The production of wheat for the past decade has not been a very profitable operation on many Missouri farms. During that time the average yield has been but 13.7 bushels per acre. Statistics having to do with the cost of production show that it requires approximately 13 bushels of wheat, at the average November price, to meet this expense together with that of taxes, interest on the investment and the value of plant food removed from the soil. This means that there must be a great many Missouri farmers growing wheat at an actual loss. It is of course realized by many farmers that wheat as they handle it is not a very paying
crop within itself but it is a good nurse crop for clover and grass and fits into a rotation so well that it is often grown for these reasons. Naturally the season is one of the greatest factors influencing the yield and very profitable returns are sometimes secured on land not specially suited to wheat, the element of chance being an incentive to continue wheat as one of the standard crops. There are, of course, certain sections in Missouri where wheat is a very profitable crop but on the average farm it does not pay as well as it should. A proper attention to the essentials of profitable wheat production will make this crop a paying one on practically all farms that are at all suited to its production. With the increasing population of the country there is little chance of a permanent depression in wheat prices in the future, and there is every reason why farmers who have land that is suited to wheat growing should expand its culture.

Wheat Soils.—The soils in Missouri which are best adapted to wheat are the well drained bottoms, the brown loess, the better limestone lands of South Missouri and the better timber and prairie lands of North Missouri. An ideal wheat soil is one with good drainage, with a medium to fine texture and one of good fertility. Lack of drainage is one of the greatest obstacles to winter wheat growing. It is on poorly drained lands that the alternate freezing and thawing of late winter has its greatest effect in causing “heaving”. On well drained soils heaving is of little consequence in average seasons. The direct freezing out of wheat during winters of light snowfall is also worse on wet lands. Good wheat can sometimes be grown on land that is inclined to be wet, but it is never sure. This is particularly true on the tight soils of the more level prairies and the heavy clay loam bottom lands.

The time of year when wheat is seeded, naturally affects the freezing out. While it is usually the late sown wheat that is most affected, sometimes the condition is reversed. The manner of sowing is also an important factor, wheat sown with a drill which throws marked furrows and ridges is usually much less apt to freeze out than that sown on ground left more level.

In general, seasonable seeding on ground that is well settled through early plowing and proper working, and on a soil that is either fertile naturally or that has been made so by proper manuring or fertilization will go a long way in preventing both direct winter killing and heaving.

Preparing the Seed Bed.—The matter of preparing land for wheat is a much more important factor in determining wheat
yields than is usually conceded. Late plowing, especially when the
land is dry or when a large amount of organic matter must be
turned under, is always to be avoided. The old adage that "July
plowing is best for wheat" can be safely followed. It is, of course,
not always feasible to plow in July, nor is it necessary in the ex­treme Southern part of the state where wheat is sown late, but in
Central and North Missouri it is always safest.

The proper depth of plowing for wheat depends upon the soil,
time of plowing and the material that is being turned under. The
thing to keep ever in mind is that wheat requires a loose seed
bed at the surface, but a compact or well settled one beneath, and
the preparation of the land should be such as to bring this about.
Consequently the later the plowing is done the shallower is it neces­
sary to plow if the land is to be well settled below, although shallow
early plowing is not advisable. This applies particularly when
there is a large crop of weeds or other plant growth to be turned
down or when the field has received a heavy dressing of barnyard
manure or straw. A loose sub-surface soil due either to late plow­
ing or to the turning under of a large mass of organic matter in
such a manner as to prevent its decay, is a most potent cause of
wheat freezing out, and this may happen on good wheat land in
good seasons. If plowing must be done late, or if much growth
must be turned under, it should be no deeper than the implements
available can work down to a satisfactory seed bed. In such cases
a thorough disk ing before plowing and the use of a roller and disk
harrow as well as a drag harrow will aid materially in putting
the seed bed into good condition.

Excessively deep breaking for wheat such as 8 to 10 inches is
rarely advisable even when done early; a depth of 6 or 7 inches is
proper for most soils and if the plowing must be postponed until
late, 5 inches is better. Naturally the fall rains also determine to
a large extent the best depth to plow but if one will remember the
rule to plow only so deep as it is possible to work down compactly
below this is safe in all seasons.

Where wheat follows corn the yield is usually less than where
the land is plowed and properly worked down, although much de­
pends upon the soil and season. The cost of plowing often more
than offsets the better conditions after breaking, however, and
where oats are not grown, wheat follows corn very well in the
rotation. Preparing corn land for wheat is usually merely a mat­
ter of making a good seed bed in which the weeds and grass are
well worked out. A disk or spring tooth harrow and drag harrow
are the essential implements. A thorough preparation of the seed bed for wheat pays large dividends, regardless of the crop preceding.

The Place of Wheat in the Rotation.—The proper place for wheat in a crop rotation depends upon conditions, but is usually after oats or corn. A rotation of corn, oats, wheat, clover is a very satisfactory one for North Missouri conditions, or if more corn is desired two years of corn may be followed by oats, this by wheat, then one year in clover or two years in clover and timothy. For South Missouri where oats are not so commonly grown a rotation of corn, wheat, clover or corn, wheat, clover and timothy, the latter two years, is good on soils where wheat follows corn well. Where wheat does not follow corn to advantage as in the case in some sections of south Missouri, it will be best as a rule to place oats between the corn and wheat, as in the first mentioned rotation. Another plan is to follow corn with cowpeas or soybeans and then sow wheat, following with clover or grass. A considerable number of complaints have been received at the Experiment Station regarding wheat following cowpeas, to the effect that it does not do well and this seems to be true on certain soils. No data is yet available, however, to show definitely just which soils are in this class or why there should be any difficulty in this respect, unless it is because of the loose condition in which cowpeas leave the ground.

Where wheat follows peas the customary practice is to simply disk and harrow the pea stubble in preparing the land for wheat. Plowing is usually not necessary. There is little doubt that in case of a very loose, ashy condition of the soil, which often results from the growth of the peas, the use of a roller would be of advantage.

In the lowlands of Southeast Missouri it is a very common practice to grow cowpeas and wheat on the land the same year. The wheat is threshed, the land broken and sown to cowpeas which are cut for hay and seed, the ground prepared by the use of disk and drag harrow and resown to wheat. Many inquiries come to the Experiment Station regarding this practice on the uplands of the state, but with the exception of the extreme southern counties it is not practicable except in especially favorable seasons. As a rule, in Central and North Missouri the time between wheat harvest and wheat sowing in the fall is too short and moreover the ground is usually hard and dry after the wheat is removed, making immediate preparation for peas impracticable except on rather limited areas. Peas may follow wheat for a green manure or pasture
to better advantage if it is not intended to follow the peas with wheat, since much more time is available in this case.

In certain wheat sections of Missouri, wheat is sometimes grown two years in succession, followed by clover the third year. The first crop of clover is often cut for hay and the second crop partly pastured off and then turned under with the seed. This brings the seed to the surface after the second year’s wheat and it is usually unnecessary to seed to clover.

Fertilizers for Wheat.—Wheat responds remarkably to the use of fertilizers. In general it responds most strikingly to the application of nitrogen and phosphorus. This is particularly true in Missouri where most of the uplands lack nitrogen and many of them phosphorus. The results secured on the University experiment fields in various parts of the state show this very conclusively. Potash fertilizers, on the other hand, have rarely paid. Of the three elements, phosphorus is the one which brings largest net returns. Naturally, the needs of soils vary widely, but in the case of wheat the almost universal return from steamed bone meal on

Effect of proper soil treatment on wheat on the Southwest Missouri prairies at the University Experiment Field, Barton County. No treatment, 12 bushels per acre. Cowpeas, Phosphorus (steamed bone meal) and Potassium, 21 bushels per acre.

the various outlying experiment fields of the University warrants its wide use as a wheat fertilizer on average Missouri soils.

Of course, in a circular of this sort applying to the whole state, only general recommendations can be given, but from the results secured on these various experiment fields the following recommendations are offered:

For the lands of medium fertility including most of the timber land and level prairie of Northeast Missouri, as well as a large
share of the limestone wheat lands of South Missouri, the use of 150 pounds of bonemeal, preferably the steamed bone, applied with a fertilizer drill with the wheat, is to be recommended. On the more worn areas of these soils a complete fertilizer containing 3 or 4 per cent nitrogen, 8 to 10 per cent available phosphoric acid and 3 or 4 per cent potash applied at the rate of 125 to 150 pounds per acre is good. Another fertilizer that will bring good returns on these thin lands is a complete fertilizer containing around 2 per cent nitrogen, 8 to 10 per cent available phosphoric acid and 2 to 3 per cent potash. This is a lower grade fertilizer than the one just mentioned and costs less per ton. It should be applied at the rate of from 25 to 50 pounds more per acre. On the level prairie land of Southwest Missouri the application of the complete fertilizers recommended above will be best.

The above recommendations are all made on the supposition that one wishes immediate returns and one should always understand that the use of fertilizer alone will not maintain soil productivity. They should be used only in connection with a system of crop rotation which involves the growing of clover or cowpeas and the application of manure in order to maintain the supply of organic matter in the soil. As a matter of fact where a series of years is considered, the greatest return per acre will be secured under a system of farming in which the soil will be built up in organic matter and nitrogen, applying phosphatic fertilizers only. In this case, either rock phosphate, applied at the rate of 600 to 1000 lbs. per acre before corn every 4 or 5 years, or acid phosphate applied with wheat at the rate of 200 lbs. per acre is to be recommended.

The top dressing of winter wheat with manure in late winter or early spring, applied at the rate of from 4 to 5 tons per acre with a manure spreader, is excellent practice on land of poor to average fertility. Such a plan is also very helpful in getting a grass and clover stand with wheat.

**Spring Cultural Treatments.**—Harrowing wheat in the spring is a practice which is receiving considerable attention of late years. Where the ground is compact and hard from beating rains of early spring, followed by rather dry weather, the harrowing of wheat with a drag harrow is a good practice. So far as experiments have shown, however, the harrowing of winter wheat is not always sufficiently beneficial to pay for the work, although where one harrows in clover seed at the same time the practice is usually a paying one. Where wheat is badly "heaved" the use of a heavy roller
in early spring is a good practice. All depends, however, upon the extent of the "heaving".

**Wheat Varieties.**—The Experiment Station has been testing wheat varieties for a number of years, both at Columbia and by means of co-operative experiments throughout the state. These experiments show that there is no one variety of wheat that is universally adapted to all soils, nor to the same soil for all seasons. In summarizing the results, therefore, it is the wheats which average best both in yield and quality that are to be recommended. It is very evident from the results, however, that certain varieties are very superior to others where averages are considered and there is no doubt that if farmers were careful to use only pure strains of some one or another of these better varieties the average yield of the state would be greatly increased without modifying the other methods of handling. Unfortunately the varieties which average highest in the tests at Columbia are not all available in this state and cannot always be secured.

Among the varieties which have proved worthy of recommendation for Central Missouri through the tests at Columbia are the following:

**Bearded Wheats**—Dietz, Rudy, Mediterranean, Fulcaster, Lebanon.

**Smooth Wheats**—Michigan Wonder, Jones Red Wave, Hickman, Beechwood, Hybrid, Dawson’s Golden Chaff, Early Ripe, Poole and Fultz.

In each of the above divisions the varieties are given in the order of their average yield for five years. It will be observed that Fultz, a standard Missouri variety, is outyielded by a number of other smooth wheats. The station has recommended Fultz in previous years to a considerable extent because of its availability and also because it is a fairly good general purpose wheat. Where any of these wheats can be secured pure, they can usually be depend-
ed upon to do better than most of the native wheats of a community. The station is making an effort to introduce these varieties which have shown especially good averages and it is hoped that most of them will be available within a short time. A list of the men in Missouri who are growing wheat for seed is each year compiled by the Experiment Station and may be had on application. The Station has also been conducting a considerable amount of wheat selection work and next season there will be 2 or 3 of these selected strains available for distribution. Some of these strains are very promising.

Seed Should be Recleaned.—No wheat should be sown that has not been carefully recleaned. Experiments indicate that it pays to sow the large, plump grains as compared with the small and shriveled ones and the use of a fanning mill is the only means of separating the two as wheat usually comes from the machine. Further the trash, weed seeds and broken grains which always occur to a certain extent in average wheat samples as coming from the machine must be removed if best results are to be secured.

Seeding.—The time and rate of seeding wheat depends upon many factors, such as season, soil and variety, and every farmer must determine for himself what is best under varying conditions. As to the time of seeding, this naturally varies with the section of the state, as well as with the season, so that no definite rules can be given. As a general rule wheat should be sown as early as possible after the danger from the Hessian fly is past, in case the fly has been prevalent in the neighborhood. In Central Missouri this is usually from September 15 to October 1, and in extreme North Missouri 10 days earlier; in extreme South Missouri it is from 10 to 15 days later. Naturally the season as well as the soil fertility are both important factors in determining the proper time, but the attempt should always be to seed sufficiently early that the plants may get a good fall start. In case wheat grows too rank in the fall, owing to especially favorable conditions of soil and season, fall and early winter pasturing is advisable.

The amount of seed to be recommended for seasonable seeding of most varieties is from five to six pecks per acre. For late seeding, seven pecks is better. Many men sow less than five pecks, but for average conditions five pecks is about the minimum amount to be recommended.

Insect Enemies and Fungus Diseases.—The two important insect enemies of wheat are the Hessian fly and the chinch bug. The joint worm has been somewhat prominent in recent years but has
never caused any great damage. The fungus diseases which are the most important are the smuts and the rusts. Wheat scab is a less important disease.

**Hessian Fly.**—The adult Hessian fly is a small almost black two winged insect which lays its eggs on the young wheat in the fall. These eggs produce a larva which crawls down within the leaf sheaves next the stem, feeding upon the young plant and finally passing into the pupa stage, which is ordinarily called the flaxseed stage with this insect, because at this stage it resembles a flax seed in general appearance. The insect passes the winter in this stage coming out and laying eggs upon the wheat in the spring. These eggs soon hatch and the larvae produced are responsible for the greatest damage from the Hessian fly. The spring larvae go into the pupal stage and remain in the wheat stubble, coming out as adults in September to deposit the eggs upon the young wheat plants. The principal remedy for the Hessian fly is late sowing. It is often recommended to sow a catch strip around the field early and allow the eggs to be deposited in this wheat, sowing the rest of the wheat field later. This catch strip can then be plowed under later in the season, thus destroying the insects.

**Chinch Bugs.**—All farmers who have had experience with chinch bugs know that the only satisfactory means of control is that of preventing the passing of the bugs from one field to another, by the use of tar, dust furrows, etc. Much damage is done to wheat in certain parts of the country on years which are known as chinch bug years, but satisfactory means of control have never been found. The method of combating the insects by a fungus disease which received so much advertising from the press a few years ago has never proved entirely satisfactory.

**The Loose Smut of Wheat.**—The loose smut of wheat is a fungus disease which causes considerable damage. The black heads
which one sees in the fields when the wheat is ripening are the results of this fungus. Infection takes place when the wheat heads are flowering and the disease is transmitted within the kernel. The only remedy that has been at all effective in controlling this form of smut is what is known as the hot water treatment, but this is so difficult to handle that it has never proved entirely satisfactory. The actual injury from loose smut of wheat is not very great.

**Stinking Smut of Wheat.**—Stinking smut may be controlled by treating infected wheat with a formalin solution using one pint of commercial formalin (40 per cent strength) to fifty gallons of water. Place this in a tub or barrel, pour the wheat to be treated into this solution and allow it to remain ten minutes. Stir with a paddle and skim off the smutted grains which rise to the surface. Pour this solution into another barrel or tub and spread out the grain to dry.
Another method which is generally recommended is to spread the wheat on floor and sprinkle with this solution, shoveling over until all is thoroughly moistened. Allow to remain in a heap for a couple of hours, then spread out to dry.

**Wheat Rusts.**—Wheat rust does a great deal of damage in certain seasons, particularly those in which there is considerable rain when the wheat is maturing. There is no satisfactory remedy. Something has been done in selecting rust resistant varieties of wheat, but there are no winter wheat varieties that are entirely rust resistant. The earlier the variety of wheat the less danger there is from rust, as most farmers know. The use of phosphate fertilizers to hurry the ripening are of some value in combating this disease. Lands that are thoroughly drained produce wheat somewhat less subject to rust than other lands.