oil.

Peanut oil is used for edible purposes. Nearly all linseed oil from flaxseed goes into the manufacture of paints, varnishes, and linoleum.

Safflower oil is used primarily as a drying oil, but an increasing amount is being consumed in edible products. The major uses of castor oil are as a drying oil and for hydraulic fluids.

Nearly all the sesame grown in this country is consumed as whole seed.

The harvested acreages of soybeans, peanuts, and flax in the United States in 1960 were about 23.6, 1.5, and 3.3 million acres, respectively.

Safflower acreage has been rising steadily, and about 300 thousand acres were grown in 1960. Castorbean acreage in 1960 was about 30 thousand, and that for sesame, 10 thousand.

The same general cultural practices that produce the best yields of high-quality seed for industrial uses also produce the best seed for planting.
The control of weeds is important in the production of all the oilseeds and is especially important in the production of planting seed. The presence of seed of noxious weeds may cause otherwise good planting seed to be rejected for certification and is sufficient cause for a farmer to refuse to buy uncertified seed. Weeds may also reduce yields and cause difficulties in harvesting. Weed seeds similar in size and weight to the harvested oilseed make further cleaning difficult and expensive.

Chemical weed control has given excellent results with flax and appears promising with peanuts, safflower, sesame, and soybeans. Current recommendations about materials and rates should be obtained locally.

Special aspects, if any, of final preparation of the seedbed are discussed for specific crops in the following sections. It is assumed that basic procedures of early seedbed preparation will be followed before the final preparation.

All oilseed crops are normally self-pollinated, but enough natural cross-pollination occurs to be troublesome when different varieties are grown close together. Safe distances between different varieties vary with the crop. The isolation of fields intended for seed is treated in a later chapter.

The length of days and nights is the primary factor in the flowering and maturing of soybeans. Each variety has rather specific photoperiod requirements for flowering. Varieties are adapted to the photoperiods of rather narrow latitudinal belts running east and west. A variety grown north of its area of adaptation flowers and matures too late. One grown too far south flowers and matures too early. The most successful production is normally obtained from varieties that utilize the full growing season but mature before frost.

Soybeans do best on fertile, well-drained soils, but they are tolerant of a wide range of soil conditions. They are highly susceptible to salt damage in saline soils. Soil conditions determine their need for fertilizer and lime. Soybeans require relatively large amounts of phosphorus, potassium, and calcium and a pH of about 6.0 for maximum yields.

The soybean, a legume, can be produced successfully without nitrogen fertilizers if it is properly nodulated. Planting seed should be inoculated unless the bacteria are known to be present in the soil. Some growers inoculate the seed every year. Others do not inoculate seed if a well-nodulated crop has been grown on the field within the previous 4 or 5 years. Inoculum prepared specifically for soybeans should be used. It can be applied following chemical treatment of the seed.

Soybeans are normally planted, cultivated, and harvested with equipment used in the production of other crops. The primary consideration in preparation of the seedbed is that weeds should be destroyed immediately before planting.

Most soybeans in the United States are planted in May or June in rows 36-42 inches apart at a rate of about one viable seed per inch of row (40-60 pounds to the acre). Row spacings of less than 36 inches often give increased yields in northern areas; the amount of the increase depends on variety, location, and growing conditions.

Planters should be fitted with soybean plates to prevent serious injury to the seed.

Cultivation with a rotary hoe, drag harrow, or similar implement should begin as soon after complete emergence as necessary to control weeds. Subsequent cultivation may be done with row cultivating equipment.

All seeds on a soybean plant mature at about the same time. At the time the seed matures, leaves soon drop and the stems dry. The final maturing process is so rapid that chemicals applied early enough to hasten the harvest date reduce the yield.

Harvesting is done with a combine harvester. The moisture in the seed should be 14 percent or less, unless the seed is to be dried artificially.
Mechanical injury increases as the moisture content of the seed drops. When seed moisture goes below 10 percent, cracking of the seedcoat and injury to the embryo are more likely to occur in threshing.

Moisture content of seeds and pods may change enough during the day to necessitate adjustments in the speed of the combine cylinder. Cylinder speed should be just fast enough for proper threshing action.

Soybean seed should be combined as soon after maturity as possible to reduce chances of weather damage. Rain and high temperatures after maturity cause rapid deterioration in quality of the seed. Some varieties withstand such conditions better than others, but long periods of warm, rainy weather will damage the seed of all.

Several seedborne diseases affect soybeans, but none need be of serious concern to the seed producer. They are so widespread in the established production areas of the United States that there is little likelihood of seriously increasing their distribution on seeds.

PEANUTS grow their seeds underground. Light-textured soils that do not bake are best. Large amounts of nitrogen, potash, or organic matter are unfavorable. Peanuts grow best on soils with a pH of 6.0 to 6.5 if enough lime is available for normal development.

Peanuts should be planted in a deep, firm seedbed when the soil is thoroughly warm. Planting machines that have seed boxes using slow-moving slant plates and seed cells of the proper size should be used to reduce injury to the tender seeds and seedcoats.

Recommended planting rates range from 35 pounds an acre for small-seeded varieties planted in 36-inch rows to 96 pounds an acre for large-seeded varieties planted in 24-inch rows.

Proper disposal of debris from previous crops before planting operations and careful cultivation to prevent covering leaves, stems, or plants help reduce the incidence of stem rot and enhance yields. Some hand hoeing may be required to remove weeds near the plants.

Numerous diseases and several nematodes may attack peanuts, but relatively few are likely to be serious. They include seedling diseases; heat canker; leaf spot; southern blight; various root, peg, pod, and seed rots; black pod; and concealed damage within the seed.

Two vital factors in sections where peanuts are widely grown are an adequate (but not excessive) supply of soil moisture from the onset of heavy flowering until about 2 weeks before digging, and a generous supply of readily available calcium in the top 3 or 4 inches of the soil where the pods are developing.

Without enough calcium in the fruiting zone of the soil, the seeds may abort, or their development may be impaired at any stage until shortly before full maturity.

Drought accentuates the adverse effects of calcium deficiency in the fruiting zone on seed development. Large-seeded varieties seem to be harmed more by such a deficiency than those with smaller seeds.

Two-thirds of the peanut crop now is cured in the windrow for several days to 2 weeks or longer. The rates at which peanuts dry or cure in different positions in the windrow vary. During warm, sunny periods, seeds in pods that are exposed to direct sunlight may dry too rapidly, become hard, have impaired viability, lose their seedcoats, and have a high percentage of breakage on shelling. Seed pods at the bottom of the windrow may become overrun with molds in warm and rainy weather.

The seed peanuts of the highest quality are cured slowly in moderate to cool temperatures. Curing in carefully constructed stacks usually can be expected to give better seed peanuts than curing in windrows.

Harvesting peanuts to insure seed of high quality begins with digging operations. Proper digging, shaking, and loose windrowning to remove all soil
from the vines help provide the uniform drying conditions essential for satisfactory combining.

The peanuts should be picked carefully with the picker or combine, which should be operated at the slowest feasible rate. The plants should be fed into the machine at a uniformly moderate rate. With proper adjustments, the recently developed combination carding-cylinder-stemmer combines harvest properly cured, windrowed peanuts with little damage to the seed.

Peanut seeds are among the most delicate that the grower handles. The shelling operation is a violent one. Few seeds come through it uninjured; 2 to 15 percent of the seed may be split in shelling. Others will have ruptured seedcoats, and one or both of the cotyledons may be partly broken away from the embryonic axis. Pieces of the cotyledons of some are broken off. Those that appear to have seedcoats intact often are bruised.

Factors that reduce damage in shelling are freedom from foreign material, such as sticks, stones, and woody pieces of the peanut plant; use of a grid of the proper size for the peanuts to be shelled; operation of the sheller at a moderate speed; and shelling at a time when the moisture of the seeds is about 8 percent.

Flax grows best on fertile soil that produces good crops of small grain or corn.

Results from commercial fertilizers have been uncertain, but often fertilizer has increased yields of flax in the same places where it has benefited small grain. Heavy rates of nitrogen stimulate growth of weeds and may do more harm than good to flax.

The seedbed should be firm and well packed below the surface inch and free from large clods. Flax competes poorly with weeds. As many weed seedlings as possible should be destroyed when the seedbed is being prepared.

Flax normally is sown early in the spring in the North Central States. It may be sown from November to January as a winter crop in California, Arizona, and Texas.

About 35 pounds of seed are sown per acre in the drier sections. This may be increased to 56 pounds in more humid areas or for production under irrigation.

Losses from rust, wilt, and pasmo have been spectacular at times, but present varieties have a high degree of resistance to rust and wilt and considerable tolerance to pasmo. Two virus diseases, aster yellows in the North Central States and curly top in California and Texas, have been serious on a few occasions.

Seed of flax should be harvested as soon as it is mature. Maturity is judged by the color of the seed bolls rather than the stems. Flax is considered mature enough to harvest when 90 percent of the bolls have turned brown. In cool, wet years, some varieties may still have green stems when the seed is mature.

Late flowers often fail to set seed in the north-central region. Seeds that develop from late flowers are immature when growth ends and are lost in harvesting and cleaning. Harvest therefore should not be delayed in the hope of getting a bigger yield from late flowers.

On the other hand, flax may be induced by extra fertilizer and irrigation to form two or three consecutive sets of seed when it is grown as a fall-sown crop in the Southwest. Quality of seed normally is not lowered by the delay in harvest in the Southwest.

Nearly all flax, whether for seed or market, is harvested with a swather followed by a pickup combine as soon as the straw is dry enough to thresh. The weather between swathing and combining affects quality. Rain on the swath may cause weathering and discoloration of the seed and allow parasitic fungi, which may later reduce the viability, to grow on the seed.

Extra care needs to be given to threshing flax, especially when it is to be used for planting seed. The seedcoat is injured easily during threshing, es-
especially if the seeds are very dry. It may be advisable to reduce cylinder speed slightly, as the seeds become progressively drier during the day. Sometimes seeds of better quality may be produced if threshing or combining is discontinued during the middle of the day, when the humidity is low.

The most important cause of poor germination of flax seeds is directly associated with a mechanical injury. Farmers' seed lots have been found to contain 10 to 50 percent of cracked seed. The cracks may be microscopic scratches or major cracks that nearly sever the seed. Bruises that are hard to see also may reduce germination.

If mechanically damaged seeds germinate at all, the seedlings are usually malformed. Disease organisms may enter the seeds through the cracks, rot the seeds, and prevent germination. Chemical treatment of damaged seeds usually increases emergence of seedlings.

A yellow seedcoat is associated with natural splitting of the seedcoat over the germ end of the seed. Yellow seeds crack more easily in harvesting and threshing than brown seeds. Such injury permits disease organisms to enter and damage the seed before the seedling can emerge.

The use of a chemical seed treatment frequently is more effective with yellow- than the brown-seeded varieties of flax.

Safflower is a member of the thistle family. All cultivated varieties have spiny leaves and seed heads, but complete mechanization of production spares one the discomfort the spines can cause.

Soils suited to the production of small grain are satisfactory for safflower. Commercial fertilizers have increased yields under irrigation and in sections where rainfall is plentiful but not excessive. The use of too much nitrogen, however, may cause heavy growth of weeds.

Safflower on nonirrigated land is seeded with a grain drill at about 20 pounds of seed to the acre. If irrigation is used, it is best to plant on beds 40 inches from center to center with two rows 14 inches apart on each bed.

The highest yields of safflower are produced under irrigation or on subirrigated land following a crop of rice. Too much soil moisture, particularly after a period of stress, can cause considerable damage from root rot. Irrigation should not be excessive at any time.

Safflower may be planted as early as November as a winter-sown crop in the Southwest. Spring sowing may extend from February in California to early May in Montana.

Weed control is important. One should try hard to destroy seedlings in preparing the seedbed. The rotary hoe has been effective in reducing weed growth when the weed seedlings are small and the safflower plants are growing vigorously. Cultivation with ordinary cultivating equipment is satisfactory when the crop is grown in rows.

The most serious diseases of safflower are rust, root rot, and leaf spot. Use of disease-free seed, treatment with a volatile mercury fungicide, and crop rotation will reduce losses from rust. Root rot may be kept low by frequent light irrigation. Seed treatment and crop rotation have been effective in the control of leaf spot.

Careless handling of the combine at harvesttime may result in damaged seed, but safflower is less easily damaged than sesame and flax. Fewer concave and cylinder teeth are required than for small grain. The teeth of cylinder and concave should just mesh. Rub- or bar-type cylinders should be adjusted to about one-half inch clearance with the concaves.

Safflower threshes more slowly than barley and wheat. The speed of the combine should be adjusted so that a minimum of seeds are cracked in the threshing.

Safflower for seed should be combined promptly when the heads turn brown and the seeds are hard. Wet weather after maturity may cause ger-
mination in the head and encourage the growth of disease-producing organisms, which lower germination.

Castorbeans are grown in cultivated rows on fertile soils, such as are suitable to cotton, corn, and grain sorghum. The seedbed should be well prepared and firm.

Often it is advantageous to use more fertilizer than with the other oilseeds. The fertilizer rates and formulations that are best for corn, cotton, and grain sorghum generally are best. An additional application of nitrogen may be required if the plants show stunting or yellowing during the growing season.

Castorbeans are planted in the spring after the soil is warm and danger of frost is past. Planting rates vary with the size of seed, but are generally from 10-15 pounds per acre.

Weed control in castorbeans is similar to that in corn, grain sorghum, and other tall-growing row crops. Ordinary cultivators are used.

Castorbeans have relatively few serious diseases in the areas of commercial production. Alternaria leaf spot, bacterial leaf spot, and Alternaria capsule mold are the most serious.

Alternaria leaf spot and bacterial leaf spot may be controlled partly by the use of resistant varieties. Sufficient fertilizer, especially nitrogen, seems to reduce the loss from Alternaria leaf spot.

We know of no practical control of Alternaria capsule mold. The disease may be avoided by restricting the crop to irrigated areas of low humidity.

Row-crop planters used on other crops are suitable for planting castorbeans. They should be equipped with planter boxes that have special seed plates of proper cell size. The plates should rotate slowly to prevent seed breakage and a buildup of oily residue on the plates. Residue buildup that may occur over a period can be controlled best by adding a little coarse corncrushed or similar material in the seedbox with the castorbean seeds.

Careful planting to obtain a uniform stand promotes the uniformly shaped plants that are the most desirable for harvesting.

Castorbeans normally are harvested and threshed in a single operation with a machine specially built for the purpose. A header attachment has been designed that will convert one make of small grain combine into a castorbean harvester.

Castorbean harvesters are two- or four-row machines. Some are self-propelled. Others are mounted on tractors. All employ the same methods of harvesting and hulling the castorbeans. The capsules are knocked from the plants by rotary knockers, which strike the stems of the plants a few inches above the ground.

The capsules fall into conveyors, which carry them to scalpers to remove sticks and leaves. The capsules are then passed through a huller device to remove the hulls from the seeds. Machines that have no scalpers move the capsules directly to the huller. This device consists of two rubber-covered disks (one stationary and one rotating), two rubber-covered rotating cylinders, or a rubber-covered cylinder and rubber concave to remove gently the hulls from the fragile seeds.

Cleaning is done by blowing the hulls and immature seeds from the sound seeds. Proper adjustment between the rubber hulling surfaces is essential so that all capsules are separated and hulls removed.

With reasonable care, one can harvest and hull castorbeans that are relatively free from mechanical damage.

Once the castorbean seed is hulled, it must be handled carefully to prevent breakage or seed injury. Frequent handling and harsh treatment with conveyors cause breakage. Conveyors with clearances more than the dimensions of the seed are best suited for loose seed.

The castorbean plant is indeterminate in its growth habit and continues to set new spikes until harvest. Mature seed, fully formed green seeds, and partly developed green seeds are all present at the same time. The green
leaves must be removed and green capsules allowed to dry before harvesting. Usually frost is allowed to kill the plants, or chemical defoliants may be used. About 2 weeks are required between frost or defoliation and the time the plants are dry enough to harvest.

Immature seeds may seem to be of good planting quality. If they are pressed between the thumb and forefinger, however, the seedcoats break with a distinct popping sound, and the seeds are found to be only partly formed. These seeds are known as pops, and have little value as planting stock.

Seed that has a low weight per bushel but appears good in other respects contains a high percentage of pops and usually will not be satisfactory for planting. Recleaning the seed with a gravity table or a strong airblast, or both, should remove the lightest seed and improve the value of the seed for planting.

Castorbeans are poisonous to people and animals. Precautions must be taken to prevent mixing the seeds with food or feed crops.

Sesame does best on fertile, well-drained soils of medium texture with a neutral reaction.
Commercial fertilizers suitable for cotton are satisfactory for sesame on the same soil.

The seedbed should be mellow, warm, and moist.

Sesame seeds are small. One pound contains about 150 thousand seeds. The seedlings emerge from the soil quickly when conditions are favorable, but the small plants make slow growth at first.

It is harder to establish a good stand of sesame than some other oilseed crops. The crop requires a warm soil and warm weather. A cool period after planting may destroy the stand. A heavy rain after planting may compact the soil and prevent uniform emergence. Replanting may be necessary then.

Sesame is normally planted about 1 pound per acre in rows 36–42 inches apart. Vegetable planter boxes are used. Ordinary cultivating equipment used for corn, cotton, and grain sorghum may be used to control weeds.

The small, rather soft seeds are easily damaged in harvesting, particularly threshing.

Two types of sesame are grown. One is dehiscent—that is, the capsules open when dried after maturity, and the seeds spill out. This type requires little mechanical work to remove the seeds from the capsules.

The other type has indehiscent capsules, which are difficult to thresh.

Since little effort is required to remove the seeds from dehiscent capsules, the cylinder on the combine may be set as far as possible from the concave. Slow cylinder speeds of not over 500 revolutions a minute for 21-inch cylinders, 580 for 18-inch, or 700 for 15-inch cylinders should be used. A slower speed may be used if all the seed is removed. The threshing surface may be increased to at least double the standard area by increasing the number of cylinder bars, concave bars, or both. Tailings should be returned directly to the shakers and not the cylinder.

Undesirable seeds, such as seeds of johnsongrass, that are harvested with sesame are extremely difficult and expensive to remove. Every effort should be made to eradicate johnsongrass plants before harvest.

Considerable success has been attained in breeding indehiscent varieties that do not shatter their seeds at maturity. Although indehiscent varieties available in 1961 were not widely grown, improved varieties may be developed that will have acceptable yield and quality of seed and can be grown by complete mechanization.

Threshing indehiscent varieties is more difficult than for dehiscent varieties and requires extra care. The plants are cut and windrowed with standard machinery. Most sesame is grown under irrigation, and the windrows are placed on the rows and not in the irri-
NEW WAYS WITH SEEDS OF SUGARBEETS

DEWEY STEWART

THE OLD method of producing seeds of sugarbeets was to grow vegetative plants one season, store them over winter in pits or field trenches, and reset them in the field the second year to let them seed.

Because it took so much work, the production of the seed cost more in this country than in Europe, and for many years the American beet sugar industry relied on the European sources of seed.

Research workers of the New Mexico Agricultural Experiment Station and the Department of Agriculture demonstrated in the 1920's that excellent yields of seed could be had in the southern part of New Mexico if the sugarbeet were grown on the seasonal schedule of a winter annual—a plant from fall-sown seed that blooms and fruits the following spring.

The new method—the winter-annual method—was developed by J. C. Overpeck and his coworkers. It greatly reduced labor requirements and permitted complete mechanization of the field operations. It met the need for homegrown seed of disease-resistant varieties.

Seed was grown by the winter-annual method on 62 acres in 1932. More than 12 million pounds of sugarbeet seeds were produced on about 7 thousand acres in 1937.

The winter-annual method proved to be successful also in the Virgin River Valley of southern Utah, the Salt River Valley of Arizona, the Willamette River Valley of Oregon, and southern California.