IRRIGATION IN OKLAHOMA

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INTRODUCTION

Irrigation in Oklahoma is new in relation to the irrigation history of other western states. The oldest irrigation areas have been practicing irrigation for slightly over a hundred years. Irrigation in this state has been limited and research information on irrigation is therefore limited.

Today research information in Oklahoma is not yet available on the best time of application, the soil reactions to water, the length of irrigation runs, and many of the other factors involved in irrigation farming. Even from the other western states where research work has been conducted there is little conclusive evidence that can be translated to Oklahoma conditions as regards definite terms of application timing, amounts to use, and the soil changes caused by irrigation.

The factors that influence good irrigation methods are better understood, but there is still much to be learned. The fundamentals are acceptable as essential anywhere irrigation development may arise.

The W. C. Austin Irrigation Project in southwestern Oklahoma and other irrigation developments over the state have pointed out the need for more information on irrigation farming.

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BENEFITS AND LIMITATIONS OF IRRIGATION

Irrigation in the beginning must be regarded realistically. It is not a cure-all for slipshod farming methods, nor is it a plaything for inexperienced farmers; but, if properly used, becomes a tool for increased production of crops and for maintaining and increasing soil fertility. Water improperly used will decrease fertility and crop production will decline.

Irrigation can provide better control over many crop production factors. Water will not substitute for good management practices, but it will present an opportunity for stabilized production. You will find a difference in soil management between dry land and irrigated land. Soil fertility can be built to a profitable higher level under irrigation. It is possible that a dry farm too small to be classed as a profitable unit would be large enough with irrigation to be classed as an economic sized farm.

If you are willing to return to the soil the green manure crops, barnyard manure, and larger amounts of all the organic matter available, then you will be doing the first step necessary under good irrigation land management. Next, you must be willing to prepare your land suitably for irrigation and to add the soil supplements necessary for higher crop yields. The development of irrigation will increase the investment in the farm and equipment and will definitely increase the amount of labor required. If you follow the best known methods of land management, irrigation will prove beneficial and will increase crop production.

Irrigation goes far beyond the simple idea of joining soil and water. Too much or too little water and improper timing of applications do not constitute irrigation. When you apply water artificially to the soil, changes are created that can be beneficial or may be detrimental to the soil. The amount, the quality, and the time that the water is applied will make the differences of profit or loss. Unless the field and distribution systems are developed for properly controlling water applications, there will be excessive losses of valuable water. In addition, fields will not be properly irrigated to allow for maximum benefits from the water applied. Uneven penetration will create uneven growth conditions of the crops involved.

Like any other tool of production, the most efficient use of irrigation will return the greatest net gains. It is easily possible that you can spend more money on an irrigation system than your land will return through increases over production without supplemental water.

If you develop an irrigation system you must plan on maximum economic returns to make it pay your increased costs of farming.

Under this line of reasoning, we get into soil supplement problems, crop rotations, insect and rodent control, and better methods of applying water.

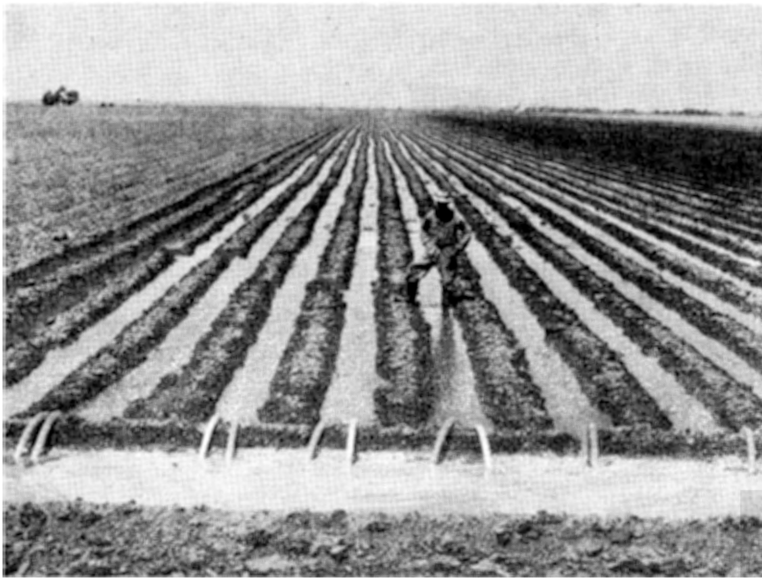


Figure 1.—Pre-irrigation of land in seed bed preparation. One-inch plastic syphons distribute water from head ditch to the furrow.

LAND MANAGEMENT UNDER IRRIGATION

It is possible to increase crop yields to the extent that limiting factors of production are corrected. Crops will respond to a balanced supply of plant food and water. Nevertheless, factors beyond our control eventually limit crop yields.

Plants do better with a balanced diet, the same as livestock. A soil low in organic material is not a fertile soil. Minerals are also essential to soils of high organic content to insure balanced diet for crops that may be grown. Efficient high production will come only from sound use of a well-balanced, soil-building program. Maintaining or increasing soil fertility under irrigation is not difficult.

Irrigation is developed because water is the limiting factor of crop production. The first plant food that is likely to become limiting to crop production under irrigation is nitrogen. Nitrogen is an essential part of all organic materials and is a regulating factor of plant growth. Nitrogen can be supplied to soils under irrigation through crop residues, green manure crops, and barnyard manures. If higher crop yields can be justified through the use of supplemental nitrogen, then the commercial forms may be used. Nitrogen is an element that can be over-used, especially where water is limited. A crop forced to mature before its full growing season will not produce maximum yields of high quality produce.

The next element that generally becomes a limiting factor in production under irrigation is phosphorus. And, although the soils may not lack organic matter, this element will become a limiting factor in a relatively short time. Phosphorus has more to do with fruiting and seeding ability of crops and will also have an effect upon the plant's general thriftiness and growth.

Another basic element that has to do primarily with crop production is potassium. In most areas potassium has not been a limiting factor of production.

Crop rotations are valuable and in most cases necessary for the continued high level of fertility necessary for maximum crop production. A good crop rotation will include several kinds of crops; each crop will differ in the amounts of plant food it requires and the water it can use efficiently. Legume crops will supply nitrogen and green manure if turned under for that purpose. Grass and legume combinations make ideal pastures and fit well in an irrigated crop rotation system. Cash or row crops do better following grass and legume crops. You will be directly responsible for what crops you grow each year and will be regulated in your choice largely by the profit you believe can be realized from producing these crops. But regardless of the economics, aside from making sure that you have a profit, you must recognize the importance of maintaining or increasing your production ability by keeping the soils in a high state of fertility and in good physical condition. As long as soils remain this way the problem of erosion is negligible.

We do not know where the maximum limit of production will fall on any of the crops that we grow in Oklahoma today. Through the use of irrigation, which will allow us a greater control of other production factors, we know that crop yields can be materially increased.

Each year production records are broken when more favorable growing conditions are provided. Any single fertility factor may limit or obscure results from other favorable growing conditions.

Within the realm of practicality, under irrigation you must plan on maximum production. It is the extra bushels, pounds, and tons of crops over and above expenses that is necessary for successful farming.

The information above presents some of the situations that you should recognize before you go into the actual development of an irrigation system. In fact, it will pay you to study your individual production program from every conceivable angle before you plan irrigation farming.

FACTORS TO RECOGNIZE IN IRRIGATION DEVELOPMENT

If you are contemplating irrigation you must recognize the factors mentioned to make successful use of supplemental water. If you are already irrigating and have not solved your production problems, then some of the information presented later will be helpful to you. Each farm layout for irrigation will be an individual unit designed for particular crops, soils, and operators preference. No two farms will be set up identically and give equal results.

The first problem in setting up an irrigation system has to do with water quality and availability. Figure out how much water you will need to produce the crops that you want to grow. Find out if the water mineral content is suitable for crop production and whether or not it will present a problem in years ahead from an alkali standpoint. Have the water analyzed for salt concentration at the A. & M. College Agricultural Chemistry Department. Do not develop a source that the college does not recommend for irrigation.

The amount of water that can be developed from a small stream or from an underground source quite often is a limiting factor in the number of acres that can be irrigated successfully. Crops you grow and the length of the growing season for which you have to supply supplemental water will determine the amount of water necessary. If you are familiar with the rainfall cycle, it will not be difficult for you to determine what seasons of the year water will be needed for irrigating.

An average irrigation on an average crop will be from 3 to 6 inches of water, which will make it necessary to have that amount of water in storage for each acre of land that you intend to irrigate. Because there is no way of applying water to land without water losses, the amount of water lost must also be figured into the total supply.

Estimating that 4 inches of water will provide an adequate irrigation for most crops under most conditions, and assuming that irrigations will be spaced 10 to 14 days apart, you can determine how much water will be needed to provide adequate water for the crops involved.

The efficiency of your irrigation layout will determine the water losses for which you must also provide. Water is lost through evaporation, ditch seepage, and deep percolation in the field. It is not easy to measure accurately these losses, but with a well designed system for surface methods of irrigating, figure your efficiency at 70%, then add to your storage supply an additional 30% to offset the water losses from your distribution system. Well designed sprinkler irrigation systems in moderate climatic zones will give you 70% efficiency, depending upon weather conditions at the time of water application.

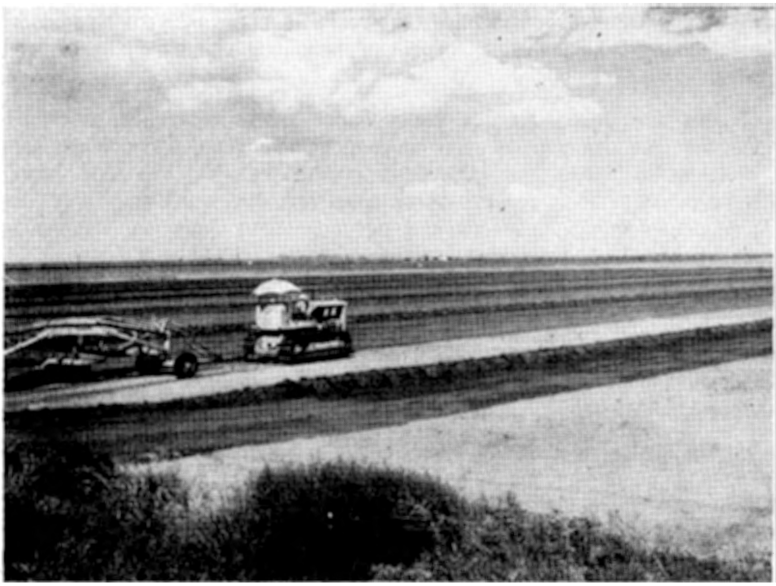


Figure 2.—A road grader, adapted for cycle casting soil, preparing borders for irrigation.

As an example, let us assume that you have five acres of land that you wish to irrigate. The crop you intend to irrigate is classified as a medium water user, and will require 3 inches of water every fourteen days. And let us also assume that you will need to apply three irrigations during the season of light rainfall. Three applications of water at the rate of 3 inches would be 9 inches of water over the entire 5 acres. Or, converted to acre-feet, would be 3¾ acre-feet of water that you must have available for the season. Then add at least 30% more for water losses, which would put your total storage at approximately an acre-foot of water for your land that you want to irrigate.

These figures would likely not fit any particular condition, but will give you an idea of how to estimate the amount of water necessary for an irrigation development.

There are certain costs connected with water development regardless of the amount of water available. Be sure there will be an adequate supply of water to justify the development costs.

Obtain the best estimates that you can on what the development costs will be. These may include wells, stream diversion structures, canals, control structures, or pumps for distributing the water to the points on the farm you intend to irrigate.

If you drill a well for irrigation water, get information on the ground water supply in your area from the United States Geological

Survey at Norman, Oklahoma. Get reliable estimates on the costs of drilling, casings, and well pumps for handling the amount of water available.

If you are going to get your water from a stream, determine whether or not the supply will be large enough at the critical times you will need water for irrigation. Streams that do not have a steady flow may need reservoirs constructed for holding water until it is needed. Obtain development permits from Oklahoma Resources and Planning Board for all well and stream developments.

All of these principles deal with developing a water supply, but are by no means the end of your costs of irrigation. Equally as important as these factors in irrigation are the situations you will face in laying out your farm distribution system and preparing your fields for irrigation.

If you anticipate using overhead sprinkling, much of the land preparation costs can be eliminated; however, the costs of installation and operating overhead systems may be considerably higher than good land preparation for surface methods of irrigation. Where the costs of preparing land for surface irrigation are too high, sprinkler irrigation should be considered.

DEVELOPMENT OF SURFACE IRRIGATION

The first step for good land preparation is leveling the surface irregularities so that the water can be distributed evenly over the field. To distribute water evenly you should have a level field or one with an unbroken slope. Generally, you will not want to run water down a slope that has more fall than two feet in one hundred feet of run. It is possible to run irrigation water down a much greater slope than this without erosion if the water is properly distributed under small heads that do not erode the soils. However, heavy torrential rains can not be controlled, and they may cause serious erosion on lands much steeper than two per cent where row crops are planted.

If you are attempting to flood lands that have a two per cent slope or higher, you will need good control of water from your ditches, and will also need relatively short runs to keep the water from channelling and cutting away the soil.

Slope is perhaps the largest single factor in determining the head of water you will use. The soil structure and organic content will determine the permeability or the soil's ability to take moisture rapidly. A sandy soil will absorb water more freely than a heavy clay type. And since you must recognize the depth to which you will apply water for a good irrigation, both the slope and the permeability will determine the size head you will use.

Since you will be growing different crops on the soil, and since different crops have different water requirements, you will need shallow or deep water penetrations at different times. It is necessary that you keep your irrigation system flexible enough to meet the needs of various crops that will be grown. The soil's permeability can be changed by management practices and cultural methods of farming. The higher you can build the organic content of the soil, the more you will change favorably its ability to absorb water and its ability to hold water for a definite time. Compare organic content of the soil with a sponge, and you will readily see the advantage for building the organic content in your soils.

The water holding capacity of the soil largely determines the frequency of irrigations. The greater the time lapse between irrigations, the smaller becomes the costs of water application and the greater the efficiency of water used on any one crop.

Perhaps there is no more important part of good irrigation than that played by ditches in your distribution system. The shape of the ditch, the size of the ditch, and the grade will determine the ditch's water carrying capacity. An agricultural engineer can help you design your ditches for the capacity desired.

Keep your distribution ditches as nearly level as possible to avoid excessive cost for control structures. The type ditch you construct will depend upon whether it is a permanent or a temporary ditch. Some farmers prefer permanent ditches with permanent con-

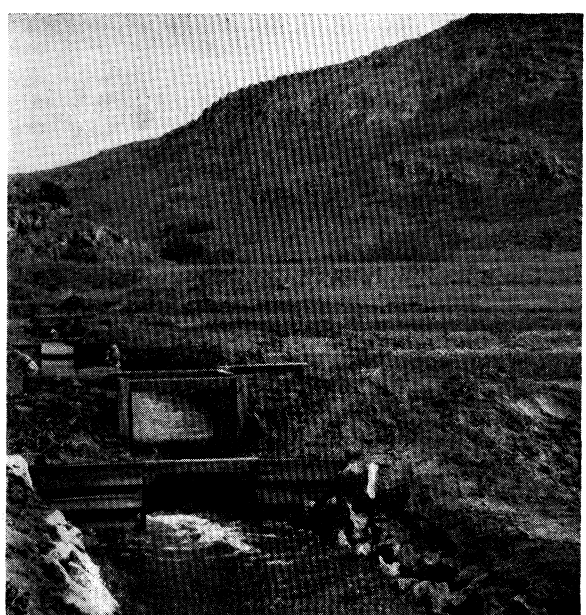


Figure 3.—Semi-permanent drop check structures are used to control the flow of water down a steep slope.

trol structures. Some farmers prefer temporary ditches with temporary structures, the principal differences being the difference in cost of maintaining and cleaning permanent versus temporary ditches. This difference should not seriously affect your decision; however, since it is efficiency of distribution that you should design into your system, costs of maintenance should be included for estimating economic efficiency.

Where ditches are constructed through extremely porous soils it might be practical and economical to line the ditches with concrete to prevent excessive water losses through percolation.

Ditch structures should be regarded from a control standpoint. The types of structures that you may design or install include the check for leveling the water within a given length of the ditch to permit distribution of the water onto the field. Permanent checks prefabricated from cement can be installed. Concrete structures can be run after forms have been built into your ditch.

There are permanent type structures designed which can be made of wood. These are entirely satisfactory, but will not have the life of a concrete structure. If your ditch has considerable fall, drop checks may be installed to prevent erosion and cutting of the ditch banks.

To do an accurate job and to know how much water you are applying there should be measuring devices put into your head ditches. Many types of measuring gates and weirs are available on the market. The parshall flume can be installed, and is an accurate measuring device for irrigation water in canals. You will need turnout gates and diversion boxes to turn the stream of water onto different parts of the field or from one ditch to another.

There are portable irrigation structures that are in common use to help distribute the water from the head ditch onto the field. Plastic and metal siphons are being used to distribute the water evenly in rows or over a given length of the field. Siphons are built in different sizes to permit varying heads of water to be taken out at given points.

Another popular portable distribution device is the spile, a straight tube made of metal, plastic, or wood, set in the ditch bank on a level grade, which permits even distribution of water at the turnout points of the spiles.

Where auxiliary or secondary ditches are used, some farmers prefer to cut the banks of the secondary ditch at as many points as is necessary to allow even distribution over the field. Secondary ditches are built on grade to correct the angle of fall in the head ditch. Where ditch banks are cut, quite often erosion takes place at several points, making it difficult to maintain an even distribution of water. Cellophane, burlap, or a piece of grass sod can be used to keep the soil from cutting at the turnout point of the

Figure 4.—Revolving sprinklers on a portable pipe line.

secondary ditch. This method, while less expensive, is naturally less efficient and should not be used except in emergencies or in the developing period, since siphons or spiles will give more efficient use of water available and cut down labor costs.

After your field has been leveled and after the ditches are designed with the necessary control structures, you will have to give consideration to the methods of preparing the field for taking irrigation water.

Dikes are quite often used for irrigating close-growing crops, such as wheat, pastures, and alfalfa. Dikes are put up around different sized parcels of land to keep water within the confines of the area to be irrigated. Borders are usually constructed with dikes on two sides to hold the water on a given piece of land. Borders usually run from 500 feet to one-half mile in length.

Borders may be constructed with a slope from a quarter to a half mile in length. Dikes on each side of the border are from thirty to one hundred and fifty feet apart. The border must be level from side to side if even distribution is accomplished. Water is turned from a ditch that runs along the ends of the border at one or two points between the dikes. Graded borders should have less than $\frac{1}{2}$ of 1 per cent slope to obtain maximum efficiency.

Level borders are leveled from end to end as well as from side to side and will permit even distribution of water turned into them. Border irrigation provides one of the fastest methods of applying water with the smallest cost for application. Level borders are effective in conserving rainfall. This, however, is also a major disadvantage of level borders because they afford generally very poor surface drainage. In seasons of high rainfall, crops may be drowned out on level borders or on land that does not have sufficient slope to permit the orderly and safe run-off of excess water.

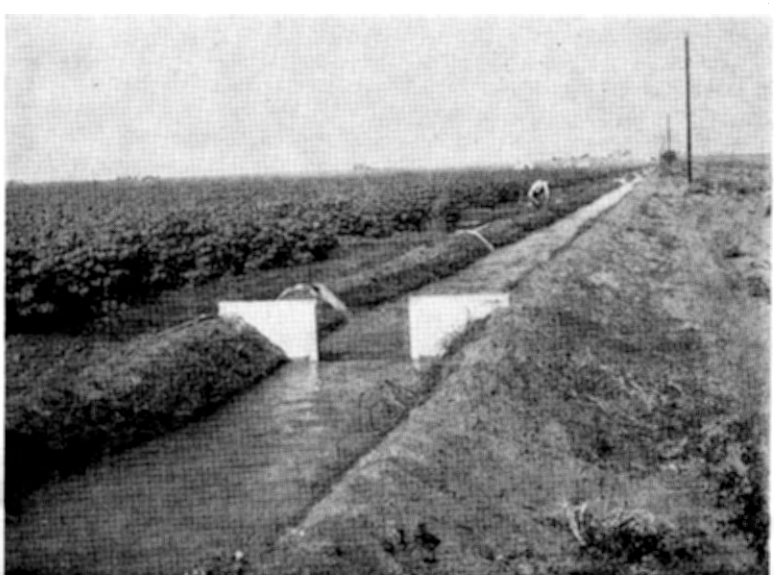
Corrugations have been used for many years, in some areas of the West on ground having a slope of 2 per cent or higher, to irrigate close-growing crops. Corrugations are made with special equipment. They are uniform in depth, width, and spacing, and they allow even carrying capacity in each of the corrugations, which provides even distribution of water over a given field. The length of the run and the spacing between corrugations are determined by the rate the soil will absorb the water.

Contour ditches are used as another method of surface irrigation. These ditches are installed near the contour at a very low grade to permit the even flow of water over the lower side of the ditch bank where it sheets out evenly over the land. These ditches are also spaced according to slope and soil's permeability.

Border ditches sometimes are used in the place of border dikes, and water is checked in these ditches to flow out over the border. This is similar to the contour ditch, the only difference being in the way they are laid out. Contour ditches will generally be more desirable than border ditches.

Irrigation of row crops will require furrows between the rows to carry evenly the water used in irrigation unless the row crops are

Figure 5.—Permanent check structures and turn-out boxes for diverting water from ditch to field.



planted within permanent borders. The furrow in the row crop irrigated will be sized and spaced in relation to the water needs of the plant, the absorption ability of the soil, and the spacing of the rows.

We have discussed various methods of surface irrigation and it would be impossible to say that one is superior to others in any general sense. All of them are being used successfully in various circumstances.

It is important to remember that the preparation of the land is equally as important as the building of your ditches. There will not be good irrigation from a poor ditch system and there will not be good irrigation on poorly prepared land. Spend enough time, thought, and effort on each of them to attain high efficiency in irrigation.

SPRINKLER IRRIGATION

Sprinkler irrigation is a specialized field and different in its installation and operation from surface methods. It is not possible to compare generally the surface method of irrigation with overhead sprinkling.

There are cases where sprinkler irrigation may be more practical than surface irrigation. Factors which will indicate the differences are the costs of installation, costs of operation and maintenance between surface methods and overhead methods of irrigating. Each

Figure 6.—A turn-out box used to divert water from ditch to field.

farm or individual development project must be analyzed in view of its peculiar problems and the desires of the owner.

There is reliable information available on sprinkler irrigation costs and development. Most dealers of sprinkler equipment will estimate costs with you.

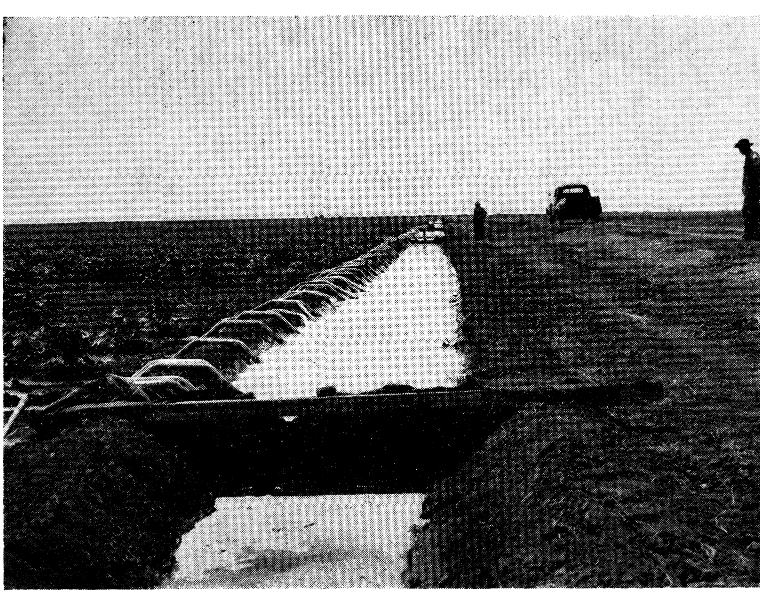
You will find it costly to deal in generalities with irrigation. It is wrong to believe that sprinkler irrigation is better than surface methods or, conversely, that surface irrigation methods are better than sprinkler irrigation. Both are good if properly used. It is extremely important that you study your own conditions before installing irrigation of any kind.

HOW TO MAKE THE MOST FROM IRRIGATION

There are certain factors that will help you determine which method or methods of irrigation you will use and combine for irrigating your fields. Bear in mind at all times that it is the crops that you intend to grow that you are watering and that the hit and miss method of watering will net you nothing. Different crops have different water requirements for maximum production. Plan a crop rotation to protect the soil fertility of your farm, utilize the water supply efficiently, and conform to your individual preference for crops.

Some crops respond better to irrigation than others and it is possible to select the crops with good response in all of your irriga-

Figure 7.—Temporary canvas check and two-inch metal syphons used together for distribution of water to field.



tion farming. Unless a crop will respond to irrigation it should not be used in an irrigation rotation.

The amount of water applied should be controlled by the crops' needs. The depth in the soil that crops can reclaim water and the amount of moisture that is already in the soil reservoir should limit any single water application. Deep rooted crops such as alfalfa and cotton may make efficient use of water to a depth of four to five feet. Shallow rooted crops may only take water efficiently from the top foot of soil. Logically, then, you will try to water for the crops' need, limited only by the soil's ability to take the water at the depth water can be reclaimed by the crop.

Irrigation methods will change some on your farm each year. Some systems will be well designed to begin with, but with time and experience can be improved. Well designed systems may deteriorate in effectiveness each year due to improper use of irrigation.

PRODUCTION HAZARDS UNDER IRRIGATION

When irrigation is developed there will always arise some drainage problems. One reason that land preparation is necessary is the matter of surface drainage of water, which must be considered a factor of irrigation.

Subdrainage may become a problem in certain types of land, depending on how much and at what time water is applied to the soil, and whether or not the water or soil has a high or low sodium content. Soils that are frequently saturated with water will cause a migration of soluble minerals up and down in the root zone of the soil. Alkali will develop under some conditions of water logging. This, then, is another problem that should be considered when you start your irrigation planning.

Other special questions connected with irrigation are primarily concerned with changes that take place in the soil, competition between crops and weeds for available moisture, insect and rodent control.

Irrigation, too, presupposes the additional land operations necessary in carrying out a more intensified farming program. In fact, the additional use of water without the consideration of the associated conditions has always been one of the greatest hazards in irrigation farming.

Rodents such as the pocket gopher are particularly troublesome to good distribution of water. Insects that are introduced with new crops also present additional hazards. Annual and perennial weeds become a greater problem under irrigation than under dry land farming and the additional costs of controlling these pests take a heavy toll of the production dollar. However, to balance the ledger against these factors are some of the more obvious benefits of irrigation.

The entire growing season can be utilized for crop production where water is in adequate supply. Larger yields can be produced if good management practices are followed. A greater diversification in the cropping and livestock program can be realized. With adequate water, the farm home yard can be improved. A wider variety of plants can be introduced for landscaping. Higher quality vegetables can be grown for family consumption and local markets. Farming can be reduced from a large acreage business to a smaller diversified program. This will increase total production, directly supporting more people on the land.

These are some of the benefits that can be derived from sound irrigation and associated practices. In order, however, to accomplish the benefits desired, you will find it profitable if all your operations are planned well in advance.

Get sound engineering advice and assistance for the development of the technical phases of irrigation. Trial and error have been successful, but often these methods are far more expensive and less efficient.

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